A Brief Facial Morphing Intervention to Reduce Skin Cancer Risk Behaviors: Results from a Randomized Controlled Trial

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Abstract

The current study was designed to test the efficacy of an appearance-based facial morphing program to reduce intentional UV exposure among individuals at risk for skin cancer. A three-arm randomized controlled trial was employed ($N = 219$) comparing facial morphing + health information to: (1) mindfulness + health information; and (2) health information only. Participants were young adults with a history of recent intentional tanning and future intentions to tan. Primary outcomes were indoor and outdoor tanning frequency and tanning intentions, with secondary outcomes of tanning attitudes, body image, and affect. Facial morphing participants reported less frequent tanning, compared to mindfulness and control participants at 1-month follow-up. Facial morphing participants also generally reported lower intentions to tan at immediate follow-up, although the magnitude of these effects weakened at 1-month follow-up. Facial morphing programs may offer a brief, efficacious, and scalable augmentation to standard of care in reducing intentional UV exposure.

Keywords: Indoor tanning, skin cancer risk, appearance, body image, randomized controlled trial

This trial is registered with clinicaltrials.gov (NCT03237013)

Introduction

Skin cancer, inclusive of melanoma and non-melanoma types (e.g., squamous cell and basal cell carcinoma), is the most prevalent form of cancer in the United States (American Cancer Society, 2017; Siegel, Miller, & Jemal, 2017). In 2017, it was estimated that 87,110 individuals would be diagnosed with, and 9,730 would die from, melanoma (Siegel et al., 2017). Further, in 2012, it was estimated that over 5 million U.S. citizens were diagnosed with non-melanoma skin cancer (Rogers, Weinstock, Feldman, & Coldiron, 2015). Indeed, the incidence of skin cancer has been steadily increasing over recent decades amongst most age groups (Jemal et al., 2011; Rogers et al., 2015), with some stabilization in melanoma rates among those under the age of 50 (Siegel et al., 2017). Despite the prevalence and incidence of skin cancer, it is also one of the most preventable forms of cancer (US Department of Health and Human Services, 2014), underscoring the role of empirically supported prevention programs.

The leading behavioral risk factor for developing skin cancer is exposure to UV radiation (Narayanan, Saladi, & Fox, 2010). Excessive UV exposure is most commonly conferred through indoor and outdoor tanning. Researchers conducting meta-analyses have found significant associations between indoor tanning and the development of skin cancer (Colantonio, Bracken, & Beecker, 2014; Wehner et al., 2012). For example, there is a 29% to 67% increased risk of developing non-melanoma skin cancer for individuals who have indoor tanned (vs. never tanned) and between 16% and 34% increased odds of developing melanoma. More recently, results from a population-based prospective cohort study revealed a 32% increased risk of developing melanoma among frequent indoor tanners (Ghiasvand et al., 2017). Additionally, initiating indoor tanning before the age of 30 was predictive of greater risk of developing melanoma, and younger age at diagnosis. Outdoor tanning has also been associated with a 71% increased risk of

developing melanoma and a 38% increased risk of developing basal cell carcinoma (Armstrong & Kricker, 2001). Collectively, these findings highlight the public health burden of tanning behaviors, particularly among younger individuals.

Individuals report varied motivations to engage in tanning behaviors; however, appearance-based motives are some of the most commonly noted in the literature (for reviews see Coups & Phillips, 2011; Holman & Watson, 2013). In U.S. culture, skin that is more tanned tends to be viewed as more physically attractive than less tanned skin (e.g., Chang et al., 2014; Robinson, Kim, Rosenbaum, & Ortiz, 2008). Thus, individuals may engage in tanning to move closer to this idealized skin tone. Indeed, results from previous research have consistently noted substantial associations between appearance beliefs and tanning behaviors and intentions (Asvat, Cafri, Thompson, & Jacobsen, 2010; Cafri, Thompson, Jacobsen, & Hillhouse, 2009; Cafri et al., 2006, 2008). Cafri and colleagues (2009) revealed that appearance-based variables both induce and reduce individuals' motivations to tan. For example, appearance based motives not to tan focus on the negative effects of UV exposure on the skin (e.g., wrinkles, sun spots), whereas appearance based motives to tan focus on the positive effects of UV exposure (e.g., appearing more fit, reducing the appearance of acne, avoiding looking pale). Given these findings, programs designed to reduce tanning behaviors may benefit from targeting appearance-based beliefs.

One intervention approach that seeks to explicitly target appearance based tanning beliefs are programs that directly focus on age-appearance changes due to tanning (for a review see Williams, Grogan, Clark-Carter, & Buckley, 2013a). Within this suite of interventions, researchers employing facial morphing (also termed facial aging) programs aim to highlight the negative impact of UV exposure on individual's skin by visually showing the changes in

appearance that are likely to occur with continued UV exposure. This is typically accomplished by taking a digital photograph of a participant's face; uploading it into a computer program that demonstrates likely facial aging over time to underscore the changes that are likely to occur (or not occur) contingent upon continued UV exposure.

