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Facial First Impressions and Partner Preference Models: Comparable or Distinct Underlying Structures?

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Abstract

Given the frequency of relationships nowadays initiated online, where impressions from face photographs may influence relationship initiation, it is important to understand how facial first impressions might be used in such contexts. We therefore examined the applicability of a leading model of verbally expressed partner preferences to impressions derived from real face images, and investigated how the factor structure of first impressions based on potential partner preference-related traits might relate to a more general model of facial first impressions. Participants rated 1,000 everyday face photographs on 12 traits selected to represent Fletcher et al.'s (1999) verbal model of partner preferences. Facial trait judgements showed an underlying structure that largely paralleled the tripartite structure of Fletcher et al.'s verbal preference model, regardless of either face gender or participant gender. Furthermore, there was close correspondence between the verbal partner preference model and a more general tripartite model of facial first impressions derived from a different literature (Sutherland et al., 2013), suggesting an underlying correspondence between verbal conceptual models of romantic preferences and more general models of facial first impressions.

Keywords: Face perception; First impressions; Person perception; Social inferences; Romantic relationships.

When individuals are asked to think about their ideal romantic partner, they typically focus on three core concerns: preferences associated with warmth and trustworthiness ("How much do I want someone who is kind and supportive?"), status and resources ("How much do I want someone who is successful?") and vitality and attractiveness ("How much do I want someone who is lively and sexy?"). In a series of questionnaire-based studies, Fletcher, Simpson, Thomas, and Giles (1999) provided empirical support for this tripartite theoretical model of partner preferences. Their approach was novel and data-driven, being the first to design a questionnaire measuring partner preferences based on traits generated by participants thinking about their abstract ideal partner.

These verbal partner preference factors have been widely validated (Campbell, Simpson, Kashy, & Fletcher, 2001; Fletcher, Kerr, Li, & Valentine, 2014; Fletcher, Simpson, & Thomas, 2000a, 2000b; Fletcher et al., 1999) and reveal good predictive validity for relationship outcomes. For instance, when people perceive a close match between their partner preferences and their actual romantic partner, relationship satisfaction is higher, frequency of separation is lower, and there are less attempts to modify the partner (Fletcher et al., 2000b, 1999; Overall, Fletcher, & Simpson, 2006).

Through this body of work, Fletcher et al.'s (1999) Ideal Partner Scale has become a standard measure for testing individual differences in partner preferences (Campbell et al., 2001; Fletcher et al., 2014, 2000a, 2000b, 1999). However, although this three-factor model appears consistently when participants are asked for conceptual preferences, most relationships are initiated in contexts where other, perhaps more critical sources of information are available. Given the prevalence nowadays of online dating, initial partner choices are often based on first impressions from information that includes facial photographs. For example, Meetic Group (who own six online dating companies, including

Match.com) moderate 15 billion profile photographs yearly and claims to have introduced six million European couples (Meetic Group, 2016).

An important question therefore involves what information people might derive from faces seen in partner preference-related contexts. When people first encounter someone in real life or online, they derive a wealth of impressions from their face (see Bruce & Young, 2012; Todorov, 2017; Zebrowitz, 2011, 2017), some or all of which might be instrumental in deciding whether to approach a potential partner. Whilst these facial first impressions are known to have at best limited validity (Todorov, 2017), it is well-established that they can be consequential, influencing real life events like political elections, online financial lending, and court decisions (see Olivola, Funk, & Todorov, 2014, for a review) as well as partner preferences. Indeed, there is already a large literature examining the effect of physical attractiveness on relationship preferences. For instance, Walster, Aronson, Abrahams, and Rottman's (1966) pioneering "Computer Dance" speed-dating study underscored the relevance of an attractive partner in determining partner likeability, desire to date the partner again, and incidence of asking the partner out for a future date. Other research has confirmed that facial evaluations, mainly focusing on attractiveness, are consequential in romantic contexts (Fiore, Taylor, Mendelsohn, & Hearst, 2008; Fletcher et al., 2014; Hancock & Toma, 2009; Todd, Penke, Fasolo, & Lenton, 2007).

Crucially, however, these studies involving faces have not tested the applicability of more general *theoretical* models of partner preferences, such as Fletcher et al. (1999). Moreover, the partner preference model may have broader theoretical applicability with potential links to perceived success (e.g., perceived professional or social success). We therefore sought to investigate how theoretical models of verbally expressed preferences relate to the evaluation of real life face photographs. Specifically, we asked whether people can reliably infer the full range of traits that relate to partner preferences from face

photographs, whether these facial trait inferences have an underlying factor structure that parallels Fletcher et al.'s (1999) verbal model, and how they relate to a more general model of impressions from faces (Sutherland et al., 2013).

