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Positive facial affect looks healthy

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ABSTRACT

A healthy appearance is linked to important behavioural outcomes. Here we investigated whether positive facial affect is a cue for perceived health. In study one, two groups of participants rated the perceived health or perceived happiness of a large set of faces with neutral expressions. Perceived happiness predicted perceived health, as did anthropometric measures of expression. In a second experimental study, we collected ratings of perceived health for a wide age range of target faces with either neutral or smiling expressions. Smiling faces were rated as being much healthier looking than neutral faces, confirming that facial expression plays a role in the perception of health. A third study investigating attractiveness as a possible mediator found that expression still had a significant direct effect on perceived health, after accounting for attractiveness. Together, these studies systematically show that facial affect plays a critical role in shaping our perceptions of health in others.

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Possessing a healthy facial appearance is a strongly desired trait, and for good reason—it has numerous positive benefits. Appearing healthy is linked with appearing attractive (Stephen et al., 2012), a trait that influences self-esteem (Feingold, 1992), which has a wide array of positive outcomes including preferential treatment by potential employers, the criminal justice system, and teachers, not to mention potential mates (Efran, 1974; Marlowe, Schneider, & Nelson, 1996; Ritts, Patterson, & Tubbs, 1992). Individuals even prefer a healthy looking leader to one that appears intelligent (Spisak, Blaker, Lefevre, Moore, & Krebbers, 2014). There are also negative outcomes to looking *unhealthy*. People avoid faces that are primed to appear unhealthy (Mortensen, Becker, Ackerman, Neuberg, & Kenrick, 2010) or appear depressed (Scott, Kramer, Jones, & Ward, 2013). Thus the mere appearance of health is advantageous, conferring positive social and psychological outcomes. These social advantages of appearing healthy are at least partly due to the fact that appearing healthy is also a valid predictor of actual health (Kalick, Zebrowitz, Langlois, & Johnson, 1998; Zebrowitz et al., 2014).

Several visual cues have been identified that mediate the perception of health from the face. Facial adiposity—the perception of weight from the face—is a correlate of body mass index (BMI) and is a cue for health perception (Coetzee, Perrett, & Stephen, 2009; Coetzee, Re, Perrett, Tiddeman, & Xiao, 2011). The reflectance properties of facial skin are known to be particularly important cues to health (Jones, Kramer, & Ward, 2012). Overall skin colour is a cue for health perception, with people finding skin that is lighter, yellower, and redder as healthier (Stephen, Coetzee, Law Smith, & Perrett, 2009; Stephen, Coetzee, & Perrett, 2011; Stephen, Law Smith, Stirrat, & Perrett, 2009). Skin texture is also an important cue for health perception (Jones, Little, Burt, & Perrett, 2004), particularly skin homogeneity, with more even skin tones considered healthier as well as younger and more attractive (Fink, Bunse, Matts, & D'Emiliano, 2012; Fink, Grammer, & Matts, 2006; Fink, Matts, Röder, Johnson, & Burquest, 2011; Matts, Fink, Grammer, & Burquest, 2007). In addition to overall skin colour and small-scale variation in skin reflectance (i.e., skin homogeneity), variation in reflectance properties between larger regions of the face can also be a cue to perceived health. While yellowness looks healthy over the entire face, there is recent evidence that redness and lightness look healthy in particular regions of the face but not others (Jones, Porcheron, Sweda, Morizot, & Russell,

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2016). Specifically, redness appears healthy in the cheek area but not under the eyes, while the opposite is true for lightness. Also, facial contrast—the colour and luminance differences between the facial features and surrounding skin—is a cue for perceived health (Russell et al., 2016). While the list of known cues to perceived health from the face is growing, there are likely many other visual cues that determine the appearance of health.

One likely cue for perceiving health from the face is facial expression. Positive facial expressions are an index of underlying 'positive affect', which has been linked to health. Individuals with higher levels of positive affect live significantly longer than those with lower levels (Levy, Slade, Kunkel, & Kasl, 2002), are less likely to suffer from serious health problems such as stroke (Ostir, Markides, Peek, & Goodwin, 2001) or the common cold (Cohen, Doyle, Turner, Alper, & Skoner, 2003), and have increased pain tolerance (Alden, Dale, & DeGood, 2001). There are also studies directly linking positive facial expressions to health status. New college students who smiled more intensely in Facebook profile pictures reported having greater life satisfaction and better social relationships just before graduation four years later (Seder & Oishi, 2011). Major league baseball players who smiled in their official photograph, taken in 1952, lived longer than those who did not (Abel & Kruger, 2010). Those with a genuine smile in their photograph were half as likely to die in any year as those who did not smile, and smiling explained 35% of the variance in survival. Smiling seems to act as an index of underlying positivity that is tied to physical and mental health (Fredrickson & Joiner, 2002). The physical act of smiling seems to confer health benefits over short-term scales as well. During a stressful task, the induction of a smile leads to lower heart rates during the recovery phase, with a slightly more pronounced effect for genuine smiles (Kraft & Pressman, 2012). Smiling may also influence perceptions of health due to simple low-level properties of the face, such as the quality of teeth shown during a smile, which reflect environmental and developmental effects on the individual and are known to affect attractiveness (Hendrie & Brewer, 2012).