To date, two known trials (Owen, Grogan, Clark-Carter, & Buckley, 2016; Williams et al., 2013b) were specifically designed to focus on facial morphing technology to change tanning attitudes and behaviors have been published (Heckman, Darlow, Ritterband, Handorf, and Manne [2016] also tested a multicomponent intervention which facial morphing was one component). In the first published trial using this methodology, Williams et al. (2013b) compared facial morphing to a health literature condition, and tested effects immediately post-intervention on tanning attitudes, perceived sun damage susceptibility, and sun protection intentions among 70 undergraduate women. Results revealed significant treatment effects favoring the facial morphing condition, with participants reporting more negative attitudes toward tanning, increased sun protective intentions, and more perceived susceptibility to skin damage from the sun. Most recently, Owen et al. (2016) also compared facial morphing to a health literature condition, and tested immediate and long-term (6 months post-baseline) effects on tanning attitudes, sun protective intentions, and sun damage susceptibility among 70 undergraduate men. Results failed to reveal significant group differences at immediate or long-term follow-up. In sum, the published literature on facial morphing programs for tanning has produced mixed findings.

Although researchers have begun to test facial morphing programs for tanning, limitations in methodology currently limit conclusions. For instance, in the two aforementioned trials (Owen et al., 2016; Williams et al., 2013b), researchers did not assess the intervention

impact on actual indoor or outdoor tanning behaviors, or intentions to tan in the future. Additionally, in neither trial did researchers include time and attention matched control groups. Finally, previous researchers (e.g., Blashill, 2013) have suggested that facial morphing programs may exert iatrogenic effects (e.g., body dissatisfaction, appearance orientation, negative affect), as the effects of interventions may inadvertently reinforce an appearance orientation by highlighting the negative impact UV exposure has on appearance. This is an important limitation, as if facial morphing reduces skin cancer risk behaviors, yet increases risk factors for maladaptive appearance changing behaviors (e.g., eating pathology), the utility of such intervention may be questioned. To date, however, there has been no empirical assessment of the potential negative outcomes of such programs.

With the above limitations in mind, the goal of the current study is to add incrementally to the literature base. Specifically, the research aims of the study are to further test the efficacy of a facial morphing program to reduce skin cancer risk behaviors by conducting a three-arm randomized controlled trial (RCT) comparing: (a) facial morphing + health literature to (b) health literature only (control), and (c) brief mindfulness + health literature (time/attention control). Brief mindfulness training was selected as a time and attention matched control, as previous research has found it to be efficacious in the prevention of other relevant health outcomes (e.g., smoking, negative affect, eating behaviors; Diaz, Jimenez, & Lopez, 2014; Marchiori & Papies, 2014; Rogojanski, Vettese, & Antony, 2011). To our knowledge, these brief mindfulness interventions have yet to be applied in skin cancer prevention. In addition to assessing the efficacy of the facial morphing program across primary outcomes (i.e., frequency and intentions of indoor and outdoor tanning behaviors), we also assessed secondary outcomes--attitudes toward tanning--and possible iatrogenic effects via changes in state and trait-level body

image variables (dissatisfaction and investment) and mood (affect, depression, anxiety, and stress) across post-intervention and follow-up (1-month post-baseline) assessments. Given the paucity of published research on these interventions, directional hypotheses were not generated.

Method

Participants, Setting, and Recruitment

The current study, titled "Strategies to Promote Skin Health," was conducted during the Spring and Fall academic semesters between February and December 2016. Participants were undergraduate students recruited from an undergraduate research participation website at San Diego State University. A general description of the study's purpose which specified the study inclusion criteria and one's time commitment for study participation (i.e., a follow-up email would be sent out approximately one month following in-lab visit) was provided for potential participants upon sign-up. Inclusion criteria were: (1) age 18 years old or older; (2) enrolled as a student at San Diego State University; (3) engaged in either indoor or outdoor tanning at least once in the last 30 days; (4) intention to tan (indoor or outdoor) in the next 30 days; and (5) English speaking. All participants who completed the in-lab visit, consisting of the baseline assessment, treatment, and immediate post-treatment assessment, received one credit in undergraduate research participation. Those who completed the 1-month follow-up survey received a $5 electronic gift card to a large, Internet-based retailer, delivered via personal email. All aspects of this study were approved of by the San Diego State University Institutional Review Board.

Study Design

In the current study, a RCT was employed comprising three arms: facial morphing, mindfulness, and control. This trial followed CONSORT 2010 guidelines (Schulz, Altman, &

Moher, 2010). Major assessments were completed at baseline, immediately post-treatment, and 1-month follow-up. All data-collection procedures were conducted online and managed electronically using a secure online data collection system.

Sample Size

Sample size was determined by conducting an a priori power analysis in G*Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007). Based on alpha = .05 and power = .80, each condition would need 64 participants (total $N = 192$) to detect a medium effect size (Cohen's $d = 0.50$). With the overall sample of $N = 219$, and $n = 73$ within each group, the current study is more than adequately powered to detect medium sized effects.

Randomization

At the in-lab visit, upon study eligibility determination, all participants were assigned a participant ID number. Each participant ID was pre-assigned to a study condition, determined by an online randomization program, prior to recruitment (Urbaniak & Plous, 2013). Study staff conducting baseline sessions knew of condition assignment, as they required this information to administer the correct intervention material. Study staff learned of randomization allocation via an open randomization list. The principal investigator was blind to condition assignment. Each eligible participant had a 1/3 chance to be assigned to each of the three study conditions (see Figure 1).

