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Is body appreciation a mechanism of depression and anxiety? An investigation of the 3-Dimensional Body Appreciation Mapping (3D-BAM) intervention

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ABSTRACT

Body appreciation is related to numerous mental health outcomes, including depression and anxiety. This pilot study investigated the effects of an intervention, *3-Dimensional Body Appreciation Mapping* (*3D-BAM*), developed to improve body image, depression, and anxiety by using 3D scanning technology to train participants to focus on ways they appreciate their bodies. Eighty-nine emerging adult women (M_{age} = 20.64) participated in the intervention and completed body image and mental health measures at baseline, pre/post-intervention, and 3-month follow up. For the intervention, participants digitally "painted" body parts of their personalized 3D avatar that they believed lived up to the cultural image of women, and that they appreciated for their appearance, utility, and role in interpersonal relationships. Following the intervention, participants reported increased body appreciation over time. Depression and anxiety decreased, but the reduction cannot be attributed to the intervention. However, body appreciation had a significant negative effect on depression and anxiety. These preliminary findings illustrate how utilizing 3D scanning technology to focus on body appreciation can improve body image among emerging adult women and reduce pathology.

1. Introduction

Positive body image is defined as an "overarching love and respect for the body" (Wood-Barcalow, Tylka, & Augustus-Horvath, 2010, p. 112) characterized by an individual's ability to maintain a mindful connection with his/her body including, but not limited to, the internalization of incoming positive information and the acceptance, admiration, and promotion of his/her body's assets even if these assets are inconsistent with external media representation. Body appreciation is comprised of the opinions individuals hold about their body, acceptance and respect of their body despite imperfections, engaging in healthy behaviors, and the ability to shield their body image from the sociocultural portrayal of the thin-ideal (Avalos, Tylka, & Wood-Barcalow, 2005). Body appreciation is related to depression and anxiety (Ramseyer Winter, Gillen, Cahill, Jones, & Ward, 2017), making this an important area of scholarship for women, who experience both mental illnesses at higher rates than men (Jones & Griffiths, 2015). The current study examines the effects of an intervention on body appreciation, depression, and anxiety among a sample of women.

1.1. Positive body image interventions

Several interventions that aim to improve positive body image have been developed and tested by researchers. Alleva, Martijn, Van Breukelen, Jansen, and Karos (2015) used a randomized controlled trial to test *Expand Your Horizon*, an intervention that trains women to focus on their body's functionality using structured writing. The authors found post-intervention, participants had significantly higher

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appearance satisfaction, functionality satisfaction, and body appreciation when compared to those in the control group. Another study also found that interventions focusing on body function successfully improved women's positive body image (Alleva, Martijn, Jansen, & Nederkoorn, 2014).

In addition to interventions that specifically focus on body function to improve positive body image, scholars have explored other mechanisms for improving positive body image. Mahlo and Tiggemann (2016) found that participation in yoga participants have higher positive body image than non-yoga participants. In a study testing the efficacy of an online health promotion program designed to improve positive body image, *BodiMojo, r*esearchers found that adolescent female participants who participated in the intervention group had significantly higher appearance satisfaction than those in the control group. Devaraj and Lewis (2010) developed a cognitive behavioral group intervention, *Positive Bodies*, which was associated with improvements in body satisfaction among female participants. The success of these diverse interventions at improving positive body image suggests that interventions delivered in many formats can improve women's positive body image.

1.2. The current study

The purpose of this current study was to advance the evidence base for positive body image interventions among emerging adult women by conducting a pilot study of the *3-Dimensional Body Appreciation Mapping* (*3D-BAM*) intervention. *3D-BAM* utilizes a personalized 3D avatar, acquired through body imaging software, to assess the impact of manipulating a 3D image of oneself. We hypothesized that participants who received *3D-BAM* would report significant improvements in body appreciation (hypothesis 1), as well as depression (hypothesis 2) and anxiety (hypothesis 3).