Facial first impressions

The current research examines facial evaluations of traits related to verbally expressed partner preferences and their relation to more general facial first impressions. An emerging literature on facial first impressions has modelled judgements to faces across different contexts (Olivola, Eubanks, & Lovelace, 2014; Oosterhof & Todorov, 2008; Sutherland et al., 2013; Sutherland, Oldmeadow, & Young, 2016; Walker & Vetter, 2009; see Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2015, for a review). In a landmark study, Oosterhof and Todorov (2008) adopted a data-driven approach involving collecting free descriptions of face photographs and used the trait attributes emerging from these descriptions to build a model of facial evaluations. Their model had factors of valence (closely corresponding to trustworthiness) and dominance (see also Walker & Vetter, 2009). Oosterhof and Todorov (2008) suggested that these factors might be important because together they signal threat: an untrustworthy and dominant face represents someone who is best avoided, while a trustworthy-looking person may be a friendly ally. Therefore, in this model trustworthiness and dominance evaluations may influence approach versus avoidance behaviours quite generally, not just in partner preference-related contexts (Slepian, Young, Rule, Weisbuch, & Ambady, 2012; see Todorov et al., 2015, for a review). This two-factor solution bears striking resemblance to other models of person perception (Rosenberg, Nelson, & Vivekananthan, 1968; Wiggins, 1979), including the Stereotype Content model's dimension of warmth and competence (Fiske, Cuddy, & Glick, 2007; Walker & Vetter, 2016; but see Sutherland et al., 2016).

More recently, Sutherland et al. (2013) extended Oosterhof and Todorov's (2008) model using a wide range of natural face images collected from the internet. They found a tripartite underlying structure comprising factors of approachability, youthful-attractiveness, and dominance. These factors overlap with the trustworthiness and dominance factors identified by Oosterhof and Todorov (2008), with an additional youthful-attractiveness factor. This youthful-attractiveness factor probably did not emerge from Oosterhof and Todorov's (2008) analysis because their face images were relatively standardised and did not vary much in age. Other studies within face perception have also found three-dimensional solutions underlying facial impressions (Wolffhechel et al., 2014), including of impressions of leaders' faces in particular (Olivola, Eubanks, et al., 2014). Moreover, this three-factor structure may parallel Osgood's (1964) famous semantic differential model, which represents attitude formation more generally.

Strikingly, Sutherland et al.'s (2013) facial first impressions model shows potential similarities with Fletcher et al.'s (1999) partner preferences model, with approachability (from the facial impressions model) seeming to parallel warmth-trustworthiness (from the partner preference model), youthful-attractiveness paralleling vitality-attractiveness, and dominance possibly paralleling status-resources. Other research has looked at facial competence as well as dominance (Olivola & Todorov, 2010; Sutherland et al., 2016), and impressions of competence may be particularly closely related to status-resources. The fact that Sutherland et al.'s (2013) facial first impressions model seems to show these potential parallels to Fletcher et al.'s (1999) verbal partner preference model is theoretically interesting because these literatures have not been linked previously and the models have been derived in such very different ways (from words describing specific partner preferences versus unconstrained judgements to visually rich images of faces) and at substantially different

levels of generality (in the specific context of partner preferences or for facial first impressions more generally).

We therefore sought to investigate these potential parallels between the dimensions underlying verbally expressed partner preferences (Fletcher et al., 1999) and facial first impressions (Sutherland et al., 2013). Examining the correspondence between these models is both of theoretical interest in its own right and critical to understanding whether a leading model of verbal partner preferences (Fletcher et al., 1999) can also have potential theoretical utility in explaining partner choices in contexts where people also have available information from faces.

