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Tailored Visuals, Implementation Interventions, and Sun Safe Behavior: A Longitudinal Message Experiment

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Abstract

Objective: One way to communicate skin cancer risk is through ultraviolet (UV) photographs, which can depict the target person (tailored visual) or someone else (stock visual). There is a need for more longitudinal research examining the relative impact of tailored UV photographs compared to other message interventions that could increase sun safe behaviors.

Methods: Students 14–18 years of age ($N = 654$) at eleven high schools in Utah were recruited to participate in a longitudinal experiment (assessments: pretest, posttest, 1 month follow-up) comparing the relative persuasive impact of receiving either (1) stock and tailored UV photographs or (2) stock UV photographs and an implementation intervention on outdoor tanning behavior. Participants completed measures of fear, appearance norms and benefits, threat susceptibility/severity, self-efficacy, response efficacy, freedom threat, reactance, and outdoor tanning behavior.

Results: Compared to the implementation intervention, participants in the tailored UV condition reported increased fear and freedom threat and decreased appearance norms and benefits of tanning immediately following exposure to the intervention and decreased outdoor tanning 1 month after the intervention. Indirect effects also emerged with tailored UV exposure decreasing outdoor tanning via appearance benefits and increasing outdoor tanning when immediate fear triggered psychological reactance.

Conclusions: The results contribute to research on lay reactions to tailored visuals, implementation interventions, and theorizing the indirect effects of affect and cognition across time.

Keywords

tailoring; stock; fear; visuals; ultraviolet; personalized; sunscreen use

Message tailoring is “the personalization of information based on user characteristics” (Jensen et al., 2014, p. 31). Experimental research on message tailoring often examines the relative persuasive impact of receiving personalized or stock messages (Kreuter, Strecher, & Glassman, 1999; Noar, Harrington, & Alrdich, 2011; Rimer & Kreuter, 2006). For example, Jensen et al. (2012) examined the relative impact of receiving a breast cancer pamphlet personalized according to age, race, and risk rather than a stock pamphlet designed for all users. Meta-analyses have found that tailored messages produce a small, but statistically significant persuasive advantage compared to stock messages (Krebs, Prochaska, & Rossi, 2010; Noar, Benac, & Harris, 2007; Wanyonyi, Themessl-Huber, Humphris, & Freeman, 2011).

The current study engages two limitations in the tailoring literature. First, comparing stock and tailored messages potentially confounds personalization with interactivity. Tailored messages require recipients to provide personal information which, in and of itself, could explain the effect of the intervention (Jensen et al., 2012). Message experiments that compare tailored messages to other interactive interventions are a priority (Jensen et al., 2014). For example, implementation intention interventions could be an ideal comparison as participants write down what behaviors they intend to perform, when and where they will perform them, and action steps needed to help them successfully implement the behavior (see also, Persson, Grogan et al., 2018, 2019).

Second, a priority of tailoring research is the identification of novel features, or combinations of features, that can be tailored to yield larger effects (Jensen et al., 2014; Noar et al., 2007). Multiple features of a message can be tailored, including the text, sound, delivery, and visuals. The latter is challenging because tailored visuals can be difficult and time consuming to construct. For example, Blashill and colleagues (2018) provided participants with tailored photos of their face morphed with age progression software. Tailored photos reduced indoor and outdoor tanning frequency 1 month after the intervention.

A program of research in the area of skin cancer prevention offers unique opportunities to advance our understanding of tailored visuals. Ultraviolet (UV) photography interventions utilize special cameras to reveal problems that are not visible to the naked eye (Gamble et al., 2012). To date, researchers have examined the impact of tailored UV photos (i.e., photos of the participant, see Mahler et al., 2010) and stock UV photos (i.e., photos of someone other than the participant, see Pokharel et al., 2019), though no study has compared the two directly (Pokharel et al., 2019; Persson et al., 2018; Williams et al., 2013). Thus, there is a need for studies comparing stock/tailored UV photography interventions, especially because tailored UV photos are original, personal images that constitute exemplars of tailored visuals.

To engage both limitations in tailoring research, we leverage a longitudinal experiment embedded within a larger, multi-group intervention (Authors, 2019). All intervention arms received stock UV photos. One condition received a tailored UV photo. Thus, we compare the stock plus tailored UV condition with a condition that included a stock photo plus a implementation intervention. This study not only advances our understanding of tailored

visuals, but it also affords researchers an opportunity to test deeper theoretical questions using a longitudinal dataset. Following a brief review of the role of UV photography in skin cancer prevention, the manuscript explicates contributions to tailoring, fear, and reactance.