In-Lab Visit and 1-Month Post-Assessment

All participants completed the initial in-lab study visit, where participants were screened for study eligibility, consented, and, if qualified, randomized to a study condition. First, participants completed the baseline assessment, consisting of a battery of self-report questionnaires administered via online survey on a lab computer. Next, all participants were

provided with hard-copy handouts on health information by research staff to review for up to ten minutes. Those participants assigned to either the facial morphing or mindfulness conditions, but not the control condition, completed further intervention-specific activities for an additional ten minutes, described in detail below. Immediately after participants completed their assigned intervention protocol, participants completed the post-intervention assessment, consisting of self-report questionnaires administered via online survey. At the end of the in-lab visit, participants provided research staff with a valid email address to be sent a subsequent follow-up survey to be completed online approximately one month after their in-lab visit date. This email provided participants with a web address redirecting them to an online survey to answer a battery of self-report measures. Following their confirmed completion of this 1-month post assessment, research staff sent participants an additional email containing $5 credit to a large, Internet-based retailer.

Assessment Measures

Tanning behaviors. Adapted from Cafri et al. (2009), intentional indoor tanning over the past month was measured with a single, free-response item ("Please give me your best estimate on how many times you have indoor tanned in the last month"). Intentional outdoor tanning (sunbathing) was measured with a single, free-response item ("Please give me your best estimate on how many times you have sunbathed [outdoor tanned] in the last month"). Self-report of skin tanning frequency is considered reliable and valid (Lazovich et al., 2008) and is highly correlated with daily diaries of tanning behavior (Hillhouse et al., 2008; Hillhouse, Turrisi, Jaccard, & Robinson, 2012). Assessments were administered at baseline and follow-up.

Tanning intentions. Adapted from Cafri et al. (2009), indoor tanning intentions for the next month were measured with a single, free-response item ("Please give me your best estimate

of how many times you plan to use an indoor tanning salon in the next month"). Outdoor tanning intentions for the next month were measured with a single, free-response item ("Please give me your best estimate of how many times you plan to sunbathe in the next month"). Past research has found that tanning intention longitudinally predicts future tanning behaviors (Cafri et al., 2009). Assessments were administered at baseline, post-intervention, and follow-up.

Tanning attitudes. Participants completed the Appearance Reasons to Tan and Appearance Reasons Not to Tan latent subscales of the Physical Appearance Reasons for Tanning Scale (PARTS; Cafri et al., 2006, 2008). The Appearance Reasons to Tan latent subscale consists of three manifest subscales: General Attractiveness (nine items), Acne (four items), and Body Shape (six items). The Appearance Reasons Not to Tan latent subscale consists of two manifest subscales: Skin Damage (six items) and Skin Aging (three items). All items were scored along a five-point scale, 1 (*definitely disagree*) to 5 (*definitely agree*). The PARTS manifest subscales have previously demonstrated structural validity and gender invariance (Cafri et al. 2008). Internal consistency estimates for the latent subscales in the current samples ranged from α = .82 to .93 across time points. Assessments were administered at baseline, post-intervention, and follow-up.

Body image. Participants completed the Body Image States Scale (BISS; Cash, Fleming, Alindogan, Steadman, & Whitehead, 2002), a six-item self-report instrument assessing state level body satisfaction. Items were scored along a nine-point scale, 1 (*extremely dissatisfied*) to 9 (*extremely satisfied*), with one item reversed scored; higher scores indicate greater body satisfaction. Internal consistency in the current sample ranged from α = .83 to .84 across time points. Assessments were administered as baseline and post-intervention. Participants also completed the Multidimensional Body-Self Relations Questionnaire-Appearance Evaluation

subscale (MSBRQ-AE; Brown, Cash, & Mikulka, 1990; Cash, 2000), a seven-item self-report instrument assessing trait level body satisfaction. Items were scored along a five-point Likert scale, 1 (*definitely disagree*) to 5 (*definitely agree*), with higher scores denoting greater body satisfaction. Internal consistency in the current sample ranged from α = .81 to .88 across time points. Lastly, as a measure of trait level appearance orientation, participants completed the Appearance Schemas Inventory-Revised Short Form (ASI-R; Cash, Melnyk, & Hrabosky, 2004), a 20-item self-report instrument assessing cognitive and behavioral investment in one's physical appearance. Items were scored along a five-point Likert scale, 1 (*definitely disagree*) to 5 (*definitely agree*), with higher scores indicating greater investment. Internal consistency in the current sample ranged from α = .78 to .88 across time points. The MBSRQ-AE and ASI-R were administered at baseline and follow-up.