Though positive affect and positive facial expressions are clearly linked to health, no studies have directly investigated the question of whether positive expressions are used as a cue for perceiving health in others. However, three studies focused on other topics have reported data that is relevant to this question. One study found evidence that a positive neutral expression predicted perceived health (Zebrowitz et al., 2014). Using a Brunswik lens model (Brunswik, 1956), Zebrowitz et al. (2014) found that participants relied on positive expression to infer the health of an individual. Interestingly, this utilization was present for both younger and older faces, indicating it may be a general-purpose cue used to judge health from the human face. Another study used an anthropometric measure of facial expression and found that positive mouth curvature, but not greater eye openness, significantly predicted variation in perceived health (Henderson, Holzleitner, Talamas, & Perrett, 2016). Mouth curvature is presumably a visual cue used to perceive facial expression, though that was not directly established. Thus, two studies found evidence for a correlation between perceived health from the face and the degree of positivity of the neutral or resting face. However, this kind of study cannot establish a causal relationship. Indeed, there is evidence for at least two variables that could underlie this correlation. Both facial adiposity (Henderson et al., 2016) and sleep loss (Sundelin et al., 2013) are related to perceived health and affect mouth curvature or expression positivity. Thus experimental evidence is needed to determine a causal effect of facial expression on perceived health.

Mehu, Little, and Dunbar (2008) conducted a study to investigate whether interactions between smiling, participant sex, and target sex influence general social trait judgments. Target faces were photographed smiling and with neutral expressions, and participants were asked to rate the faces on ten different attributes, of which health was one. They found links between smiling and some of these traits, including perceived health, providing initial evidence in support of the idea that smiling is a cue to health. However, the authors did not address the question of whether smiling affects perceived health, as it was an incidental finding. Further, with ten dependent variables there is a likelihood of Type I error and the possibility that the effect of smiling on perceived health is part of a "halo" effect rather than a relationship that is specific to those variables. In summary, while there is evidence to suggest that facial expression may affect the perception of health from the face, the evidence is either exploratory or incidental, and has not conclusively

established a causal relationship independent of a broader "halo" effect.

Here we sought to systematically test the hypothesis that positive facial expression enhances perceived health by collecting converging evidence using multiple approaches to build a complete picture of the relationship between expression and perceived health. Unlike previous studies that have incidentally reported data germane to this hypothesis, we conducted multiple confirmatory tests of the hypothesis with large target face sets and participant sample sizes. In three studies with very different experimental designs, we sought to systematically investigate the utility of positive facial expression as a cue for judging perceived health from the face, and to determine whether the utility of the cue is merely due to "halo" effects. Additionally, in one study (Study 1) we tightly controlled the demographic variables of the target set to eliminate possible sources of variance, while in the other two studies (Studies 2 and 3) we used a more heterogeneous target set to establish the generalizability of the effect and to investigate possible moderating variables.

In Study 1, we examined perceived health ratings and perceived happiness ratings for a large sample of faces with neutral facial expressions, and included anthropometric measures to support perceptual measures. This allowed us to test whether individual differences in naturally occurring facial positivity predicted perceived health. In Study 2 we experimentally manipulated facial expression by presenting the same target faces either smiling or holding a neutral expression, and asked participants to rate the perceived health of the faces. In this way we tested whether the same individual was perceived as more healthy when smiling than not. In Study 3 we collected ratings of perceived health and also ratings of perceived attractiveness on target faces that were either smiling or holding a neutral expression. This allowed us to examine whether the effect of expression on health perceptions is mediated by attractiveness, and more broadly the possibility that it is merely part of a larger "halo" effect of positive expressions on person perception.

Study 1

Materials

We sought to minimize differences between stimuli in terms of non-health variables by selecting a group of target faces that did not vary in terms of age, sex, or race. Having decided for this reason to use a narrow age range, we chose a sample of somewhat older, rather than younger adults, from the belief that older adults would exhibit greater variation in actual and apparent health than younger adults, because they have had more time to experience the effects of health-related environmental and genetic variation. This notion is supported by the findings of Zebrowitz et al. (2014), who found that perceived health was a much better predictor of actual health in older faces than in younger faces. Toward this end, full face images of 146 Caucasian women aged 56–60 (M = 58.10, SD: 1.40 years) were acquired using a closed photographic system that allows accurate and reproducible positioning of the models as well as controlled lighting conditions.