Direct and Indirect Effects of Tailored UV Photographs

Scholars had been investigating the potential impact of UV photography since the early 2000s (e.g., Gibbons et al., 2005; Mahler et al., 2005; Pagoto et al., 2003; Persson et al., 2018; Stock et al., 2010; Weinstock et al., 2002). Multiple systematic reviews and meta-analyses have found that UV photography interventions are commonplace and effective at increase sun safe behaviors (Asai et al., 2021; Persson et al., 2018; Williams et al., 2013). Gamble et al. (2012) accelerated this research when they demonstrated that sun damage in UV photographs was significantly correlated with phenotypic melanoma risk in 12-year-olds. Their study demonstrated that UV photographs were more than just a visual curiosity; the images were meaningfully related to phenotypic risk, even at a relatively young age. In response to Gamble et al. (2012), two health behavior scholars were asked to write a follow-up articulating the value of the findings to health communication (Hornung & Strecher, 2012). They argued that health communication researchers should continue to develop and evaluate UV photography interventions, notably for adolescents who were positioned to benefit from decades of sun safe behavior.

From a health communication standpoint, Gamble et al. (2012) utilized tailored visuals in their study. Tailored visuals are personalized images that depict information directly related to, or of, the target individual (Rimer & Kreuter, 2006). In a tailored UV intervention, each person has their photograph taken with a UV camera system and then that person is provided with the photograph (Mahler, 2018). Tailored UV photography interventions are different than stock UV photo interventions; the latter utilize images of other individuals collected before the intervention (e.g., Pokharel et al., 2019).

Past work has found that viewing a stock or tailored UV photograph can increase sun protective cognitions and behaviors (Gibbons et al., 2005; Mahler, 2014, 2015, 2018a, 2018b; Mahler, Kulik, Gerrard, & Gibbons, 2003, 2007, 2010; Mahler et al., 2005; Mahler et al., 2006; Mahler et al., 2008; Pagoto et al., 2003; Pokharel et al., 2019; Stock et al., 2010; Walsh & Stock, 2012; Walsh, Stock, & Peterson, & Gerrard, 2014; Weinstock et al., 2002). For instance, Mahler et al. (2010) found that a tailored UV photograph increased perceived susceptibility to photoaging and intentions to engage in sun safe behavior.

More recently, scholars have started to explore the role of affect in UV photography interventions (Mahler, 2014, 2018a, 2018b; Pokharel et al., 2019). Mahler (2018b) noted that the general pattern observed so far is “stronger negative emotional reactions (which predict) subsequent sun protection behaviors” (p. 38–39). For example, Mahler (2014) observed that an index of negative emotions was related to sun safe behaviors following exposure to a tailored UV photograph. That study did not have a comparison condition, but Mahler (2018a) found a similar pattern when comparing tailored UV photo conditions to a no photo control condition. Likewise, Pokharel et al. (2019) found that a stock UV photo generated increased fear compared to non-UV skin cancer prevention visuals. Moreover,

exposure to the stock UV image was indirectly related to sun safe behavior expectations via fear.

Both stock and tailored UV photographs appear capable of generative negative emotion, notably the discrete emotion fear. Given these findings, Pokharel et al. (2019) argued that UV photos that depict skin damage could be conceptualized as fear appeals. A fear appeal is “a persuasive message that attempts to arouse the emotion fear by depicting a personally relevant and significant threat” (Witte, 1994, p. 114). Notice that both tailored messages and fear appeals leverage personally relevant information to persuade.

Researchers have been studying fear appeals for over six decades and several theoretical frameworks exist to guide research and practice (Tannenbaum et al., 2015; Witte & Allen, 2000). For example, the extended parallel process model (EPPM) postulates that three constructs – threat, efficacy, and fear – explain the impact of a fear appeal. The EPPM argued that high threat/high efficacy led to behavior change, whereas high threat/low efficacy triggered fear control (Witte, 1994). Fear was positioned as an affective state that was triggered by a lack of efficacy in response to a threat. An early meta-analysis found support for this model (Witte & Allen, 2000), but more recent meta-analyses have supported an alternative model: fear and threat mediate the impact of fear appeals on outcomes. For example, Tannenbaum and colleagues (2015) found that fear appeals typically triggered direct positive impact on attitude, intention, and behavior change, and the effect was channeled positively through fear and threat. Dillard and colleagues (2017a) noted that this pattern was consistent with the drive model (Hovland et al., 1953). The drive model postulates that increased fear leads to increased behavioral response to mitigate the fear (e.g., sun safe interventions that cause fear lead to more sun safe behavior).

In summary, there is still some debate about variable ordering in fear appeal research, focused primarily on the position of affect (Dillard et al., 2017a; Dillard et al., 2017b; Pokharel et al., 2019). However, mounting evidence seems to point toward the drive model as the best fit for the data; though Tannenbaum et al. (2015) also noted there was a pressing need for more fear appeal research that directly tested fear as a mediator or indirect pathway. Despite six decades of fear appeal research, only a small number of studies have directly tested fear as a mechanism. In terms of the present study, past research in the area of UV photo interventions has aligned more with the drive model (Mahler, 2014, 2018a; Pokharel et al., 2019), underscoring the value of that model for the work at hand.

Current Study

The current study analyzes data from a larger, four-arm intervention study carried out in Utah high schools (for more details about each arm, see the Method section). The first publication from that data reported the relative impact of each intervention arm on eleven sun safe behaviors (Authors, 2019). The analysis found that all four arms positively impacted some aspect of sun safe behavior 1 month after the interventions were complete.