To investigate the applicability of models of facial first impressions to Fletcher et al.'s (1999) verbal partner preference model, we additionally conducted an initial exploration of whether the underlying structure of potential partner preference traits and factors might apply equally to male and female participants and to male and female face images. The romantic relationships literature has often maintained that women (relative to men) in many societies place greater value on status and less emphasis on attractiveness (de Sousa Campos, Otta, & de Oliveira Siqueira, 2002; Dunn, Brinton, & Clark, 2010; Eastwick, Luchies, Finkel, & Hunt, 2014; Feingold, 1990; Finkel & Eastwick, 2009; Hitsch, Hortaçsu, & Ariely, 2010; Shackelford, Schmitt, & Buss, 2005). Yet, relationship researchers have not examined whether the underlying structure of models of preferences remains relatively stable across participant gender and face image gender. Hence, identifying whether the structure of partner preferences remains stable across participant gender and face gender allows us to draw broader inferences regarding the stability of factors involved in person perception, an issue that facial impression models have, also, not yet thoroughly considered. Only recently has research examined some facial impressions as a function of face and participant gender, for

instance, revealing that gender influences judgements of political candidates (Olivola, Sussman, Tsetsos, Kang, & Todorov, 2012; Olivola & Todorov, 2010).

Research overview

We sought to test the potential parallels between the underlying structure of verbal partner preference and facial first impressions models. To achieve this overall aim, we first established whether the traits that are important in verbal theories of partner preferences could be reliably perceived in everyday faces. Having shown this to be the case, we investigated two key questions: (1) whether, when evaluated from faces, these traits have an underlying factor structure equivalent to Fletcher et al.'s (1999) verbally-derived partner preference model, and (2) how closely the structure of Sutherland et al.'s (2013) facial first impressions model corresponds to the structure identified from verbally expressed partner preferences by Fletcher et al. (1999). At the same time, we carried out a more exploratory evaluation as to whether the structure of partner preference traits differs in major ways with participant gender and face image gender.

Because our principal focus of interest was in parallels between the underlying structure of traits involved in verbal partner preferences and in facial first impressions, we did not ask participants directly to evaluate the faces as romantic partners *per se*. Instead, we concentrated on the question of whether participants can reliably evaluate partner-preference related traits in faces and, if so, how the structure of these evaluations relates to facial first impressions more generally.

We began by collecting evaluations of 1,000 highly varied images of faces (Santos & Young, 2005, 2008, 2011) on 12 traits representing Fletcher et al.'s (1999) partner preference factors. Researchers have already found that individuals can reliably evaluate face images on some traits that relate to verbally expressed partner preferences (e.g., trustworthiness, warmth, and attractiveness; Sutherland et al., 2013; Todorov, 2011; Zebrowitz & McDonald,

1991). Hence, we were interested in examining whether face images might be able to represent the full range of traits related to the verbal partner preference model. Moreover, we were interested in how the structure of partner preference traits represented by face images corresponds to the structure identified from verbally expressed preferences by Fletcher et al. (1999). That is, we explored whether the factors identified in the verbally derived partner preference model can also be applied to first impressions of face images. The issue is important because the partner preference model might not apply to facial impressions if verbal and conceptual evaluations are derived in unrelated ways. Given the abundance of facial information in real life romantic contexts, this question is both relevant and timely. Furthermore, we additionally examined the structure of facial impressions separately by participant gender and face gender to determine whether the underlying factor structure shifts substantially in accordance with gender-differentiated concerns, or whether it is more general in nature.

A main focus of interest involved the critical theoretical issue of how the factor structure of traits involved in partner preferences relates to a previous model of facial first impressions. Using ratings of traits that were derived from studies of facial first impressions, Sutherland et al. (2013) identified three factors corresponding to approachability, youthful-attractiveness, and dominance from the highly variable face images used in the present study. We were interested in exploring how closely these facial first impression factors might respectively correspond to the partner preference factors of warmth-trustworthiness, vitality-attractiveness, and status-resources. By investigating this correspondence between models, we sought to determine whether these different types of social evaluation share a common underlying structure that can transcend the specific contexts in which they are made.

In line with previous studies from which our model of facial first impressions was derived (e.g. Sutherland et al., 2013, 2016) all of the analyses we report involve the

underlying structure of facial impressions. To achieve this, we use the averaged responses to each of the 1,000 face images as the primary data, rather than individual participants' responses (cf. Sutherland et al., 2013, 2016). Recent work has shown that individual participant responses comprise a mix of 'shared' (common to all participants) and 'private' (idiosyncratic to that participant) taste (Germine et al., 2015; Hehman, Sutherland, Flake, & Slepian, 2017; Hönekopp, 2006). By averaging participants' responses, we reduce much of the impact of differences in private taste and thus establish whether there are substantial influences based on shared taste.