Affect. Participants completed the Positive and Negative Affect Scale-Short Form (PANAS-SF; Thompson, 2007), a 10-item self-report measure to assess state-level affect, consisting of a positive affect subscale (five items) and a negative affect subscale (five items). Items are measured along a five-point Likert-type scale, which ranges from 1 (*never*) to 5 (*always*), with higher scores denoting increased (positive or negative) affect. Internal consistency for the affect subscales in the current sample ranged from α = .76 to .85 across time points. Assessments were administered at baseline and post-intervention. Additionally, participants completed Depression Anxiety Stress Scales Short Version (DASS-21) as a marker of trait level negative affect (Henry & Crawford, 2005). The DASS-21 is a 21-item self-report measure consisting of three seven-item subscales: depression, anxiety, and stress. Items are measured along a four-point response scale, which ranges from 0 (*not at all like me*) to 3 (*applied to me very much, or most of the time*), with higher scores denoting increased symptoms. Internal

consistency for the subscales ranged from α = .76 to .89 across time points. The DASS-21 was administered at baseline and follow-up.

Skin type. Skin type was measured using the Fitzpatrick Skin Type Scale (Fitzpatrick, 1988). Participants were presented with both a table and a scale of images representing six skin types and asked to identify which skin type (1-6) best matches their untanned skin color; the options were presented along with descriptors to aid participants in identifying the best fit to their own skin color and characteristics (e.g., Skin Type 4; Brown-typical Mediterranean Caucasian skin; Rarely burns, tans with ease).

Demographics. Participants completed a demographic section that assessed age, sex, race, ethnicity, and sexual orientation.

Intervention Conditions

Control condition. Following baseline assessment, research staff provided all participants health literature on tanning behavior from the U.S. Centers for Disease Control and Prevention (CDC). These materials included informational pamphlets addressing common myths regarding tanning behaviors, including "Tanned skin is not healthy skin," and "A base tan is not a safe tan." These misconceptions were accompanied by "burning truth," scientific data debunking these myths (https://www.cdc.gov/cancer/skin/burningtruth/). Additionally, participants received and reviewed a packet on sun protective practices for oneself and family, which included skin cancer statistics and information on UV exposure (https://www.cdc.gov/cancer/skin/pdf/SkinCancer_FAMILY.pdf). Participants were given 10 minutes to read this information. Participants assigned to the control condition then immediately completed the post-intervention assessment; participants in the facial morphing or mindfulness conditions completed additional intervention-specific activities.

Facial morphing condition. APRIL® Age Progression Software (APRIL, 2012), a unique computer program that creates a series of images of a person's face as it is likely to change with age (up to the age of 72), both with and without damage from UV exposure, was employed in this condition. This program has been used for other health and lifestyle factors such as smoking (Grogan et al., 2011). The software is based on the results of a 5-year study of the faces of over 7,000 individuals of varying races, ages, and lifestyle habits (APRIL, 2012).

Participants stood against a blank white wall while research staff took a digital photograph of participants' emotionless faces; participants wearing non-religious apparel were asked to remove any clothing obstructing their faces (e.g., hats, glasses, etc.) These photographs were then uploaded to the APRIL® software and the research staff entered the participant's reported age and race. Participants were instructed to sit in front of the computer to view two side-by-side identical 2D images of their faces. Research staff then began the digital "facial morphing" process: the participant viewed these side-by-side images as the program gradually progressed the image of their face from their current age, in 2-year intervals, to age 72, the maximum age, with the "UV exposure" setting turned on. This process was immediately repeated once more. After completing both facial morphing progressions, research staff set the projected ages of both images to 10 years beyond the participant's current age. The research staff then turned the "UV exposure" setting off for the right image of the participant's face while the "UV exposure" setting for left image remained on. The right image was toggled between the "UV exposure" on/off settings three times, each toggle lasting 10 seconds (five seconds on, five seconds off). After three toggles, the participant's projected age was increased a further 10 years, and the process was repeated (i.e., three toggles of the right image to be compared to the left

"UV exposed" image). This was repeated at 10-year intervals until maximum age (72). Participants were asked if they wished to view any age over again.

Once participant requests were satisfied, research staff then transformed the identical 2D images to 3D images, using the options available in APRIL®. Research staff then tilted these identical 3D images to show each facial profile of the participant's face (i.e., the left image displayed the participant's left facial profile, while the right image displayed the right facial profile). As before, participants viewed as the program progressed the image of their face from their current age, in 2-year intervals, to age 72, with the "UV exposure" setting turned on for both images, viewing 3D images of their left and right facial profiles. As before, after completing both facial morphing progressions, research staff set the projected ages of both images to 10 years beyond the participant's current age. Research staff then toggled the "UV exposure" setting for *both* facial profiles of the participant's face from on to off three times, each toggle lasting 10 seconds (five seconds on, five seconds off). Following, the participant's projected age was increased a further 10 years, and the process repeated (i.e., three toggles of both the left and right images from "UV exposure" on to off). This process was repeated at 10-year intervals until maximum age (72). Participants were asked if they wished to view any age over again. The overall facial morphing condition consisted of 10 minutes of health information in addition to roughly 10 minutes of the facial morphing intervention (20 minutes total).