The analysis reported here examines the underlying cognitive mechanisms at work by contrasting two intervention conditions: those who received a stock and tailored UV

visual versus those who received a stock UV visual and an implementation intervention. Participants in all four intervention arms were exposed to stock UV photographs but one group was also exposed to a tailored UV photograph. That allows researchers to examine the relative persuasive impact of being exposed to a stock UV photograph versus stock *and* tailored UV photographs, a contrast that has been called for in past work (Pokharel et al., 2019). Moreover, the reporting of the four arm results focused only on behavioral outcomes (Authors, 2019). The current analysis reports cognitive data that was collected at multiple points in time during the intervention. These variables could be key to understanding the impact of tailored visuals.

Based on past research, several hypotheses are warranted. First, compared to stock UV plus implementation intervention condition, it is hypothesized that the stock plus tailored UV condition will be related to decreased outdoor tanning (H1) 1 month after the intervention. Second, research and theory suggest that tailored UV visuals will immediately increase fear, threat susceptibility, and appearance-based perceptions such as appearance norms about tanning and appearance benefits of tanning (H2a – d). Moreover, all four of these variables are hypothesized to form indirect pathways connecting exposure to tailored UV visuals with outdoor tanning (H3a – d).

Appearance-based perceptions have emerged as a key mechanism for understanding UV visuals, though there is a need for research that explicates those perceptions into defined process models. For example, past work has identified appearance norms related to tanning and appearance benefits of tanning as two important variables which are strongly related (Jackson & Aiken, 2000, 2006), but whether they unfold as a process to explain message impact is unclear. One intriguing possibility is that appearance norms influence appearance benefits; if a person perceives tanning as normatively desirable then it increases their own belief that it is beneficial (see, e.g., Carcioppolo et al., 2019). Accordingly, the current study postulates a serial model wherein appearance norms and benefits indirectly link tailored UV exposure to outdoor tanning (H4).

But tailored messages are not always positively received. Indeed, researchers have found that tailored UV photographs can generate reactance. Notably, Schüz, Schüz, and Eid (2013) observed that a tailored UV photograph increased defensive reactance and decreased sun safe behavior. Psychological reactance theory describes reactance as an aversive motivational state triggered when a person perceives a threat to their freedom (i.e., freedom to think, feel, or act of their own volition; Ratcliff, 2019). In turn, a person will often attempt to restore their freedom—first becoming angry or defensive and, ultimately, rejecting the threatening message or doing the opposite of an advised action (Dillard & Shen 2005; Ratcliff, 2019). Further, Ratcliff and colleagues (2018) cautioned that tailored or personalized health information might elicit negative reactions by threatening autonomy in other ways; for example, it may feel like an invasion of privacy or impinge upon a person's sense of self-determination. For these reasons, we hypothesize that tailored UV visuals will increase threat to freedom (H5a) and reactance (H5b). Consistent with reactance theory, we also postulate a negative indirect pathway via freedom threat and reactance such that exposure to tailored UV visuals increases outdoor tanning (H6). Finally, fear has been shown to trigger perceived freedom threat and reactance (Quick et al., 2018; Witte, 1994), a

phenomenon that is sometimes used to explain failed fear appeals. This also suggests a serial model whereby increased fear leads to undesirable behavior by triggering threat to freedom and reactance (H7).

Method

Procedure

A cluster randomized four-arm intervention was carried out across Utah high schools. Thirteen high schools were invited to participate in the intervention and eleven agreed to do so (84.62%). Prior to data collection, parents were sent a consent letter allowing their child to opt out of the study. No student opted out of the study. Researchers then visited each school between March and May 2017. During the initial visit, participants completed a pretest survey assessing skin type (via the Fitzpatrick skin type scale; Fitzpatrick, 1988), demographics, threat susceptibility/severity, self- and response-efficacy, and sun safe behavior. After the pretest, participants received one of 4 interventions (education-only, education + sunscreen efficacy demonstration, education + implementation intervention, and education + tailored UV photograph).

Interventions were delivered in group settings (e.g., classrooms) with multiple students present during each session, so randomization occurred at the level of school. Immediately after the intervention, participants completed a posttest measuring affective and cognitive responses to the intervention. One month after the posttest, participants completed a follow-up survey that assessed those same affective and cognitive responses and sun safe behavior. All procedures were approved by the University of Utah Institutional Review Board and school board authorities.

Participants

The current manuscript focuses on two arms of a larger four-arm intervention: tailored UV and implementation intervention. For the two arms under examination, 654 students completed the pretest and 347 had complete data across all three time points. That is, 307 students were missing one or more datapoints. Madley-Dowd and colleagues (2019) recommend multiple imputation in situations where a large percentage of participants have missing data that is missing at random. Accordingly, two-hundred imputations were carried out using thirty-one constraints (all pretest, posttest, and 1 month later variables, and age, grade, sex, race, and family history of skin cancer) to generate a pooled dataset (for more details on imputation approach, see Von Hippel, 2020). The final, pooled dataset consists of 654 participants with 457 in the implementation intervention and 197 in the tailored UV condition. The tailored UV condition was smaller, by design, as it was an experimental arm and it required equipment to be transported from location to location (the UV camera system).