Method

Participants

One hundred and twenty-four participants, university students, were recruited at the first author's university (50% male, mean age of 21 years, *SD* = 3.32). Participants were self-reported native English speakers, raised in a Western environment. The participants provided written consent to procedures approved by the Ethics Committee of the university's Psychology Department.

Face images

Our study adopted a novel approach to exploring partner preference-related traits by using highly variable everyday face images (termed ambient images by Jenkins, White, Van Montfort, & Burton, 2011), rather than the standardised images typically used in face perception experiments. Face images on social media are examples of ambient images that include the variable properties of pose, expression, lighting and so on that are inherent in natural contexts. Ambient images provide perceivers with more facial cues, relative to standardised images, resulting in a naturalistic exploration of facial impressions.

The study used 1,000 ambient image photographs of faces (Santos & Young, 2005, 2008, 2011), representing 500 female and 500 male Caucasian non-famous adults. Like other

face databases (e.g., Oosterhof & Todorov, 2008) to avoid other-race effects (Anzures et al., 2013; Feng et al., 2011; Hugenberg & Bodenhausen, 2003; O'Toole & Natu, 2013) non-Caucasian faces were not included. The only exclusion criteria were non-adult and non-Caucasian appearance. Face images were taken from the internet and left deliberately unconstrained regarding variability between images (e.g., pose, lighting, background, age, expression, facial hair, amongst others; see Figure 1 for examples). Images were 150 pixels in height and were cropped to reveal only the individuals' head and shoulders.

Figure 1. Example ambient images like those used in the study (from the authors' personal collections). The authors have permission from the individuals depicted here to share their likenesses. Photographs from the database of 1,000 images are not shown for reasons of copyright and confidentiality.

Partner preference ratings

We sampled 12 traits from Fletcher el al.'s (1999) verbal partner preference model: understanding, supportive, considerate, kind, sexy, adventurousness, good lover, outgoing, has a good job, is financially secure, has a nice house or apartment, and is successful (these last four traits were accompanied by *'or potential to achieve'* in parentheses as per Fletcher et al. 1999). To offer a strong test of the correspondence between verbal partner preference and facial first impression models, traits were non-overlapping with those used by Sutherland et al. (2013).

Participants were informed that the study involved first impressions of faces and that the task was self-paced, but to rely on their first impressions (Sutherland et al., 2013;

Todorov, Mandisodza, Goren, & Hall, 2005). Participants completed six practice trials, by rating face stimuli randomly selected from the database, and then rated 1,000 images, in a random order, on a single trait to avoid carry-over effects (e.g., Hamermesh & Abrevaya, 2013; Rhodes, 2006). Ten participants (five male) were randomly assigned to rate only one of the 12 traits. Ratings were made on a Likert scale (e.g. 1: not supportive – 7: very supportive). Hence, for each trait, 10 different participants rated all 1,000 faces. Images remained on the screen until participants had made their judgement; the inter-trial interval was 750ms. On completion, participants were debriefed and reimbursed with a small payment. The task was programmed using E-Prime 2.0 (Psychology Software Tools, Pittsburgh, USA) and took 60 minutes.

Facial first impression ratings

We used the 13 facial first impressions traits from Sutherland et al. (2013): aggressiveness, approachability, trustworthiness, degree of smile, confidence, health, attractiveness, age, babyfacedness, dominance, masculinity, intelligence, and (tanned) skin tone. Mean ratings across at least 10 participants were available for these traits, excepting attractiveness (n = 6; collected by Santos and Young, 2005, 2008, 2011). Ratings from four additional participants on attractiveness were collected for the present study using the same method (to arrive at n = 10).

Results

There was good internal consistency of trait judgements across raters (all Cronbach's alphas over .66; Nunnally & Bernstein, 1994), in line with previous studies (e.g. Sutherland et al., 2013). Therefore, traits that are important to theories of verbally expressed partner preferences are also reliably evaluated in everyday face images. In this context Cronbach's alpha represents the correlation between the evaluations of different groups of raters, rather than individual participant reliability *per se*. These alpha values therefore offer a solid basis

for the analyses we conducted, which were based on averaged (i.e. group) evaluations of the different face images.

To examine the structure of trait impressions, we averaged the ratings across the participants for each trait and face image. We conducted three main analyses. First, we conducted a factor analysis of the facial impressions involving the traits derived from Fletcher et al. (1999), to model the structure of these partner preference-related traits when they were derived from facial evaluations. Second, we conducted four independent factor analyses of the trait impressions separated by participant gender and face image gender, to examine whether the structure remained stable across these combinations. From these analyses, we created averaged images to visualise the facial cues corresponding to each factor. Third, we correlated the factor scores derived from the face-related partner preference model and Sutherland et al.'s (2013) facial first impressions models to test the overlap between the models.