2. Material and methods

2.1. Participants

The final sample sizes were 158 at the baseline survey (T1), 105 immediately following the 3D scan (T2, attrition rate = 34%), 99 immediately after the intervention (T3, attrition rate = 6%), and 89 three months after the intervention (T4, attrition rate = 10%). There were no significant differences between those who completed T1 and T2 and those who only completed T1 on the following variables: BMI, body appreciation, depression, and anxiety. As such, we attribute the high attrition between T1 and T2 to the limited availability of the 3D scanning lab as dates and times did not work for all participants. The majority of the T4 sample was White (89.0%; n = 79) and heterosexual (94.4%; n = 84). The mean age was 20.64 (SD = 1.73, range = 18–25) and the mean BMI was 23.65 (SD = 3.94, range = 16.64–36.90) at T1, which is what the Centers for Disease Control and Prevention (CDC), the United States' primary government health agency, refer to as a "normal/healthy weight" (n.d.). See Table 1 for a full list of participant characteristics, study indicators and correlations.

Table 1
Participant characteristics and study indicators.

Characteristic/study indicator	*N*	%	
Race (T1)			
White/Caucasian	79	88.8	
Black/African American	8	9.0	
Multiracial	2	2.2	
Sexual orientation (T1)			
Heterosexual	84	94.4	
Bisexual	2	2.2	
Pansexual	2	2.2	
Asexual	1	1.1	
Characteristic/study indicator	*M*	*SD*	*Correlations*
Age (T1)	20.64	1.73	
BMI (T1)	23.65	3.94	
BMI (T4)	23.77	4.23	0.96
Body appreciation score (T1)	3.52	0.62	
Body appreciation score (T4)	3.78	0.60	0.75
Depression score (T1)	5.27	5.37	
Depression score (T4)	4.83	5.46	0.70
Anxiety score (T1)	13.03	4.86	
Anxiety score (T4)	11.79	4.71	0.48

Note: Pansexuality is defined as "a sexual orientation that encompasses an attraction towards all" (Gonel, 2013, p. 36).
Note: The correlations are for the correlation between T1 and T4 for each characteristic.

2.2. Procedure

We obtained ethical approval from the University of Missouri Institutional Review Board (IRB Project Number: 2006526). Participant requirements were as follows: 18–25 years old, identify as a woman, have lived in the US for the previous 10 years, not currently pregnant, and not have an eating disorder diagnosis. We recruited participants through fliers posted around campus, email, and presentations to classes on campus. When participants emailed us to indicate their interest in the study, a link to the baseline survey (Time 1) was sent to them. At the beginning of this survey, participants answered a series of questions to determine if they qualified for the study. Those who qualified were taken to an informed consent form. Once consent was obtained online, participants were automatically directed to the full survey. This baseline survey took approximately 20 min to complete and included questions about body image and mental health as well as various physical, sexual, and relationship health measures.

After completing the baseline survey, we emailed participants to arrange a time for them to be scanned to create a personalized 3D avatar. Once an appointment was set, we provided the participants with information on what to wear (form fitting clothing such as leggings and a tank top). Participants came to their scanning appointment and changed clothes, if necessary. They were then scanned. We used a TC^2 scanner, which includes 14 digital cameras that create point cloud data. The scanning process itself took 3–5 s and the participant was in a private booth with a curtain during the scan. Following the scan, participants were asked to select the skin tone that most closely matched their own from a continuum of 10 colors from very light to very dark (Landor & Zeiders, 2018; Landor & Barr, 2018). After selecting their skin tone, participants completed a 3–5 min survey on a tablet (Time 2), in which we collected data relating to body image, self-objectification (i.e., viewing one's own body as an object meant for others' consumption; Fredrickson & Roberts, 1997), and measures about their experience with the scanning process.

After a research assistant processed their scan from point cloud data to a personalized 3D avatar, participants were scheduled for their intervention. The interventions were conducted by the first author and a research assistant. Following the 20-min intervention (see details below), participants completed a 3–5 min survey (Time 3) on body image and self-objectification. Finally, we emailed each participant 3 months after they completed their intervention and asked them to complete a follow-up survey (Time 4) to determine if changes in body image were maintained over time. With the exception of not including demographic variables, the T4 survey was the same as the T1 survey. Finally, after all interventions were complete, we conducted qualitative interviews (Time 5) with 19 study participants to gain an understanding of how they viewed the intervention process.