Grade ranged from 9th – 12th, and age ranged from 14 – 18 ($M = 16.01$, $SD = 1.06$). Participants identified as female ($n = 312$, 47.70%), male ($n = 342$, 52.30%). Participants primarily identified as White ($n = 464$, 70.90%) followed by Black or African American ($n = 35$, 5.40%), Asian or Asian American ($n = 21$, 3.20%), American Indian/Alaskan Native

($n = 21$, 3.20%), other ($n = 98$, 15.00%), or did not report ($n = 22$, 3.40%). Participants could check more than one racial identification category. Approximately 19% ($n = 123$) of participants identified as Spanish, Hispanic, or Latino/a. By the Fitzpatrick (1988) skin type scale, participants were categorized as follows: type I ($n = 26$, 4.00%), type II ($n = 64$, 14.40%), type III ($n = 259$, 39.60%), type IV ($n = 202$, 30.90%), type V ($n = 35$, 5.40%), and type VI ($n = 3$, 0.50%).

Intervention

All interventions included a twenty-minute educational component. The education component was delivered by a public health educator using a PowerPoint presentation focused on sun safety. The PowerPoint presentation was developed by the research team in collaboration with dermatologists and a cancer learning center located at an NCI-designated cancer center. The presentation was designed to teach participants about sun safe behavior, skin cancer, and skin cancer risk. The PowerPoint presentation included stock UV photographs (see Appendix A). The PowerPoint, all study protocols, and dataset are located on Open Science Framework here.

In the education-only condition, that was the end of the intervention. In the other three conditions, the PowerPoint presentation was followed by one of the following activities: tailored UV photograph, implementation intervention, or sunscreen efficacy task. Both the tailored UV photo exercise and the implementation intervention occurred after the educational component and took about 20 minutes to complete. Thus, the contrast of the tailored UV and implementation intervention conditions is optimal as both were approximately the same length from a participant standpoint.

Tailored UV Intervention.—After completing the pretest questionnaire, participants were called to the front of the classroom one at a time. At the front of the classroom was a UV camera system (Canfield VISIA CA) and a member of the research team. The camera system includes a UV camera, chin/head rest, computer monitor, and laser printer. The computer monitor can be positioned so that neither the individual being photographed, nor the rest of the class can see the screen. The camera system was used to take a UV photograph of each participant. As photographs were taken, they were printed on glossy, photograph quality 8.5×11-inch paper. Once all students had been photographed, the research team handed out the photographs. A member of the research team then described the camera system, how UV photographs were related to skin cancer risk, and answered participant questions. Following this intervention, participants completed a posttest.

Implementation Intervention.—Most sun safe behaviors are relatively easy to perform, yet many people fail to do them (Jensen et al., 2020). Behavioral researchers refer to individuals who intend to perform a behavior, but fail to follow through as inclined abstainers (Gollwitzer & Sheeran, 2006). Past research has found that inclined abstainers can be moved to action through a strategy referred to as implementation intentions. In an implementation intentions intervention, participants write down what sun protective behaviors they intend to perform, when and where they will perform them, and action steps

needed to help them successfully implement the behavior (see also, Persson, Grogan et al., 2018, 2019).

Measures

All items are provided in Appendix B and have been validated with U.S. adolescent populations in past research. Authors (2019) examined the impact of all four intervention conditions on eleven sun safe behaviors, ranging from sun screen use to wearing wide-brimmed hats to indoor tanning. The current analysis focuses on one those behaviors (outdoor tanning) to explore theory-driven questions related to message tailoring. Outdoor tanning was measured using items from Glanz and colleagues (2008) on a 5-point scale (*never, rarely, sometimes, often, always*): In the past month, if you were outdoors in the sun for 15 minutes or more, how often did you spend time in the sun in order to get a tan?

Fear (5 items), threat susceptibility (3 items), and threat severity (3 items) were measured with items from Witte (1994). Self-efficacy (3 items) and response efficacy (3 items) were measured with items from Tripp et al. (2013) and Lescano and Rodrigue (1997). Threat to freedom (4 items) and the affective or anger component of reactance (4 items) were measured using items from Dillard and Shen (2005). Appearance norms for tanning (1 item) and appearance benefits of tanning (1 item) were measured with items adapted from Jackson and Aiken (2000, 2006). All eight variables were measured on 5-point scales: *strongly disagree, disagree, neither agree nor disagree, agree, strongly agree*. To maximize comparability across time points, all cognitive and affective items examined agreement with specifying a time period (i.e., “Please mark how much you agree or disagree with each of the following sentences.”). The affective items also specified a stimulus (i.e., “This/the skin cancer information . . .”).

Analysis

Data were analyzed using SPSS 27 and PROCESS 4.0. To test H1, H2a – d, and H5a-b, a series of ANOVAs were conducted – for the posttest scores and for the data collected 1 month later – with intervention condition as a fixed factor nested within school and class. Bonferroni corrections were applied to all post-hoc comparisons. Hypotheses specifying an indirect path (H3a – d, H4, H6, and H7) were tested using a path analysis program – PROCESS (Hayes, 2018). Specifically, H3a – d were testing using PROCESS model 4 which specifies a parallel mediation model. Serial mediation models (H4, H6, and H7) were tested with PROCESS model 6. All PROCESS models utilized 95% confidence intervals and 10,000 bootstrap tests.