Mindfulness condition. Those assigned to mindfulness listened to a 10-minute guided audio recording of a standard mindful sitting meditation. The script for the meditation was based on sitting meditation practices taught in standard mindfulness-based interventions (MBCT; Segal, Williams, & Teasdale, 2012) and used in published studies of brief mindfulness interventions (Erisman & Roemer, 2010). First, participants learned what mindfulness is, when it

can be used, and benefits from practice. Next, participants were guided to sequentially notice the breath, body, sounds, and thoughts with an attitude of openness and curiosity, gently returning their attention to each focal point whenever it wandered off. After the exercise, participants were provided a handout highlighting key points about mindfulness, strategies to incorporate informal mindfulness practice into their daily life (e.g., mindfully drinking coffee, listening to music), and a web-link to access free guided recordings online. The mindfulness condition consisted of 10 minutes of health information in addition to 10 minutes listening to the guided mindfulness meditation (20 minutes total).

Statistical Analyses

Data were analyzed via generalized linear modeling (GENLIN) in SPSS (version 24). GENLIN models are more versatile than their general linear model counterparts due to the flexibility afforded in modeling non-normally distributed outcomes. Indeed, all outcome variables were initially screened for normality via histograms and P-P plots, and the appropriate test was selected based on the distribution. For example, both indoor and outdoor tanning behaviors were count in nature, and were modeled with Poisson distributions. Indoor tanning intentions were positively skewed, and thus, gamma distributions were employed. All remaining outcome variables were normally distributed. Baseline values of each outcome variable were controlled for in each model, with the condition variable (facial morphing set as the referent) entered as the categorical predictor variable. Some outcome variables were a priori selected to only be assessed at one follow-up assessment, whereas others were assessed at both post-intervention and 1-month follow-up. For instance, indoor and outdoor tanning behaviors could only be assessed at 1-month follow-up, as these variables measured actual tanning frequency over the previous 30 days. Conversely, state-based measures of body satisfaction and affect were

only measured at the post-intervention assessment, as changes in state-level constructs would not be as applicable 1-month follow-up.

Intent to treat (ITT) analyses were conducted for all outcome variables. Given that missing data were present among 1-month follow-up variables (roughly 50%), multiple imputations (MI; Rubin 1987) were conducted to obtain a full dataset. Within MI, baseline and post-intervention (if applicable) variables of the given missing 1-month variable were entered as predictors, along with treatment condition. Consistent with the recommendation of Graham, Olchowski, and Gilreath (2007), 50 imputations were run, and subsequently pooled to complete the final analytic dataset.

Lastly, as a metric of effect size, Cohen's d_{ppc} was calculated for all outcomes, comparing mindfulness to facial morphing, and control to facial morphing. Calculations of d_{ppc} were based on the following formula: (unadjusted mean change in facial morphing- unadjusted mean change in comparison condition / unadjusted pooled standard deviations from baseline; Morris, 2008). This metric is appropriate for pretest-posttest control (PPC) designs (Feingold, 2013) and in simulations studies has been found to outperform other effects size estimates in terms of deviation from the population mean and variance (Morris, 2008). Interpretation of d_{ppc} is: $d_{ppc2} = 0.20$ (small); $d_{ppc2} = 0.50$ (moderate); and $d_{ppc2} = 0.80$ (large).

Results

Participant Characteristics

Figure 1 displays participant flow through the entirety of the study. Table 1 depicts sociodemographic information across the total sample, and as a function of treatment condition. Lastly, Table 2 includes unadjusted means, standard deviations, and effect size estimates of each outcome variable for the total sample and as a function of treatment condition.

Indoor Tanning Behaviors

At the 1-month follow-up, there was a significant main effect of condition (Wald $\chi^2 = 18.76$, $p < .0001$), with facial morphing participants reporting significantly fewer indoor tanning sessions compared to mindfulness participants ($b = 0.49$, $SE = 0.19$, 95% CI: 0.11, 0.87, $p = .01$, $d_{ppc} = 0.30$). A nonsignificant effect was found when comparing facial morphing participants to those in the control condition ($b = 0.38$, $SE = 0.22$, 95% CI: -0.06, 0.82, $p = .09$, $d_{ppc} = 0.30$).

Outdoor Tanning Behaviors

At the 1-month follow-up, there was a significant main effect of condition (Wald $\chi^2 = 23.73$, $p < .0001$), with facial morphing participants reporting significantly fewer outdoor tanning sessions compared to those in the control condition ($b = 0.35$, $SE = 0.14$, 95% CI: 0.06, 0.63, $p = .02$, $d_{ppc} = 0.16$). A nonsignificant effect was found when comparing facial morphing participants to those in the mindfulness condition ($b = 0.22$, $SE = 0.15$, 95% CI: -0.08, 0.51, $p = .16$, $d_{ppc} = 0.16$).

Indoor Tanning Intentions

At the post-intervention assessment, there was a significant main effect of condition (Wald $\chi^2 = 9.57$, $p = .008$), with facial morphing participants reporting significantly lower intent to indoor tan compared to those in the control condition ($b = 0.75$, $SE = 0.25$, 95% CI: 0.27, 1.23, $p = .002$, $d_{ppc} = 0.30$). A nonsignificant effect was found when comparing facial morphing participants to those in the mindfulness condition ($b = 0.45$, $SE = 0.25$, 95% CI: -0.04, 0.93, $p = .07$, $d_{ppc} = 0.18$). At the 1-month follow-up, there was a nonsignificant main effect of condition (Wald $\chi^2 = 5.23$, $p = .07$).