The structure of facial impressions involving traits derived from the verbal partner preference model

We carried out a factor analysis on the ratings of the 1,000 face images to model the structure of impressions of partner preference-related traits when these were evaluated from faces. Factor analysis was used rather than principal components analysis (PCA) because factor analysis is superior to PCA for model building by attempting to model the structure between the variables and thus contains an estimation of error, unlike PCA (Fabrigar, Wegener, MacCallum, & Strahan, 1999). The 12 trait ratings entering the analysis were: understanding, supportive, considerate, kind, has a good job, is financially secure, has a nice house or apartment, is successful, sexy, adventurousness, good lover, and outgoing.

The value for the Kaiser-Meyer-Olkin measure of sampling adequacy was .94 and Bartlett's test of Sphericity was $\chi^2\ (300) = \ 29118.81, p\ <\ .001$, indicating that a factor

analysis was suitable for these data. Concerning factor extraction, four criteria were used to be as objective as possible: Kaiser's criterion, the scree test (Fabrigar et al., 1999; Kline, 1994; O'Connor, 2000), a parallel analysis (Horn, 1965), and Velicer's (1976) minimum average partial analysis. All four criteria revealed a three-factor solution. To examine the factor structure, a direct oblimin rotation on the principal axis factor analysis was conducted. An oblique rotation was used to avoid forcing the factors to be orthogonal and we interpreted loadings above .50. Table 1 shows the structure matrix, which depicts correlations between the factors and variables.

A three-factor solution was found. Factor one primarily represented what Fletcher et al. (1999) considered to be warmth-trustworthiness traits, factor two represented status-resources traits, and factor three represented vitality-attractiveness traits. Of note, though, the traits adventurous and outgoing loaded strongly on both vitality-attractiveness and warmth-trustworthiness (unlike in the verbal partner preference model, in which these traits load strongly only on vitality-attractiveness). The scale reliability for traits loading over .50 was calculated for each factor and indicated good reliability with Cronbach's alphas over .86 for each factor (i.e., the traits loading strongly on each factor did reliably represent these factors).

Following an oblique rotation, the variance accounted for by each factor cannot be identified. However, to ascertain the model robustness, we also conducted a PCA, which derived an almost identical three-factor structure and revealed that the warmth-trustworthiness factor accounted for 52% variance, status-resources accounted for 18% variance, and vitality-attractiveness accounted for 14% variance. To further test model robustness, a maximum likelihood factor analysis with promax rotation, an alpha factor analysis with direct oblimin rotation, a PCA with orthogonal rotation, and a split half analysis were conducted, which again derived almost identical three-factor structures. Hence, the three-factor solution is not dependent on the specific analysis conducted. Furthermore, since

the traits adventurous and outgoing loaded strongly on two factors in the three-factor solution, a principal axis factor analysis with a direct oblimin rotation to extract four factors was conducted to determine whether a four-factor solution would be more adequate. The fourth factor accounted for only 2% of the variance; hence, it seems reasonable to infer that a three-factor solution best represents the 12 traits selected to depict the face-related factors derived from potential partner preference traits.

Participant gender and face image gender

Despite the extensive literature on gender-differentiated partner preferences (Buss, 1989; Dunn, Brinton, & Clark, 2010; Fisman, Iyengar, Kamenica, & Simonson, 2006; Tither, O'Loughlin, Friesen, & Overall, 2004), these studies have not examined whether the structure of traits in measures of partner preferences differs with participant gender. Therefore, we examined whether the previously identified three-factor solution held when these trait ratings were calculated separately for participant gender and face image gender.

We recalculated the mean trait ratings for each face separated by participant gender. Following the same procedure outlined previously, four separate factor analyses were carried out on the ratings of the ambient images to model the structure of partner preference traits for: female participants rating female faces, female participants rating male faces, male participants rating female faces, and male participants rating male faces. As before, the 12 trait ratings entering the analyses consisted of: understanding, supportive, considerate, kind, has a good job, is financially secure, has a nice house or apartment, is successful, sexy, adventurousness, good lover, and outgoing.