Power Analysis

G*Power was utilized to calculate sample size for the study (Faul et al., 2007). For main effects, with $\alpha = .05$ and power = .95, a sample size of 210 was optimal to detect an effect size of $f = .25$ (medium effect) and 578 to detect an effect size of $f = .15$ (small effect). The final sample of 654 is powered to detect both effects with relatively high precision. Power for mediation analyses was calculated using the *pwr2ppl* package for *R* (Schoemann, Boulton, & Short, 2017). Power was lower, but still .80 or higher for all mediation models.

Results

Descriptive Statistics

Means, standard deviations, and alphas by data collection phase are reported in Table 1. Bivariate correlations are reported in Table A1 (Appendix C). Statistical assumptions for models were tested for tanning – 1 month later and all cognitive and affective posttest variables. To examine multicollinearity, all of the posttest variables were regressed on tanning behavior – 1 month later. VIF scores ranged from a 1.40 to 3.18, revealing no evidence of multicollinearity concern. Deviations from linearity revealed no deviation. Scatterplots confirmed data homoscedasticity. In terms of distributions, Kolmogorov-Smirnov tests revealed that all variables were slightly non-normal; however, Micceri (1989) noted that this is typical and that all analyses reported here are robust against violations of non-normality.

Main Effects

Compared to the implementation interventions condition, it was hypothesized that the tailored UV condition would generate immediate increases in posttest fear, threat susceptibility, appearance norm, appearance benefit, threat to freedom, and reactance (H2a-d, H5a-b) and long-term decreases in outdoor tanning 1 month after the intervention (H1). For the immediate posttest data, ANOVA revealed significant main effects for fear, $F(1, 647) = 9.64, p = .002$, appearance benefits of tanning, $F(1, 647) = 4.84, p = .028$, appearance norms for tanning, $F(1, 647) = 6.77, p = .009$, response-efficacy, $F(1, 647) = 5.87, p = .016$, and freedom threat, $F(1, 647) = 5.10, p = .024$. Post-hoc follow-up tests revealed that the tailored UV condition generated more fear and freedom threat and decreased appearance benefits and norms immediately after exposure to the intervention (support for H2a, H2c-d, H5a, see Table 2 for mean, standard errors, F s, and effect sizes). Tailored UV visuals also decreased response efficacy.

For the 1 month later data, the univariate tests (see Table 2) revealed significant main effects for self-efficacy, $F(1, 647) = 9.39, p = .002$, response-efficacy, $F(1, 647) = 8.62, p = .003$, and outdoor tanning, $F(1, 647) = 5.85, p = .016$. Post-hoc follow-up tests revealed that the implementation intervention condition increased self-efficacy and response efficacy and the tailored UV condition decreased outdoor tanning 1 month after exposure to the intervention (support for H1).

Indirect Pathways: Fear, Susceptibility, and Appearance-Based Beliefs

PROCESS model 4 was utilized to test for indirect pathways (Hayes, 2018). Model 4 allows researchers to test multiple, parallel indirect pathways at a single time. Indirect pathways were hypothesized via posttest fear, susceptibility, appearance norms, and appearance benefits (H3a – d). The outcome model was significant, $R = .44, R^2 = .20, MSE = 1.25, F(5, 648) = 31.63, p < .001$. There were significant indirect paths via posttest fear, effect = .03, Boot $SE = .02$, 95% Boot CI: .0048, .0672, and posttest appearance benefits, effect = $-.18$, Boot $SE = .04$, 95% Boot CI: $-.2674, -.0980$ (see Figure 1). Tailored UV exposure increased posttest fear which increased outdoor tanning behavior 1 month later and decreased posttest appearance benefits which decreased outdoor tanning (support for H3d).

Even though there was a significant indirect pathway through fear, it functioned contrary to expectation: increased fear led to *increased* outdoor tanning.

Indirect Pathways: Serial Appearance-Based Belief Model

PROCESS model 6 was utilized to test for serial mediation linking exposure to tailored UV visuals and outdoor tanning 1 month later via posttest appearance norms and benefits (H4). The cognitive variables were entered in the following order (appearance norm, appearance benefit). The outcome model was significant, $R = .43$, $R^2 = .19$, $MSE = 1.26$, $F(3, 650) = 50.16$, $p < .001$. There was a significant serial path via the norm-benefit chain, effect = $-.08$, Boot $SE = .02$, 95% Boot CI: $-.1202, -.0387$ (see Figure 2). Tailored UV exposure decreased posttest appearance norms which was negatively related to posttest appearance benefits, and, ultimately, decreased outdoor tanning behavior 1 month later (support for H4).