2.2.1. Intervention

The 3-Dimensional Body Appreciation Mapping (3D-BAM) intervention utilized 3D scanning technology. In the intervention, participants digitally "painted" body parts of their personalized 3D avatar on a

computer following a series of seven prompts from the researcher. The intervention is evidence-informed. Many stand-alone interventions have utilized cognitive behavioral therapy and others have focused on body function and psychoeducation techniques, among others (Alleva, Sheeran, Webb, Martijn, & Miles, 2015). However, in a recent meta-analysis, researchers found that existing stand-alone interventions that utilize *one* of these techniques make a small, but statistically significant improvement in body image (Alleva, Jansen, & Karos, 2015). For example, in a study of 18–25 year old college women who experience body dissatisfaction, researchers found that participants who were exposed to a short video (<30 min) prior to viewing media were significantly less likely to experience weight concerns, make disparaging comments about their bodies, and experience body image disturbance when viewing the media, when compared to the control group (Posavac, Posavac, & Weigel, 2001). Another study of college women aged 18–30 found that a brief (<30 min) conditioning intervention significantly increased body satisfaction in the short-term and were maintained at the 4 and 12-week follow ups (Aspen et al., 2015). These are just a couple samples of studies that have improved body image using brief one-time interventions. We combined multiple techniques (e.g., exposure exercise, cognitive behavioral) in the 3D-BAM intervention prompts. The selected intervention techniques have been identified by scholars as being effective for improving women's body image (Alleva et al., 2015, 2015; Aspen et al., 2015; Posavac et al., 2001)

Each prompt utilized a different color, resulting in colorful avatars at the end of the intervention (see Fig. 1). For example, one prompt was "Please paint the parts of your body that you appreciate for their utility, the things they do for you." All of the prompts focused on reasons to appreciate one's body. After completing all seven prompts, the researcher went back through each prompt and reminded the participant what she had painted for each one. This gave participants the opportunity to correct our interpretation of what she painted and paint additional body parts if she wanted to. The intervention lasted approximately 20 min.

2.3. Measures

2.3.1. Body appreciation

We measured body appreciation with the Body Appreciation Scale-2 (BAS-2; Tylka & Wood-Barcalow, 2015). The BAS-2 includes 10 items with a 5-point response scale from (1) *never* to (5) *always*. Sample items include, "I take a positive attitude towards my body" and "I am comfortable in my body." Reliability was estimated to be high at T1 (Cronbach's $\alpha = 0.90$) and T4 (Cronbach's $\alpha = 0.92$).

2.3.2. Depression

We measured depression with the Patient Health Questionnaire (PHQ-9; Kroenke, Spitzer, & Williams, 2001). The PHQ-9 has 9 items with a 4-point response scale from (0) *not at all* to (3) *nearly every day*. The following is a sample item: "Over the last 2 weeks, how often have you been bothered by the following… Trouble falling or staying asleep, or sleeping too much." Reliability was estimated to be high at T1 (Cronbach's $\alpha = 0.89$) and T4 (Cronbach's $\alpha = 0.91$).

2.3.3. Anxiety

We used the Generalized Anxiety Disorder-7 scale (GAD-7; Spitzer, Kroenke, Williams, & Löwe, 2006) to measure anxiety. The GAD-7 includes 7 items with a 4-point response scale from (0) *not at all* to (3) *nearly every day*. The following is a sample item: "Over the last 2 weeks, how often have you been bothered by the following problems… Feeling nervous, anxious or on edge." Reliability was estimated to be high at T1 (Cronbach's $\alpha = 0.90$) and T4 (Cronbach's $\alpha = 0.92$).

2.3.4. Body size

Body size was measured by computing body mass index (BMI) from self-reported height and weight information using the standard formula of weight/height^2 (kg/m^2). We included BMI as a possible explanatory variable in our analyses.

2.4. Analytic strategy

For each of our hypotheses, we conducted paired t-tests to assess whether or not there were significant changes in response scores before and after the women received the 3D-BAM intervention. For hypothesis 1, the response variable was the change in BAS-2 score between T1 and T4 for each individual. Similarly, the change in PHQ-9 score and GAD-7 score between T1 and T4 were the response variables for hypotheses 2 and 3, respectively. We hypothesize that as a result of the 3D-BAM intervention, emerging adult women would report significant improvements in body appreciation scores (increases in BAS-2), depression (decreases in PHQ-9), and anxiety (decreases in GAD-7). We