Across the four analyses, the values for the Kaiser-Meyer-Olkin measure of sampling adequacy were over .86 and Bartlett's test of Sphericity was $\chi^2\ (66) >\ 3170.18, ps\ <\ .001$, indicating that factor analyses were suitable for these data. All four criteria (as before) for each of the four factor extractions revealed a three-factor solution. To examine the factor

structure, direct oblimin rotations on the four principal axis factor analyses were conducted. Table 2 shows the structure matrices of four principal axis factor analyses.

The four analyses separated by participant gender and image gender revealed mostly comparable three-factor structures. An interesting difference was that the order of factors differed across stimulus face gender: for female faces, the vitality-attractiveness factor explained more variance than the status-resources factor, and vice versa for male faces. The status-resources factor for participants judging male faces also actually appeared in inverse form; for simplicity and ease of comparison across models we reversed the factor scores for this factor (note that this procedure will not change model fit). In general, however, we found high similarity across face and participant gender. Of note, as per the previously reported factor analysis, across the four gender-differentiated factor analyses the traits adventurous and outgoing loaded strongly across two factors (warmth-trustworthiness and vitality-attractiveness). Hence, the underlying structure of partner preference traits again varies slightly for face images relative to verbal models, given that these two traits load only on vitality-attractiveness in verbal models (Fletcher et al., 1999).

To ascertain model robustness, we also conducted PCAs (separated by participant gender and face image gender) which led to an almost identical three-factor structure and revealed across all four analyses that factor 1 accounted for at least 42% variance, factor 2 accounted for at least 18% variance, and factor 3 accounted for at least 12% variance. See Table 3 for the variance separated by participant gender and face image gender. Further analyses (separated by participant gender and face image gender) including maximum likelihood factor analyses with promax rotation, PCA with orthogonal rotation, and alpha factor analyses with direct oblimin rotation, again derived almost identical three-factor structures. Hence, it seems reasonable to infer that a three-factor solution best represents the

12 traits selected to depict the face-related factors derived from potential partner preference traits, independent of participant or stimulus face gender.

These findings do not contradict previous research that has shown that men and women may show relative differences in partner preferences. Rather, they show that despite such differences, men and women nevertheless mostly agree on the traits that make people *look* high in warmth-trustworthiness, status-resources, and vitality-attractiveness. Importantly, these traits reveal largely the same underlying structure as that which Fletcher et al. (1999) identified from purely verbal responses. Given that our gender-differentiated analysis (by participant gender and face gender) has not been attempted previously for either partner preference traits or, more generally, for facial first impressions traits, these findings constitute an important validation of the verbal partner preference and facial first impression models, suggesting that these impressions are grounded in something more general than romantic preferences.

Visualising partner preference trait factors

Because ambient images differ in so many ways, computer image averaging techniques enable visualisation of potentially important cues, since many consistent cues will remain evident in averaged images while inconsistent cues tend to be averaged out (Sutherland, Rhodes, & Young, 2017). To visualise the facial cues underlying judgements of partner preference-related traits in terms of the three factors we identified, we followed the procedure used by Sutherland et al. (2013) to create face-like averaged images representing high and low levels of each factor using PsychoMorph (Tiddeman et al., 2001) for each combination of face gender and participant gender (see Figure 2). As per Sutherland et al. (2013), each face-like average in Figure 2 was made by averaging the 20 highest and 20 lowest loading images.