Indirect Pathways: Serial Psychological Reactance Model

As above, PROCESS model 6 was utilized to test for serial mediation linking exposure to tailored UV visuals and outdoor tanning via posttest fear, freedom threat, and reactance (H6, H7). The cognitive variables were entered in the following order: fear, threat to freedom, and anger. The outcome model was significant, $R = .23$, $R^2 = .05$, $MSE = 1.47$, $F(4, 649) = 9.28$, $p < .001$. The threat-reactance chain was not significant, effect = $-.02$, Boot $SE = .01$, 95% Boot CI: $-.0420, .0033$, but there was a significant serial path via the fear-threat-reactance chain, effect = $.02$, Boot $SE = .01$, 95% Boot CI: $.0048, .0454$ (see Figure 3). Tailored UV exposure increased posttest fear which was positively related to freedom threat, threat was positively related to reactance, and, ultimately, reactance increased outdoor tanning 1 month later (support for H7).

Discussion

Compared to a stock UV plus implementation intervention, a stock plus tailored UV intervention increased fear and decreased appearance-based perceptions of tanning. Moreover, tailored UV imagery indirectly impacted tanning via these same mechanisms; fear increased and appearance-based benefits decreased outdoor tanning behavior 1 month after the intervention (see Appendix D for a table detailing support/no support for all hypotheses).

The addition of a tailored UV photo shifted participant perceptions of the benefits of tanning. Specifically, participants were less likely to agree with the statement “I look better with a suntan” after viewing a personalized photo that revealed (invisible) UV damage to their skin. Consistent with the theory of normative social behavior, there was also support for a serial norm-benefit model that positioned appearance norms as a potential driver of appearance benefits (Carcioppolo et al., 2019). Both of these findings parallel past work that UV images might influence sun safe behaviors via appearance-based perceptions (Persson et al., 2018). That suggests that future research should include multi-item measures that focus on appearance-based perceptions (Blashill et al., 2018). It also suggests that future research should examine whether highlighting appearance-based perceptions during the tailored UV intervention maximizes impact, especially for younger audiences. Researchers may find that

the framing of UV images is just as important as the image itself. For example, in the current study, public health educators focused on the technical components of the image (i.e., what a UV photograph is), possible links to melanoma (i.e., based on the findings of Gamble et al., 2012), and questions raised by participants. An alternative approach could be to frame the image in appearance terms and to encourage participants to think about the underlying image implications. An example of this type of approach with morphed facial imagery is provided by Blashill and colleagues (2018).

Consistent with psychological reactance theory, tailored visuals triggered a negative indirect effect on outdoor tanning via fear, freedom threat, and reactance. Whether reactance emerged as a fear-control mechanism (Quick et al., 2018; Witte, 1994) or because the personalized images were threatening to participants' autonomy in another way (Ratcliff et al., 2018) is unclear. Identifying if and how to frame tailored UV visuals to minimize reactance is a priority (Schüz et al., 2013). One of the challenges of visual interventions is that there are almost infinite format and presentation features that could be modified. In a larger sense, this is a primary reason scholarship on visual communication is less frequent and, paradoxically, often simplistic (King, 2015). There are so many features to modify that it overwhelms designers and evaluators alike. Despite these challenges, explicating visual features, especially to reduce reactance, is valuable as visual communication might be ideal for reaching groups with education, literacy, or language barriers (Jensen, 2012).

It is puzzling that tailored UV imagery increased fear but not threat susceptibility. Theory and past research both suggested a relationship between fear and susceptibility, and prior meta-analyses have found that personalized UV images increased susceptibility (Persson et al., 2019; Williams et al., 2013). It is important to note that the meta-analysis found a relationship for susceptibility to photoaging rather than skin cancer. That difference could explain the results observed here. It is also possible that threat susceptibility is already high; past research in France has found that approximately 89% of the public may be aware of the link between UV exposure and skin cancer (Stoebner-Delbarre et al., 2005). Alternatively, it is possible that threat susceptibility measures need refinement or that fear appeal theories would benefit from additional refinement. Concerning the latter, fear may function independent of threat susceptibility or it may manifest faster.

Both intervention conditions provided participants stock UV photos. A strength of this design is that the perceived novelty of UV photographs was reduced. Like engagement, perceived novelty is a potential confound in tailoring research as tailored messages can also be more novel. Novelty could be a mechanism of effect for tailoring interventions, but it might be one with limited long-term utility as novelty could diminish overtime. Yet, providing stock UV photos to both condition is also a limitation of the design because it may limit the impact of the tailored UV condition. Moreover, it is possible that providing both a stock and tailored UV photo could have negatively impacted perception of the tailored condition by triggering repetitiveness (i.e., seeing the same basic message multiple times). Future research could engage this limitation by comparing tailored UV and implementation interventions directly without stock UV images.

The current study had several limitations. Participants were students recruited from eleven high schools in Utah. Utah residents are at elevated risk for developing skin cancer which may influence the effectiveness of interventions. Fear was measured via self-report and only at a single point in time. Neither approach is optimal for an affective state that likely spikes and fades. Appearance-based perceptions were measured with single items; future research should utilize multi-item scales (e.g., Blashill et al., 2018). The study utilized a longitudinal design with a pretest, randomized experiment, immediate post-test, and 1-month follow-up; however, the serial mediation models still lacked temporal ordering for the cognitive measures. The intervention occurred in classrooms where multiple students could see, and comment on, personalized UV photographs from other students.