Outdoor Tanning Intentions

At the post-intervention assessment, there was a significant main effect of condition (Wald $\chi^2 = 17.75$, $p < .0001$), with facial morphing participants reporting significantly lower intent to

outdoor tan compared to those in the control (b = 0.84, SE = 0.23, 95% CI: 0.37, 1.30, p < .0001, d_{ppc} = 0.49) and mindfulness (b = 0.87, SE = 0.23, 95% CI: 0.41, 1.32, p < .0001, d_{ppc} = 0.55) conditions. At the 1-month follow-up, there was a nonsignificant main effect of condition (Wald χ^2 = 4.36, p = .11).

Attitudes Toward Tanning

At the post-intervention assessment, there was a significant effect of condition (Wald χ^2 = 311.80, p < .0001), with facial morphing participants reporting significantly greater appearance based attitudes not to tan compared to those in the control (b = -0.17, SE = 0.01, 95% CI: -0.20, -0.14, p < .0001, d_{ppc} = 0.25) and mindfulness (b = -0.23, SE = 0.01, 95% CI: -0.25, -0.20, p < .0001, d_{ppc} = 0.32) conditions. At the 1-month follow-up, there was a nonsignificant main effect of condition (Wald χ^2 = 1.94, p = .38).

At the post-intervention assessment, there was a significant effect of condition (Wald χ^2 = 7.12, p = .03), with facial morphing participants reporting significantly lower appearance based attitudes to tan compared to those in the control (b = 0.20, SE = 0.08, 95% CI: 0.03, 0.36, p = .02, d_{ppc} = 0.21) and mindfulness (b = 0.20, SE = 0.08, 95% CI: 0.03, 0.36, p = .02, d_{ppc} = 0.22) conditions. At the 1-month follow-up, there was a nonsignificant main effect of condition (Wald χ^2 = 0.94, p = .63).

Body Image

At the post-intervention assessment, there was a nonsignificant main effect of condition for state body satisfaction (Wald χ^2 = 5.26, p = .07), and at the 1-month follow-up there were nonsignificant main effects of condition for trait body satisfaction (Wald χ^2 = 2.96, p = .23), and appearance orientation (Wald χ^2 = 2.03, p = .36).

Affect

At the post-intervention assessment, there was a significant effect of condition for state negative affect (Wald $\chi^2 = 23.22$, $p < .0001$), with facial morphing participants reporting significantly greater levels compared to those in the control ($b = -0.35$, $SE = 0.10$, 95% CI: -0.55, -0.15, $p = .001$, $d_{ppc} = 0.55$) and mindfulness ($b = -0.47$, $SE = 0.10$, 95% CI: -0.67, -0.27, $p < .0001$, $d_{ppc} = 0.61$) conditions. A nonsignificant main effect of condition was revealed for positive affect (Wald $\chi^2 = 0.51$, $p = .78$). At the 1-month follow-up, there were nonsignificant main effects of condition on depressive symptoms (Wald $\chi^2 = 5.30$, $p = .07$), anxiety symptoms (Wald $\chi^2 = 5.68$, $p = .06$), and stress (Wald $\chi^2 = 4.47$, $p = .11$).

Discussion

The current study was one of the few existing published trials of facial morphing programs targeting tanning attitudes, intentions, and behaviors (Heckman et al., 2015; Owen et al., 2016; Williams et al., 2013b). Additionally, given past concerns about possible iatrogenic effects on body image and affect (e.g., Blashill, 2013), this was the first known study to measure these outcomes at both post-intervention and follow-up assessment points. Generally, results from the current study found facial morphing to reduce indoor and outdoor tanning frequency at 1-month follow-up, and future intentions to tan and positive attitudes toward tanning at immediate follow-up, with these effects abating over time. Additionally, facial morphing did not increase negative outcomes such as body dissatisfaction, appearance investment, or symptoms of depression, anxiety, or stress, compared to the other conditions.

Results from two previously published trials of facial morphing on tanning have produced mixed findings (Owen et al., 2016; Williams et al., 2013b). A challenge in comparing the current study's findings to these past trials is that different constructs and measures were employed, and the two prior studies compared facial morphing to a health literature control condition, whereas in

the current study, we compared a combined facial morphing + health literature condition to health literature only, in addition to a time and attention matched control (mindfulness + health literature). Despite these salient methodological differences, some similarities are worth noting. For instance, Williams et al. (2013b) found an effect size of $d_{ppc} = 0.32$ favoring facial morphing in changing sun risk attitudes. In the current study, significant changes in tanning attitudes were also noted, with d_{ppc} ranging between 0.21 and 0.32 at post-intervention assessment; however, effects dropped substantially at 1-month follow-up, suggesting the possibility that additional "doses" of facial morphing may be needed for benefits to persist across time. The failure to detect significant treatment effects in Owen et al. (2016) may be due to sample composition, as all participants were men. In comparison, Williams et al. (2013b) sample was exclusively women, and the current study was primarily women (over 80%). Thus, it is possible that results from facial morphing interventions may yield stronger effects among women vs. men, possibly linked with relatively greater societal pressure to retain a youthful appearance in women relative to men (Grogan, 2016), a conjecture that should be tested formally in future research.