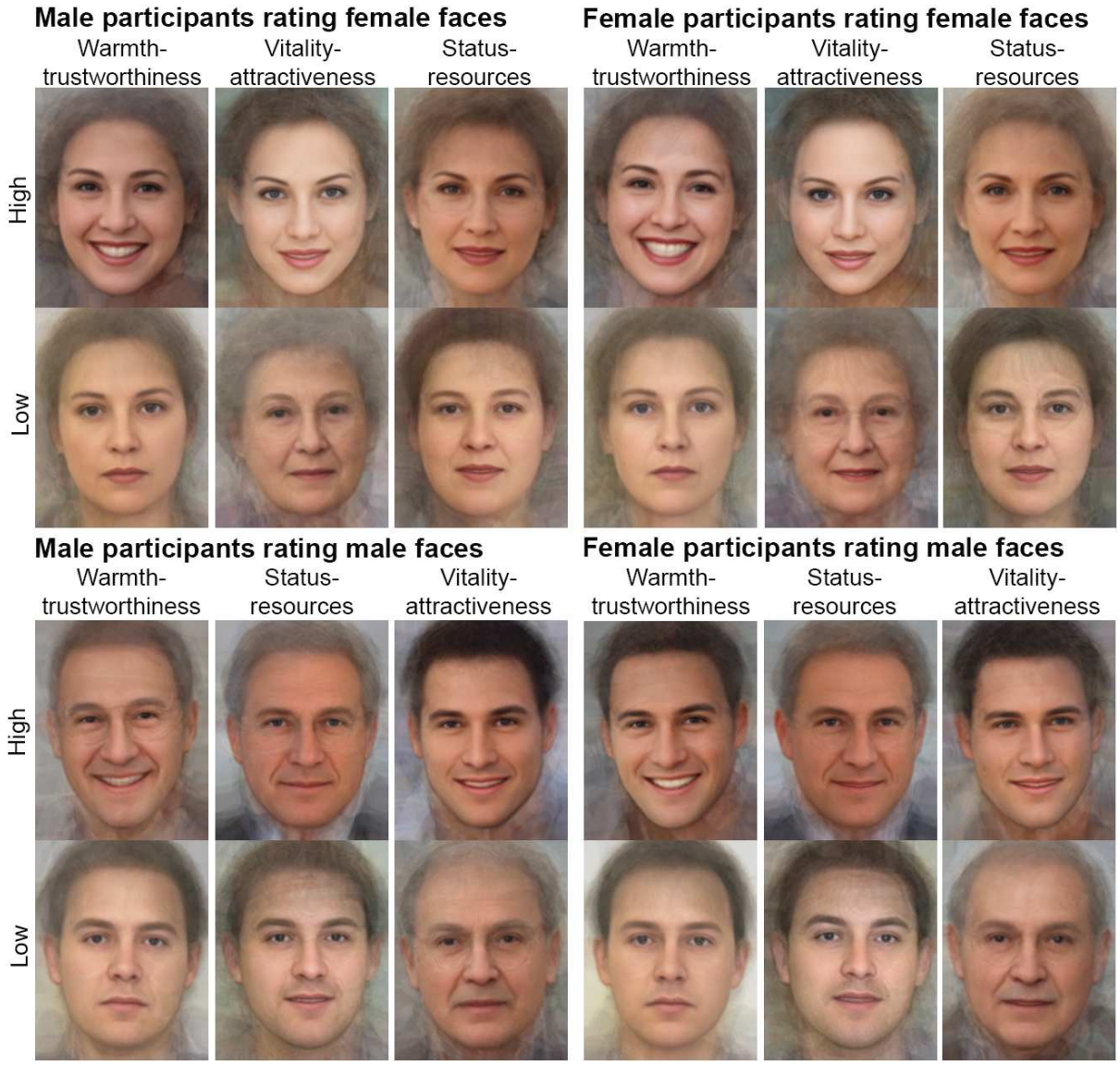

Figure 2. Averaged face images of female faces rated by male participants (top left panel), female faces rated by female participants (top right panel), male faces rated by male participants (bottom left panel), and male faces rated by female participants (bottom right panel). Each average is made from 20 images representing high (top rows) and low (bottom rows) levels of each face-related factor.

Two key points concerning these images are immediately apparent. First, although the images representing each factor are different from each other, there is strikingly high similarity between each of the gender-differentiated face-like averages representing the same factor as judged by male and female participants (e.g., between the high warmth-

trustworthiness averages). This underscores our analyses demonstrating a largely consensual factor structure between men and women rating face images in terms of partner preference-related traits. Second, each factor involves multiple interacting cues. For example, averaged images that are perceived as high or low in warmth-trustworthiness show differences in expression, skin tone, face shape and age. This point has been noted in previous work (Sutherland et al., 2013; Sutherland, Young, & Rhodes, 2017; Vernon, Sutherland, Young, & Hartley, 2014) and we will return to its implications in our Discussion.

Relationship between the partner preference and facial first impressions models

Our final question concerns the relationship between the factor structures of the Fletcher et al. (1999) and Sutherland et al. (2013) models. As a first step, we created the face-like averaged images shown in the left panel of Figure 3 to visually represent the factor structure of facial impressions derived from the Fletcher et al. (1999) partner preference traits. These Figure 3 (left panel) images were created using the same overall procedure as for Figure 2, but now the averages were based on the data across all participants rating all face images. For comparison, the averaged face-like images that Sutherland et al. (2013) created for the factors from their general facial first impressions model are presented in the right panel of Figure 3. As can be seen, there are strong similarities between the averaged face-like images that Sutherland et al. (2013) created for their facial first impressions factors and those images we created to represent the face-related partner preference traits model derived from the present data. This held even though the images in each panel of Figure 3 were derived from separate factor analyses involving non-overlapping sets of trait labels. We now turn to look more formally at the similarities between these models.