UV image interventions are an intriguing avenue for skin cancer prevention, especially efforts targeted at younger populations. The continued development of UV image interventions will require research testing how variations in image features influence impact, comparison of UV imagery to other forms of sun safe/skin cancer risk imagery, and innovative delivery mechanisms that allow effective communication with high-risk populations.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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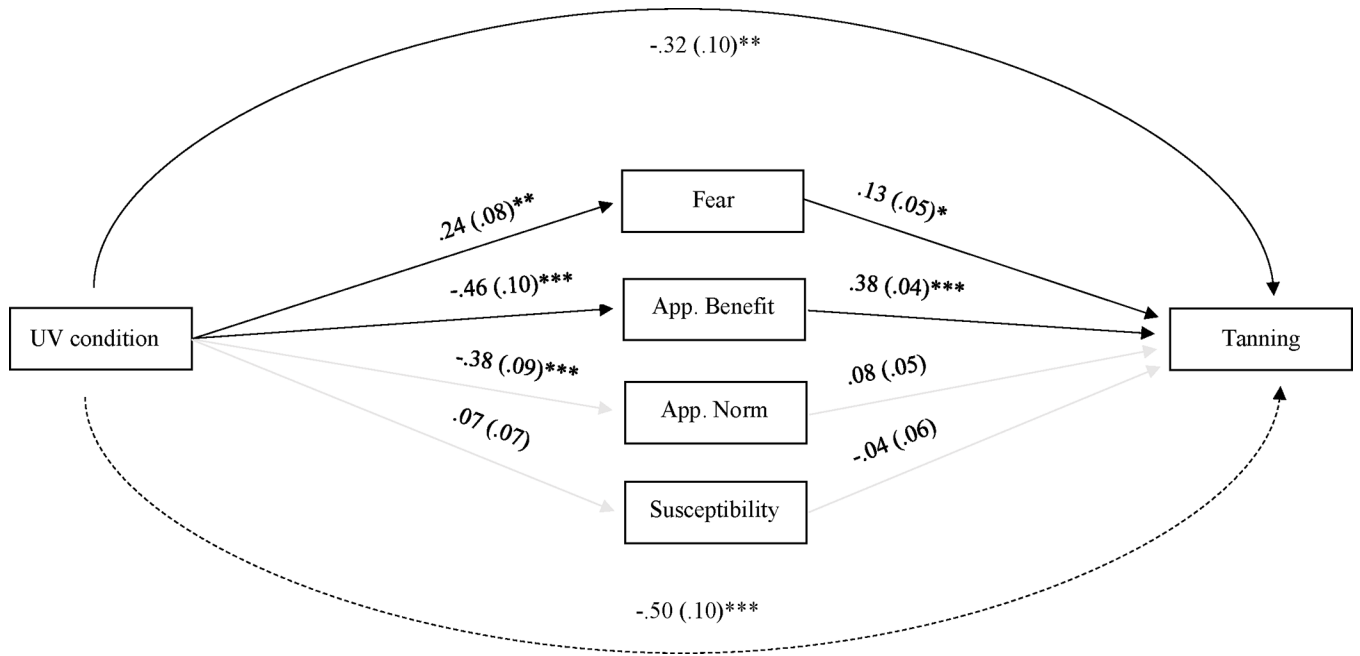


Figure 1. Parallel mediation model. Immediate indirect pathways through fear and appearance benefits. App Norm = Appearance Norm, App Benefit = Appearance Benefit.
 * $p < .05$, ** $p < .01$, *** $p < .001$

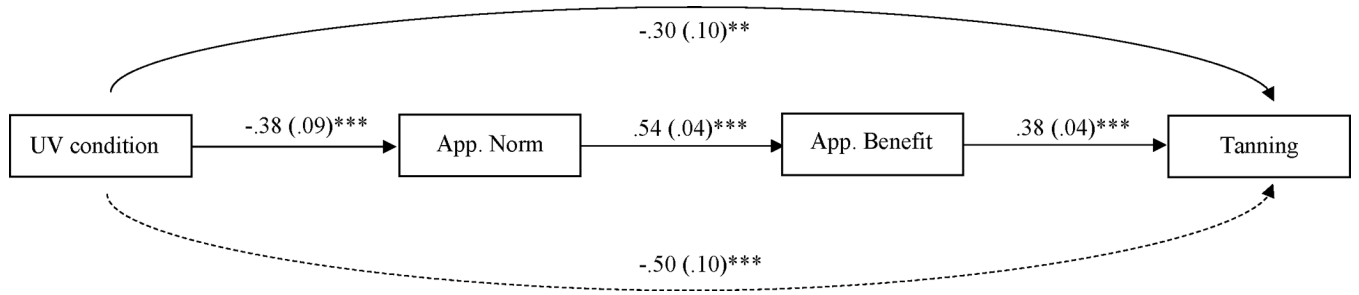


Figure 2.
 Immediate indirect pathways through appearance norms and benefits of tanning. App Norm = Appearance Norm, App Benefit = Appearance Benefit.
 ** $p < .01$, *** $p < .001$