The height of the camera (Canon EOS-1 Ds Mark II, 17 MP) was adjusted to the height of the face. Each face was illuminated by three flashes: one in front of the face (diffuse light), the height of this flash was adjusted to the height of the subject's face; and two flashes illuminating the face from a 45 angle (direct light), the height of these flashes was fixed. The models wore no makeup or adornments. Critically, they were asked to keep a neutral expression while gazing directly into the camera. The images were cropped to leave the face contour just visible.

Objective measurements of eyelid openness and mouth curvature

Expression was assessed by measuring the amount of eyelid openness and mouth curvature for each face, following the procedure used by Henderson et al. (2016), described in greater detail elsewhere (Talamas, Mavor, Axelsson, Sundelin, & Perrett, 2016). All 146 faces were landmarked in JPsychomorph (Tiddeman, Burt, & Perrett, 2001), including points that indicated the centre of the pupil, the middle of the upper eyelid, and the inner and outer canthus of the eyes. Points also marked the left and right corners of the mouth, as well as the centre of the mouth. Eyelid openness was calculated as the distance between the centre of the pupil to the top of the eyelid, divided by the width of the eye, which was defined as the distance between the inner and outer canthus of the eye. This procedure was repeated for both eyes, and the resulting values averaged. Mouth curvature was calculated by averaging the height of the left and right corners of

the mouth, and subtracting the height of the centre of the mouth. This value was then divided by the width of the mouth, defined as the distance between the left and right corners of the mouth. The sign of mouth curvature values were reversed so positive values indicated a more upturned mouth, and negative values indicated a downturned mouth. Custom Python software was used to extract the necessary landmarks and calculate these metrics.

Participants

A sample of 93 university students (55 females, 18–25 years, $M = 19.11$, SD = 1.32) rated the target faces for perceived happiness, completing the study for course credit. A separate sample of 100 students (47 females, 18–22 years, $M = 18.68$, SD = 0.92) rated the target faces for perceived health, also for course credit. Though the sample of participants was younger than that of the target stimuli, Zebrowitz et al. (2014) found that accuracy in health judgments are accurate regardless of the age of the observer and the face. All participants gave informed consent, and the Gettysburg College Institutional Review Board approved the research.

Procedure

Participants rated each target face on a 1–7 Likert scale, indicating their response via a key press. Stimuli were presented in a random order, one at a time. Before beginning the ratings task, participants were familiarized with the set of stimuli by briefly viewing each face for 500 ms. The purpose of this familiarization phase was to give participants a sense of the range of faces in the set, to facilitate their use of the entire rating scale. Participants who rated perceived happiness were asked "How happy does this person look?" with a score of 1 being very unhappy, 4 being neither unhappy nor happy, and 7 being very happy. Although not analysed here, these participants also rated faces for perceived energy in another block in order to examine a different research question. Presentation of these blocks was randomized for each participant. Participants rating the faces for perceived health were asked "How healthy is this face?", with a score of 1 being very unhealthy, and 7 being very healthy. Stimuli were presented using software written in PsychoPy (Peirce, 2007), and remained visible until a judgment was made. Thus, two scores were calculated for each target face; the perceived happiness averaged across all participants and the perceived health averaged across all participants, with separate participant groups making these two ratings. Participants showed good agreement for perceived happiness and perceived health, with Cronbach's $\alpha = 0.96$, and $\alpha = 0.98$, respectively.

Results

We first sought to validate the use of landmark-based methods for capturing variation in facial expression. To do this, we used the measure of eyelid openness and mouth curvature to predict our measure of perceived happiness using multiple regression. The model was significant, $F(2, 143) = 63.68$, $p < 0.001$, $R^2 = 0.471$. That is, eyelid openness and mouth curvature captured approximately 47% of the variation in perceived happiness. Both eyelid openness, $b = 0.173$, $t = 2.83$, $p = 0.005$, and mouth curvature, $b = 0.650$, $t = 10.64$, $p < 0.001$, independently predicted expression. As upward mouth curvature and eyelid openness increased, so did ratings of happiness, indicating its validity in capturing variation in neutral expression.