Results were not substantially different when viewing comparisons between facial morphing and control, and facial morphing and mindfulness. Mindfulness was selected as a time and attention matched control group, although it appears that mindfulness was not comparable to facial morphing in regard to tanning behaviors or intentions. These findings suggest that brief mindfulness exercises may not be an appropriate intervention for reducing intentional UV exposure among young adults who are at-risk for developing skin cancer. However, it is also possible that greater doses of mindfulness training (e.g., standard 8-week interventions) may have a beneficial effect, and that some groups of tanners (e.g., those who tan to regulate negative affect)

may be most likely to benefit from mindfulness training, although these possibilities need to be tested in future research.

It is also important to note that the mindfulness condition may not have been fully matched to facial morphing in regard to attention. Attempts were made to model the mindfulness condition to be fully time and attention matched with facial morphing; however, the mindfulness condition did not include a human experimenter reading the mindfulness script. Having a human experimenter read the mindfulness script to participants would match the attention in facial morphing, although it also could create excess error, as there would likely be within-experimenter and between-experimenter variation in the tenor and timing of how the script was delivered. Thus, we chose to deliver the mindfulness script via an audio recording, which standardizes the material across participants within that condition.

The results from the current study also mirror those found in multicomponent cognitive behavioral skin cancer prevention programs. In a recent RCT of an online multicomponent skin cancer prevention program (which included a facial morphing component), Heckman et al. (2016) found significant and small-to-medium effect size estimates in UV exposure (including indoor tanning) between the experimental and control condition at both 3-week and 12-week follow-up. Similarly, Stapleton et al. (2015) also conducted a RCT of a multicomponent online intervention to reduce skin cancer risk behaviors. Compared to a waitlist control condition at 6-weeks post baseline, participants in the experimental condition reported significantly fewer indoor tanning sessions and lower intention to tan in the future, with small-to-medium effect size estimates noted. Viewed in the context of recent online multicomponent skin cancer prevention programs, the results from the current study revealed comparable effect size estimates on indoor tanning

frequency, and given the brief nature of the intervention may constitute a relatively efficient program.

Results from the facial morphing intervention did not display evidence of iatrogenic effects in comparison to the other conditions. Previously, researchers have questioned the theoretical underpinnings of facial morphing interventions (e.g., Blashill, 2013). Specifically, concerns have been raised that highlighting the importance of negative changes in appearance due to UV exposure may inadvertently reinforce appearance orientation among participants, and maintain or increase body image concerns. Results from the current study did not reveal elevated body image concerns among facial morphing participants at the post-intervention, or 1-month follow-up assessment points, compared to the other conditions. Although there was a medium-sized spike in negative affect at the post-intervention assessment, symptoms of depression, anxiety, and stress were not significantly different from comparison conditions at 1-month follow-up. These results suggest that any short-term change in negative affect may not confer longer-term impact, and that acute elevations in negative effects do not appear to be specific to appearance concerns, by virtue of non-significant differences noted with body image variables.

Findings from the current study should be interpreted with several limitations. Of note, the follow-up period was rather short, at only 1-month post baseline, casting uncertainty regarding the durability of treatment effects. Future research should explore additional follow-up time points, and also consider designs that include booster intervention contact points. For example, it may be possible to send participants an email or text including an image of their digitally morphed face, after the intervention session, which could enhance treatment longevity. Related, retention at the 1-month follow-up was lower than anticipated, with roughly 50% of the sample preserved. Although robust multiple imputations were employed to account for missingness, and data were missing at

random, replication of these results with samples with higher retention rates would be crucial in adding confidence to the efficacy of this intervention. Lastly, moderators of the treatment effects were not explored in the current study, but would be important to explore in future research. For instance, the impact of facial morphing may vary as a function of appearance orientation (e.g., participants with high orientation may benefit from facial morphing more so than those who score lower on orientation).

In summary, results from the current study add to the limited literature on facial morphing interventions for skin cancer prevention. Results revealed that the facial morphing intervention reduces indoor and outdoor tanning behaviors and intentions, exerting small to small-to-medium sized effects over a control and time and attention matched control condition. Findings suggest this brief intervention may have the potential for scalability and augmentation of standard of care for skin cancer prevention provided across clinics in the U.S.

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Table 1. Sample Characteristics

Variable		Total	FM	M	C
			***N* (%)**		
Race					
	African American/Black	3 (1.4%)	1 (1.4%)	0 (0%)	2 (2.7%)
	White	141 (64.4%)	43 (58.9%)	49 (67.1%)	49 (67.1%)
	Native American	2 (0.9%)	0 (0%)	1 (1.4%)	1 (1.4%)
	Asian/Pacific Islander	34 (15.5%)	11 (15.1%)	14 (19.25)	9 (12.35)
	Other	37 (16.9%)	17 (23.3%)	9 (12.3%)	11 (15.1%)
Ethnicity					
	Hispanic/Latino	54 (24.7%)	19 (26.0%)	19 (26.0%)	16 (21.9%)
Sex					
	Women	178 (81.3%)	64 (87.7%)	57 (78.1%)	57 (78.1%)
Fitzpatrick Skin Type					
	I	1 (0.5%)	0 (0%)	0 (0%)	1 (1.4%)
	II	25 (11.4%)	9 (12.3%)	6 (8.2%)	10 (13.7%)
	III	112 (51.1%)	36 (49.3%)	40 (54.8%)	36 (49.3%)
	IV	74 (33.8%)	24 (32.9%)	27 (37.0%)	23 (31.5%)
	V	6 (2.7%)	4 (5.5%)	0 (0%)	2 (2.7%)
	VI	1 (0.5%)	0 (0%)	0 (0%)	1 (1.4%)
			***M* (*SD*)**		
Age		19.72 (2.50)	19.65 (2.77)	19.90 (2.85)	19.60 (1.75)