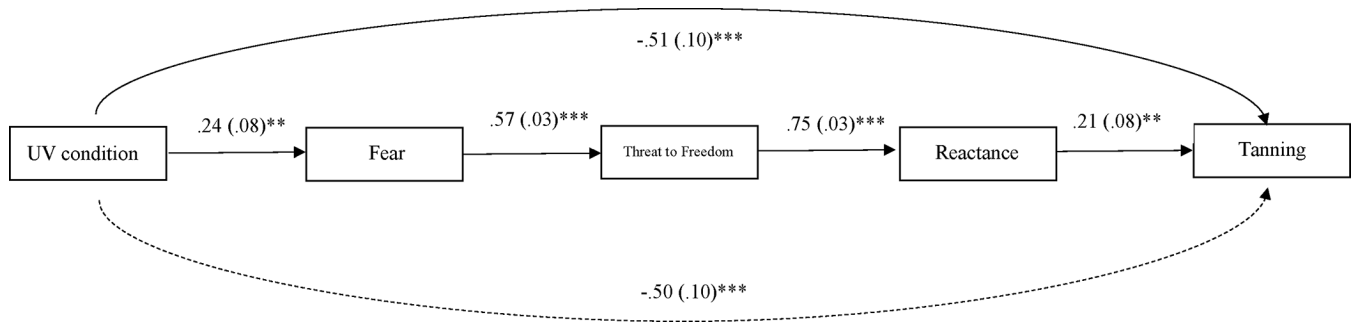


Figure 3.
 Immediate indirect pathways through fear and threat to freedom.
 ** $p < .01$, *** $p < .001$

Descriptive Statistics for Affect, Cognitions, and Behaviors by Data Collection Phase (Pretest, Posttest, 1 Month Later).

Table 1.

	Pretest		Posttest		1 Month Later	
	M(SD)	α	M(SD)	α	M(SD)	α
Fear	--		2.40 (.90)	.95	2.15 (.93)	.96
Appearance Norm	3.75 (1.01)	--	3.76 (1.03)	--	3.63 (1.10)	--
Appearance Benefit	3.39 (1.20)	--	3.32 (1.20)	--	3.27 (1.27)	--
Self-efficacy	3.07 (.86)	.68	3.43 (.83)	.78	3.23 (.87)	.74
Response-efficacy	3.47 (.87)	.75	3.59 (.85)	.80	3.55 (.91)	.81
Threat Susceptibility	3.18 (.84)	.83	3.36 (.84)	.89	3.31 (.89)	.87
Threat Severity	3.71 (.82)	.81	3.76 (.83)	.85	3.70 (.93)	.85
Threat to Freedom	--		2.18 (.89)	.93	2.10 (.94)	.96
Reactance	--		2.12 (.92)	.96	2.04 (.87)	.94
Tanning	2.17 (1.24)		--		2.09 (1.24)	--
N	654		654		654	

Note. Participant self-reported data by time (pretest, posttest, 1 month later). Fear, threat to freedom, and reactance were not measured in the pretest because they are message perceptions. Appearance benefit, appearance norm, and outdoor tanning are single-item measure so no alpha is reported. Outdoor tanning were only assessed in the pretest and 1 month after exposure to the intervention.

Table 2. Cognitions and Behavior by UV Condition and Data Collection Phase (Posttest, 1 Month Later).

	Posttest		1 Month Later		<i>F</i>	<i>d</i>
	Stock	Tailored	Stock	Tailored		
Fear	2.24 (.06)	2.61 (.11)	2.07 (.06)	2.11 (.11)	.13	.03
Appearance Benefit	3.50 (.08)	3.15 (.14)	3.43 (.08)	3.29 (.15)	.66	.08
Appearance Norm	3.90 (.06)	3.54 (.12)	3.71 (.07)	3.48 (.13)	2.50	.14
Self-efficacy	3.44 (.05)	3.25 (.10)	3.24 (.06)	2.88 (.10)	9.39***	.27
Response-efficacy	3.63 (.05)	3.37 (.10)	3.54 (.06)	3.19 (.11)	8.62***	.26
Threat Susceptibility	3.43 (.05)	3.41 (.10)	3.33 (.06)	3.43 (.11)	.67	.07
Threat Severity	3.78 (.05)	3.70 (.10)	3.64 (.06)	3.62 (.11)	.04	.02
Threat to Freedom	2.06 (.06)	2.33 (.11)	2.08 (.06)	2.00 (.11)	.44	.06
Reactance	2.03 (.06)	2.20 (.11)	2.05 (.06)	2.03 (.10)	.03	.02
Tanning	--	--	2.23 (.08)	1.83 (.15)	5.85*	.22
<i>N</i>	457	197	457	197		

Note. Means and standard errors (in parentheses). Participant self-reported data by condition (UV stock, UV tailored) and time (posttest, 1 month later).

* $p < .05$,

** $p < .01$,

*** $p < .001$