Next, we sought to replicate the findings of Henderson et al. (2016), and extend it by including our measure of emotional expression, examining how these variables may predict perceived health. Both landmark-based measures were entered into the first step of a stepwise regression model, adding the perceptual measure of expression in a subsequent step. The first model was significant, $F(2, 143) = 8.19$, $p < 0.001$, $R^2 = 0.103$, with both eyelid openness, $b = 0.227$, $t = 2.85$, $p = 0.005$, and mouth curvature, $b = 0.208$, $t = 2.62$, $p = 0.010$, predicting health. The model remained significant when adding in perceived expression as a predictor, $F(3, 142) = 15.83$, $p < 0.001$, $R^2 = 0.251$. Change statistics confirmed the increase in explained variance was significant, $F(1, 142) = 28.02$, $p < 0.001$, $R_{change} = 0.148$. In this new model, only perceived emotional expression remained a significant predictor, $b = 0.529$, $t = 5.29$, $p < 0.001$, with eye openness reducing to a trend, $b = 0.135$, $t = 1.81$, $p = 0.073$. Mouth curvature was no longer a significant predictor in the second model, $b = 0.135$, $t = 1.38$, $p = 0.167$. Additionally, despite eyelid openness and mouth curvature predicting the perceived measure of expression, there was no evidence of problematic

Table 1. Results from the stepwise regression in Study 1.

Model	Predictor	β	t value	p value	VIF
1	Eyelid openness	0.227	2.85	0.005	1.00
	Mouth curvature	0.208	2.62	<0.001	1.00
2	Eyelid openness	0.135	1.81	0.073	1.06
	Mouth curvature	0.135	1.38	0.167	1.81
	Perceived expression	0.529	5.29	<0.001	1.89

Note: Increase in $R^2 = 0.148$, $F_{change} = 28.02$, $p < 0.001$, after the introduction of perceived expression. Model fits reported in text.

multicollinearity, with all variance inflation factors (VIF) for predictors being less than 2 (Perceived expression: 1.89; mouth curvature: 1.81; eyelid openness: 1.06). These data are summarized in Table 1.

Discussion

There are several findings of note from this study. Overall, we show that faces with a more positive neutral expression are perceived as healthier. The effect was quite large, considering the nature of the relationship. Even with "neutral" facial expressions, perceived positivity of expression, along with mouth curvature and eyelid openness, explained 25% of the variance in health judgments. The size of the effect is not dissimilar to the effect sizes of other contributors to perceived facial health, like cosmetics (20%; Nash, Fieldman, Hussey, Lévêque, & Pineau, 2006), facial adiposity (26%; Coetzee et al., 2009), perceived age (29%; Fink et al., 2006), and peri-orbital luminance (17%, Jones et al., 2016).

By including a landmark-based measure of eyelid openness and mouth curvature, we were able to partially replicate the findings of Henderson et al. (2016). We first confirmed that these measures explained a significant proportion of the variance in judgments of positivity, suggesting they are a valid measure of perceived expression in neutral faces as well as a valid measure of the physical openness of the eye and curvature of the mouth (Talamas et al., 2016). We then found that these measures explain significant variation in perceived health, replicating the findings of Henderson et al. (2016). However, we found that eyelid openness was a slightly stronger predictor of perceived health than mouth curvature, whereas Henderson et al. (2016) found that mouth curvature but not eyelid openness predicted perceived health. This difference is likely due to the different age samples used in the two studies. Henderson et al. (2016) used a sample of younger faces (18–32 years old), while we used a sample of older faces (56–60 years old). It may be that eye openness is a more useful cue to perceived health in older faces, perhaps because of the tissue slackening around the eyes that increases with age (Puizina-Ivić, 2008).

When adding in a perceptual measure of perceived expression to the model, we found that this significantly increased the proportion of variance explained in perceived health, and became the only significant predictor. This suggests that the predictive value of eyelid openness and mouth curvature for perceived health is entirely due to their utility for perceiving facial expression, and that there are other physical features that are important for perceiving facial expression. Though landmark-based methods capture a good deal of the variation in health perception, a perceptual measurement of facial expression captures more. Our results also replicate the findings of Zebrowitz et al. (2014) that relied on a perceptual measure of expression. Thus, these converging results suggest good generalizability of the finding, and confirm that positive facial expression plays a significant role in the perception of health from faces, an important implication for future studies.

It is not entirely clear, however, what is the cause of these links between positive facial expressions and perceived health in "neutral" faces. It is possible that these subtle variations in the perceived happiness or positivity of neutral expressions reflect varying levels of positive affect. For example, individuals who smile more frequently may have higher levels of positive affect, resulting in a more positive neutral expression (Malatesta, Fiore, & Messina, 1987). There might be reason to suspect that a more positive neutral expression is also linked with actual health, as Henderson et al. (2016) showed that faces with greater adiposity (due to higher BMI) tended to have a more downward mouth curvature. This suggests that a less positive facial expression might share variance with a trait that is negatively related to health—high weight. Further, the relationship between a negative neutral expression and a lack of sleep, which negatively affects health, suggests a possible link with underlying health (Sundelin et al., 2013).