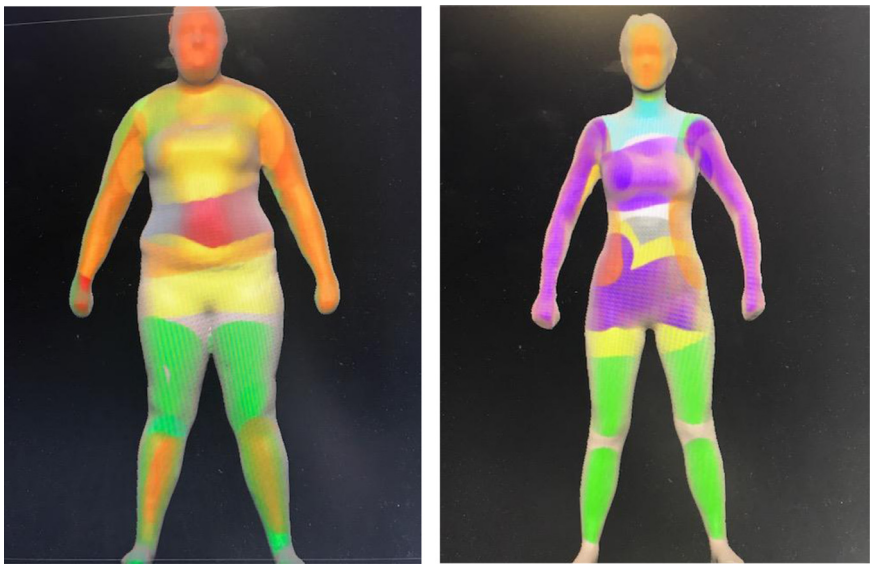

Fig. 1. Examples of avatars after the intervention
Note: Participants used a different color for each prompt during the intervention. We have not included a key for the colors, as they are layered on top of one another (i.e., participants could color body parts more than once), making a key misleading.

evaluated the significance of these three tests using a familywise error rate of $\alpha = 0.05$, which resulted in a conservative individual type 1 error rate of $\alpha = 0.017$ following the Bonferroni approach to multiple comparisons.

Secondary analyses consisted of investigating the correlations within and between the three metrics, BAS-2, PHQ-9, and GAD-7, as well as BMI. First, we conducted pairwise comparisons of the change between T1 and T4 for each of the four metrics (BAS-2, PHQ-9, GAD-7, and BMI). Then, we assessed whether there was a significant relationship between the change in the response for each metric and the value reported at T1, controlling for each of the other three metrics at T1. Lastly, we assessed the relationship between the change in each metric with BMI at T1, again, controlling for the other three metrics at T1. We report the p-values for each of these exploratory pairwise and partial correlations.

3. Results

The average change in BAS-2 score between T1 and T4 was 0.261. The average changes in GAD-7 and PHQ-9 were −1.129 and −0.353, respectively. The results of the analyses revealed a significant increase in body appreciation score ($t = 5.72$, $p < 0.001$) supporting hypothesis 1. We detected a significant decrease in anxiety ($t = -2.16$, $p = 0.017$) in support of hypothesis 3, while the decrease in depression score in support of hypothesis 2 was not significant ($t = -0.797$, $p = 0.214$).

For our additional exploratory analysis, we computed the six pairwise correlations between the change in BAS-2, PHQ-9, GAD-7, and BMI (Table 2). The change in BAS-2 was negatively correlated with both change in PHQ-9 and BMI ($p = 0.027$ and $p = 0.006$, respectively), and change in PHQ-9 was positively correlated with change in GAD-7 ($p < 0.001$). This indicated that increases in body appreciation may improve depression and individuals that experience a decrease in anxiety may also experience a decrease in depression. Notably, the negative correlation between the change in BAS-2 and GAD-9 was not significant, indicating that increases in body appreciation score did not relate to significant decreases in anxiety in this sample.

The increase in BAS-2 score from T1 to T4 was significantly greater for females with lower BAS-2 scores at T1 ($p < 0.001$), while accounting for PHQ-9, GAD-7, and BMI at T1. The negative correlation between the change in BAS-2 and BMI at T1 was not significant after controlling for the other metrics ($p = 0.25$). Individuals with larger GAD-7 scores at T1 experienced a significantly greater decrease in GAD throughout the study ($p < 0.001$), controlling for the other metrics at T1. Lastly, the change in PHQ-9 score was greater for individuals with lower PHQ-9 scores at T1, however this change was not significant after accounting for the other metrics at T1 ($p = 0.43$).