Note. FM = Facial Morphing; M = Mindfulness; C = Control.

Table 2. Unadjusted Means and Standard Deviations of Outcomes Across Conditions and Time

	Baseline	Post	Follow-up	d_{ppc2} (Post)	d_{ppc2} (Follow-up)
Indoor Tanning Frequency					
FM	1.51 (2.83)	-	1.35 (2.81)	-	-
M	1.28 (2.41)	-	1.92 (2.86)	-	0.30**
C	1.30 (2.68)	-	1.98 (3.21)	-	0.30
Outdoor Tanning Frequency					
FM	7.25 (5.04)	-	2.69 (3.31)	-	-
M	7.02 (4.84)	-	3.24 (3.60)	-	0.16
C	7.69 (5.35)	-	3.96 (4.07)	-	0.16*
Indoor Tanning Intentions					
FM	4.13 (2.17)	2.21 (1.59)	2.60 (1.76)	-	-
M	4.27 (2.20)	2.74 (2.07)	3.16 (1.82)	0.18	0.19
C	4.36 (2.17)	3.10 (2.05)	3.12 (1.90)	0.30*	0.13
Outdoor Tanning Intentions					
FM	5.56 (1.59)	3.41 (1.85)	3.37 (1.83)	-	-
M	5.90 (1.20)	4.53 (1.62)	3.89 (1.76)	0.55***	0.13
C	5.96 (1.37)	4.53 (1.74)	3.48 (1.97)	0.49***	0.20
Appearance Attitudes To Tan					
FM	3.29 (0.91)	2.90 (.99)	3.13 (0.80)	-	-
M	3.46 (0.74)	3.25 (.76)	3.13 (0.61)	0.22*	-0.20
C	3.49 (0.77)	3.28 (.90)	3.22 (0.66)	0.21*	-0.13
Appearance Attitudes Not To Tan					
FM	3.31 (0.78)	3.83 (.93)	3.61 (0.82)	-	-
M	3.36 (0.77)	3.63 (.83)	3.59 (0.62)	0.32***	0.09
C	3.41 (0.76)	3.74 (.79)	3.40 (0.72)	0.25***	0.40
State Body Satisfaction					
FM	5.48 (1.37)	5.36 (1.41)	-	-	-
M	5.32 (1.37)	5.49 (1.34)	-	-0.21	-
C	5.70 (1.35)	5.67 (1.28)	-	-0.07	-
Trait Body Satisfaction					
FM	3.42 (0.68)	-	3.33 (0.66)	-	-
M	3.39 (0.74)	-	3.30 (0.70)	-	0.00
C	3.52 (0.78)	-	3.32 (0.68)	-	0.15
Appearance Orientation					
FM	3.54 (0.58)	-	3.34 (0.49)	-	-
M	3.64 (0.56)	-	3.42 (0.44)	-	-0.04
C	3.66 (0.50)	-	3.50 (0.47)	-	0.07
State Positive Affect					
FM	3.45 (0.76)	3.32 (0.92)	-	-	-
M	3.33 (0.79)	3.31 (0.80)	-	-0.14	-
C	3.59 (0.63)	3.45 (0.82)	-	0.01	-
State Negative Affect					
FM	2.07 (0.75)	2.22 (0.80)	-	-	-
M	2.02 (0.72)	1.72 (0.77)	-	-0.61***	-
C	2.20 (0.70)	1.95 (0.73)	-	-0.55***	-
Depressive Symptoms					
FM	6.32 (8.84)	-	9.16 (8.00)	-	-
M	5.97 (7.59)	-	12.06 (8.56)	-	0.39
C	4.82 (4.95)	-	11.35 (7.91)	-	0.51
Anxiety Symptoms					
FM	7.86 (7.83)	-	10.74 (8.63)	-	-
M	6.38 (5.86)	-	12.82 (8.81)	-	0.51

C	6.63 (5.82)	-	13.22 (8.40)	-	0.54
Stress					
FM	11.39 (9.28)	-	14.02 (9.02)	-	-
M	11.56 (8.82)	-	15.43 (8.96)	-	0.14
C	10.38 (7.82)	-	16.75 (9.29)	-	0.44

Note. FM = Facial Morphing; M = Mindfulness; C = Control; d_{ppc} = Cohen's *d* for pre-post control designs. Effect size estimates are coded to indicate positive values favoring the FM condition; **p* < .05, ***p* < .01, ****p* < .001.