Study 2

Having found in a correlational design that perceived facial expression significantly predicted perceived

health, we sought to determine with an experimental design that facial expression is causally related to perceived health. Such a causal relationship would support the idea that facial expression of emotion is indeed a cue for perceived health. Toward this end, we designed an experiment with facial expression as a manipulated independent variable, by using photographs of the same faces that were either smiling or making a neutral expression. Unlike in the previous study, here we sought to test this hypothesis with a more demographically variable set of target faces that included both sexes and a wide range of adult ages. This allowed us to investigate whether any effects of facial expression on perceived health vary with gender or age.

Materials

We used the FACES database as a stimulus set (Ebner, Riediger, & Lindenberger, 2010). The FACES database consists of 171 female and male faces in young (n = 58, 19–31 years, M = 24.20, SD = 3.40, 29 females), middle aged (n = 56, 39–55 years, M = 49.0, SD = 3.90, 27 females), and older (n = 57, 69–80 years, M = 73.20, SD = 2.80, 29 females) adults with carefully posed facial expressions. We selected the "happy" and "neutral" expressions of each model for use in this study, and cropped the images to leave the face contour visible. Models were trained to give high intensity expressions, validated against measures of facial expression (see Ebner et al., 2010, for more details). Example stimuli are shown in Figure 1.

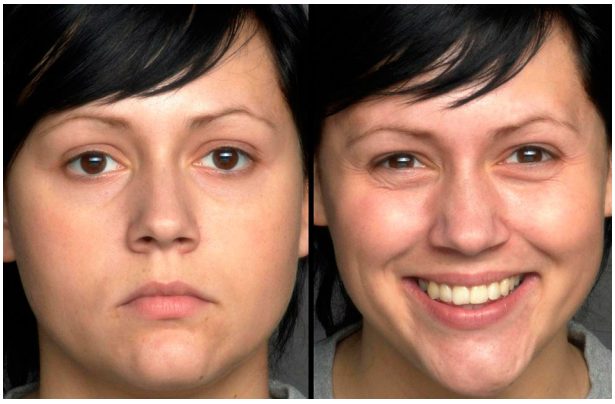

Figure 1. Example stimuli from Study 2, illustrating the two smile conditions [neutral, smiling]. Participants viewed each identity once, but only one of the two smile conditions. For example, any single participant viewed only one of the above two images.

Participants

A different sample of 57 university students (30 females, 18–21 years, M = 18.74, SD = 0.82, age unavailable for 20 participants due to a software error) completed the study for course credit.

Procedure

Participants rated the FACES stimuli for health, using custom Python software written with PsychoPy (Peirce, 2007). We used a carefully controlled presentation of stimulus to prevent carry over effects between smile conditions, and to more clearly isolate the effects of smiling, if any, on perceived health. Each observer rated all 171 faces in a random order, but each face was presented in a randomly selected smile condition – either neutral or smiling. That is, while each observer saw all the faces, no two observers saw the same combination of smiling and neutral images, as the smiling condition (neutral or smiling) of each face was determined randomly at the beginning of the experiment. This method prevents carry over effects and gives a better idea of the true effects of smiling on perceived health. For example, if participants viewed faces in both smile conditions the effect of smiling on health would be artificially increased or decreased, as observers would be able to compare both versions of each face in the same session. Conversely, if observers viewed only the faces in one condition (for example, all smiling), then the effect of smiling on health would be reduced, given that the only source of variation in health would be the differences between faces. This approach has been used successfully elsewhere to measure the effect size of other facial attributes on perceptions (Jones & Kramer, 2015, 2016; Morrison, Morris, & Bard, 2013).

The three different age groups of the FACES set were presented to participants in separate blocks. Before each block began, participants were familiarized with each face by a brief 500 ms exposure, as in Study 1. The orders of blocks were counterbalanced across participants. Participants were asked "How healthy is this person's face?", and rated the images on a scale of 1 (*very unhealthy*) to 7 (*very healthy*), indicating their responses via mouse click. Stimuli remained on screen until a judgment was made.

Results

Each image received an average of between 27 and 29 ($M = 28.50$, SD = 3.61) ratings. We averaged the ratings of each image to provide an average rating of health in each condition for each model, i.e., both neutral and smiling. Mean ratings by condition are presented in Figure 2. Treating the stimulus as the unit of analysis, we carried out a 2 (Smile: Neutral, Smiling) × 2 (Sex of Face: Female, Male) × 3 (Age of Face: Young, Middle, Old) mixed model ANOVA, with repeated measures for Smile, to examine the effect of smiling on perceived health in male and female faces across age groups.