4. Discussion

This study examined the use of the *3D-BAM* intervention to influence body appreciation, depression, and anxiety in a sample of emerging adult women between the ages of 18 and 25. Findings demonstrate that this type of intervention utilizing 3D body scanning and digital body mapping of body appreciation increased body appreciation and decreased anxiety 3 months after the intervention. Results did not support our hypotheses that the *3D-BAM* intervention would decrease depression, as measured by the PHQ-9 scale. One explanation as to why we did not find a significant decrease in depression was due to participants' low levels of depression at baseline. The mean PHQ-9 score at baseline was 5.27; a score of 5–9 is considered mild depression (Kroenke et al., 2001). We found a decrease ($t = -2.107$, $p = 0.0213$) in depression score between T1 and T4 when only considering individuals with at least mild depression (PHQ ≥ 5) at baseline ($n = 36$). Future research should be directed towards the effects of 3D-BAM on this subpopulation of young women with mild or more severe depression scores. However, our analyses did support a predictive relationship between body appreciation and depression.

Table 2
Pairwise correlations between the change in response between T1 and T4 of each outcome.

Characteristics/study indicators	*Correlation*
Body appreciation score (T4-T1) & depression score (T4-T1)	−0.24
Body appreciation score (T4-T1) & anxiety score (T4-T1)	−0.08
Body appreciation score (T4-T1) & BMI (T4-T1)	−0.30
Depression score (T4-T1) & anxiety score (T4-T1)	0.72
Depression score (T4-T1) & BMI (T4-T1)	0.15
Anxiety score (T4-T1) & BMI (T4-T1)	−0.04

Previous research has demonstrated an inverse relationship between body appreciation and both depression and anxiety among ethnically diverse women (Ramseyer Winter et al., 2017). The current results add support to this relationship between body appreciation and mental health. Our results indicating that the *3D-BAM* intervention is successful at increasing body appreciation 3 months following participation suggest that this type of intervention may be useful in a variety of settings where body image improvement is the overall goal, including clinical settings, sexual education programs, and eating disorder treatment programs. 3D technology is becoming more accessible and affordable (a handheld scanner that attaches to a tablet can be purchased for several hundred dollars) and minimal training is required to implement this technology, making this a feasible intervention to incorporate in various settings. Further research should be conducted to replicate these findings and add support to the use of the 3D-BAM intervention to increase body appreciation among other populations as well, including individuals with disabilities, those who do not identify as cisgender (i.e., when one's sex assignment at birth matches one's gender identity), racially and ethnically diverse individuals, and individuals from other age groups. Expanding this research to other populations is important, as identity impacts how one experiences body image (e.g., Grabe & Hyde, 2006). It will also be important to test the intervention using different types of scanners such as the handheld scanner mentioned above, as the type of scanner could impact levels of objectification (i.e., "being treated as a body…valued predominantly for its use to…others"; Fredrickson & Roberts, 1997, p. 174) and self-objectification.

Future research could also further explore how 3D body imaging technology could be used in body image interventions in other ways. The current intervention targeted one aspect of body image, body appreciation, so other aspects of body image such as body satisfaction and body dissatisfaction could be explored using this technology. Research related to body image (Domina, Heuberger, & MacGillivray, 2008) and eating disorders (Stewart et al., 2011) has begun to use 3D body imaging technology as a tool. Grogan et al. (2017)) have also explored the use of 3D body imaging technology as an intervention to increase healthy eating and exercise in women; however, the research on using 3D body scanning in interventions for body image is scant.

The results of the current study should be considered in the context of a few limitations. First, we did not utilize an experimental design. The lack of a control group limits our ability to draw definitive conclusions from the study. As such, future studies testing the efficacy of interventions should utilize experimental designs. The current study excluded participants with a previous eating disorder diagnosis to avoid triggering these participants, but did not do so using a validated measure. Future research that excludes participants with eating disorders should utilize a validated scale to assess the presences of eating disorder symptoms. Additionally, our sample is homogenous in terms of race, age, and sexual orientation and the convenience sampling method employed does not allow us to generalize the results. Future research should address these concerns by employing recruitment methods that will result in a representative sample. One way to do this may be to move the research into the larger community and out of the university.

5. Conclusions

This pilot study reported on the effects of an intervention using 3D body scanning technology on the body appreciation, depression, and anxiety of emerging adult women. Results provide preliminary evidence that an intervention using 3D technology, *3D-BAM*, may prove to be effective in improving emerging adult women's body appreciation over time. Given associations between body appreciation and physical, mental, and sexual health, interventions that significantly improve body appreciation, such as *3D-BAM*, could have important implications for health and well-being.

Declarations of interest

None.

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Supplementary materials

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