There was a large and significant main effect of smiling on perceived health, $F(1, 165) = 341.86$, $p < 0.001$, $\eta^2 = 0.23$, with smiling faces ($M = 4.63$, 95% CI [4.54, 4.72]) perceived as healthier than neutral faces ($M = 3.84$, [3.74, 3.94]). There was also a significant main effect of Age of Face, $F(2, 165) = 32.42$, $p < 0.001$, $\eta^2 = 0.18$, with ratings of health declining with age from young ($M = 4.69$, [4.54, 4.84]), to middle aged ($M = 4.17$, [4.02, 4.32]), to older adults ($M = 3.84$, [3.68, 3.98]). There was no main effect of Sex of Face, indicating that female and male faces were rated as equally healthy, $F(1, 165) = 0.13$, $p = 0.723$, $\eta^2 = 0.00$. There was not a significant interaction between Sex of Face and Age Group, $F(2, 165) = 0.55$, $p = 0.575$, $\eta^2 = 0.00$, or Sex of Face and Smile condition, $F(1, 165) = 0.56$, $p = 0.455$, $\eta^2 = 0.00$, and neither was there a three-way interaction, $F(2, 165) = 0.95$, $p = 0.389$, $\eta^2 = 0.00$. However, there was an interaction between Smile and Age Group, $F(2, 165) = 3.06$, $p = 0.050$, $\eta^2 = 0.01$. We examined this interaction in more detail by looking at the differences between smiling and neutral faces in each age group, regardless of the sex of the face. We observed significant differences in the young, $t(57) = 8.69$, $p < 0.001$, $d = 1.79$, middle, $t(55) = 11.27$, $p < 0.001$, $d = 2.42$, and older age groups, $t(56) = 12.20$, $p < 0.001$, $d = 2.71$. Notably, the effect size (Cohen's d, corrected for the correlation between neutral and smiling faces within each group) of smiling on perceived health increased in each age group, indicating a greater effect of smiling on perceived health as age increases.

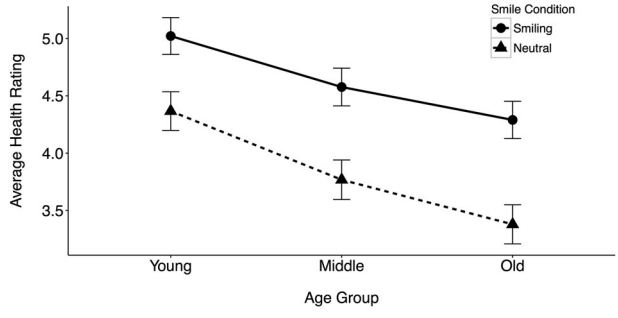

Figure 2. Mean ratings of perceived health across smile condition and age groups. Error bars represent 95% CI.

Study 3

Having found a link between facial expression and perceived health in Studies 1 and 2, we sought to determine if this relationship was the result of a "halo" effect. Previous studies have found high correlations between ratings of perceived health and attractiveness of faces (Boothroyd, Jones, Burt, & Perrett, 2007). It may be that smiling makes the face appear healthier because it makes the face look more attractive. In other words, the effect of smiling on perceived health may be mediated by attractiveness. To test this possibility, we again treated facial expression as a manipulated independent variable, by using a subset of the photographs from Study 2 that were either smiling or making a neutral expression. Unlike in the previous studies, here we collected ratings of attractiveness as well as of perceived health. This allowed us to investigate whether the effect of facial expression on perceived health can be explained by a change in attractiveness.

Materials

We used the young group within the FACES database as a stimulus set (Ebner et al., 2010). This consisted of 58 female and male faces (19–31 years, $M = 24.2$, SD = 3.40, 29 females) with carefully posed facial expressions. We again selected the "happy" and "neutral" expressions of each model for use in this study, and cropped the images to leave the face contour visible.

Participants

A different sample of 87 university students ($M = 19.03$, SD = 1.06) completed the study for course credit. All participants gave informed consent, and the Gettysburg College Institutional Review Board approved the research.

Procedure

Participants rated the young FACES stimuli for perceived health and attractiveness, using custom E-Prime software. The two different ratings were presented to participants in separate blocks. The order of blocks was counterbalanced across participants. In one block, participants were asked "How healthy does this person look?", and rated the images on a scale of 1 (*very unhealthy*) to 7 (*very healthy*) and in the other block, participants were asked "How attractive does this person look?", and rated the images on a scale of 1 (*very unattractive*) to 7 (*very attractive*), indicating their responses via key press. Stimuli remained on screen until a judgment was made.

Results

Participants showed high levels of inter-rater reliability for both judgments (for health ratings Cronbach's $\alpha = 0.97$; for attractiveness ratings Cronbach's $\alpha = 0.98$), so we averaged the ratings of each image to provide an average rating of perceived health and attractiveness in each condition for each model, i.e., both neutral and smiling. The bivariate correlations between the attractiveness ratings and the perceived health ratings were significant for neutral faces, $r(56) = 0.873$, $p < 0.001$, and for smiling faces, $r(56) = 0.883$, $p < 0.001$.

To test whether attractiveness mediates the effect of expression (i.e., neutral, smiling) on perceived health, we used the SPSS plugin MEMORE (Montoya & Hayes, 2017). We conducted a mediation analysis with perceived attractiveness ratings entered as the mediating variable and perceived health ratings as the dependent variable (see Figure 3). Percentile bootstrap confidence intervals for indirect effects were calculated using 5,000 bootstrapped re-samples.

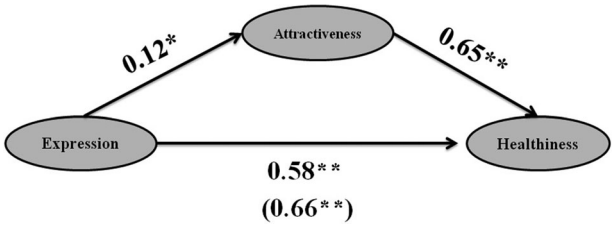

Figure 3. Statistical mediation model with expression (neutral, smiling) as the independent variable, rated attractiveness as the mediator variable, and perceived health as the dependent variable. *$p < 0.05$, **$p < 0.001$.

Expression significantly predicted attractiveness ($\beta = 0.12$, $p = 0.033$), with smiling faces rated as more attractive than neutral faces. And attractiveness significantly predicted perceived health ($\beta = 0.65$, $p < 0.001$), with more attractive faces rated as appearing healthier. The total effect of expression on perceived health was significant ($\beta = 0.66$, $p < 0.001$), meaning that the smiling faces, on average, were rated as 0.66 points higher on perceived health than the neutral faces. In addition, the direct effect of expression ($\beta = 0.58$, $p < 0.001$) was also significant in predicting perceived health. This provides evidence that attractiveness only partially mediates the relationship between expression and perceived health. In other words, attractiveness only explains part of the observed relationship between expression and perceived health since there is still a significant residual direct effect of expression on perceived health.

General discussion

Here we examined the effects of facial expressions on the perceptions of health. We found in a first study that a more positively valenced neutral facial expression predicted perceived health. In a second study we found that faces were perceived as much healthier when they were smiling than when they had a neutral expression. In a third study we found that this relationship held even after accounting for changes in attractiveness. These findings provide clear evidence in support of the hypothesis that facial expressions of emotion or valence, specifically of positivity, impact the perception of health from the face. The effect of facial expression on perceived health was present in faces of a wide range of adult ages, but increased in magnitude with the age of the face. That is, a smile increased perceptions of health more for older faces than for younger faces.

In Study Two, the effect size of smiling, $\eta^2 = 0.23$, was a little larger than the effect size of age, $\eta^2 = 0.18$. That is, smiling explained somewhat more variation in ratings of health than did age. This is particularly surprising given that the age range of face was large—19–80 years old. The connection between advancing age and poorer health is one of the most basic facts of the human condition, and implicit attitudes towards this relationship are present even in children (Nosek, 2002). Further, there is empirical evidence that facial age is a primary

social dimension that strongly influences perceptions of attractiveness (Cunningham, 1986; Cunningham, Roberts, Barbee, Druen, & Wu, 1995; Fink, Matts, et al., 2012; Fink et al., 2011) and personality (Berry & Landry, 1997). Thus, the fact that smiling contributed as much variation to health judgments as did age indicates that it is an important cue for health perception.

One possible interpretation of these findings is that the effect of smiling or a positive neutral expression on perceived health is the result of a halo effect. That is, rather than there being a direct link between positive facial affect and perceived health, these findings may be a manifestation of a broad link between smiling and positivity in which faces appear more positive for any given trait when smiling. Our finding in Study 3 that the effect of facial expression on perceived health is partially mediated by attractiveness provides some support for this argument. Attractiveness did significantly mediate the relationship. However, it was only partial mediation, and there remained a significant direct effect of facial expression on perceived health, suggesting the effect of facial expression on perceived health is not entirely due to attractiveness. Also, two lines of evidence from the literature contradict the notion that the effect of facial expression on perceived health is due to a halo effect. First, Mehu et al. (2008), using multivariate analyses, demonstrated that smiling does not consistently alter the perception of a large variety of social traits. For example, smiling did not significantly alter perceptions of trustworthiness either way, and actually made individuals appear more competitive. This suggests that smiling does not indiscriminately affect all social traits, but instead is a complex signal whose interpretation depends on the sender, the receiver, and the trait being appraised (Mehu et al., 2008). Second, Ganel (2015) demonstrated that smiling reliably increases perceived age; a face looks older with a smile than with a neutral expression. Appearing older is a negative social trait that is inversely related to both actual and perceived health. While the relationship between smiling and perceived health may be partly the result of a halo effect, there is ample evidence that this is at best a partial explanation.

We suggest that the relationship between positive facial affect and perceived health is caused at least in part by the underlying associations between positive facial affect and actual health outcomes (Abel & Kruger, 2010; Seder & Oishi, 2012) and the even deeper associations between positive affect and health (Cohen & Pressman, 2006; Pressman & Cohen, 2005). Individuals disposed to more positive affect obviously experience more positive emotions (Danner, Snowdon, & Friesen, 2001), and the act of smiling is a reflection of an underlying positive emotional state (Levenson, Ekman, & Friesen, 1990). It seems likely that a positive neutral expression or smiling could be an index representing underlying health. This would also predict that partial or fake smiles (involving only the zygomatic major muscles around the mouth, but not the *orbicularis oculi* muscles around the eyes) would not look healthy, since it is the true "Duchenne" smile (involving both muscles) that is linked to healthy outcomes such as better physiological responses to stress (Kraft & Pressman, 2012) and greater longevity (Abel & Kruger, 2010). Our research involved ratings given to unfamiliar faces. Because of this, the expression held at the moment the photograph was taken is the only expression that the raters can associate with the face. This may have the effect of inflating the influence of the expression on trait ratings made of the person. In contrast, traits assigned to known, familiar targets presumably integrate experiences in which the target displays many different expressions. Thus it may be that trait ratings assigned to known targets are be less influenced by momentary expressions, and that such expressions are particularly influential in first impressions or other fleeting interactions.

Though the effects of both smiling and age on perceived health were substantial, there was also an interaction between the two factors. When considering the individual effect sizes of smiling on perceived health in each age group, we found that while they were large overall (all $ds > 1$), they were larger in older faces. While overall ratings of health were lower in older faces, smiling produced a larger difference in perceived health in older adult faces than in younger adult faces. Why might this be? Younger faces possess a number of cues to youth and health such as skin homogeneity, healthy colouration, and higher contrast (Fink, Matts, et al., 2012; Porcheron, Mauger, & Russell, 2013; Russell, Sweda, Porcheron, & Mauger, 2014; Stephen et al., 2011). These cues to health decline with age, which may explain why the effect of smiles was particularly pronounced in older faces —the signal is not diluted by other healthy cues.

Related, it might be that some specific aging features such as facial sagging or wrinkling contribute to perceptions of 'negative affect' in older faces, making them appear less positive. Observers perceive older faces as being sad even when faces are displaying neutral expressions (Hess, Adams, Simard, Stevenson, & Kleck, 2012). There are a number of factors contributing to the decreased ability to perceive emotional expressions in older faces that extend beyond age-related structural changes (Fölster, Hess, & Werheid, 2014), and these may contribute to how health is perceived in this demographic group. For example, smiles increase perceptions of traits such as competence (Reis et al., 1990), which may be unexpected coming from older faces as there are established negative biases towards older faces (Fölster et al., 2014). In adults over the age of 65 years, positive affect is a protective factor against the onset of frailty (Ostir, Ottenbacher, & Markides, 2004), which may be indexed by smiling, making it a particularly salient cue in older faces. We propose that the pronounced effect of smiling on health in older adults is likely a combination of signal clarity (in the absence of other health cues) and the dissonance between the positive social effects of smiling and negative age stereotypes.

Nonetheless, the role of age needs additional study. In particular, it is possible that the larger effects found with older faces in Study 2 is actually due to the participants all being young. Testing a wider age range of participants will be helpful in this regard. Similarly, it will be helpful to test the generalizability of Study 1 across different participant ages, as well as different target ages, sexes, and races. Along these lines, different cultures promote different "display rules" for the facial expressions of emotions. Because of this it would be helpful to investigate the effects of facial expressions on perceived health in other cultural contexts. In conclusion, we have shown that either a positive neutral expression or a smiling expression increases perceptions of health, and to a similar degree. Additionally, we have shown that the effect of expression on perceptions of health persists even after accounting for changes in attractiveness. We also demonstrate that while perceptions of health decline with age, the effect of smiling on perceived health is more pronounced in older adults, a population in which positive affect and health outcomes are particularly important (Ostir et al., 2004). These findings show that positive expression—whether an overt smile or merely a positive-looking resting face—is a cue for perceiving health from the face.

Disclosure statement

No potential conflict of interest was reported by the authors.

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