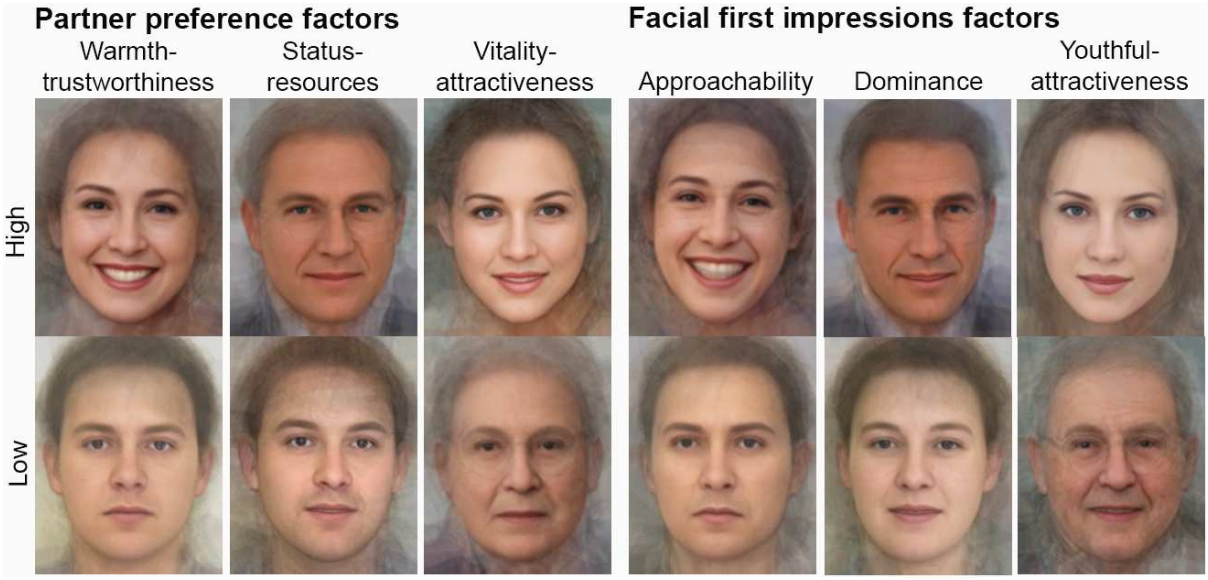

Figure 3. Averaged face images depicting partner preference-related factors for all faces rated by all participants in the present study (left panel) and averages generated by Sutherland et al. (2013) for comparable factors from their facial first impressions model (right panel). In the partner preference panel, each average is made from 20 ambient images representing high (top rows) and low (bottom rows) levels of each face-related factor. Images in the right panel were created in the same way to visualise the factors in Sutherland et al.'s (2013) facial first impressions model and reproduced with permission (© Cognition, 2012). Note that the images in each panel are derived from separate factor analyses involving non-overlapping sets of trait labels.

To test the overlap between the structure of facial impressions of traits from leading partner preference (Fletcher et al., 1999) and facial first impressions models (Sutherland et al., 2013), we correlated the (face-related) partner preference factor scores and the facial first impression factor scores. Factor scores for each of the 1,000 images were calculated to represent loadings for each of the three factors of the face-related partner preference model derived from the factor analyses including (1) data from all participants rating all face images; (2) data from male participants rating female faces; (3) data from female participants

rating female faces; (4) data from male participants rating male faces; and (5) data from female participants rating male faces. These were compared to factor scores indexing the three facial impressions factors for the same 1,000 photographs taken from Sutherland et al. (2013).

Figures 4 and 5 present correlations between the factor scores for facial impressions of partner preference-related factors derived from Fletcher et al.'s (1999) traits and the facial impression factors from Sutherland et al. (2013), to examine the relationship between each model. The data for the partner preference-related factors are separated by participant gender and face image gender in Figure 4, and aggregated across all participants and all face images in Figure 5. High correlations (rs > .73, ps < .001, ns = 1,000) were found between (1) the warmth-trustworthiness and approachability factors, (2) the status-resources and dominance factors, and (3) the vitality-attractiveness and youthful-attractiveness factors.

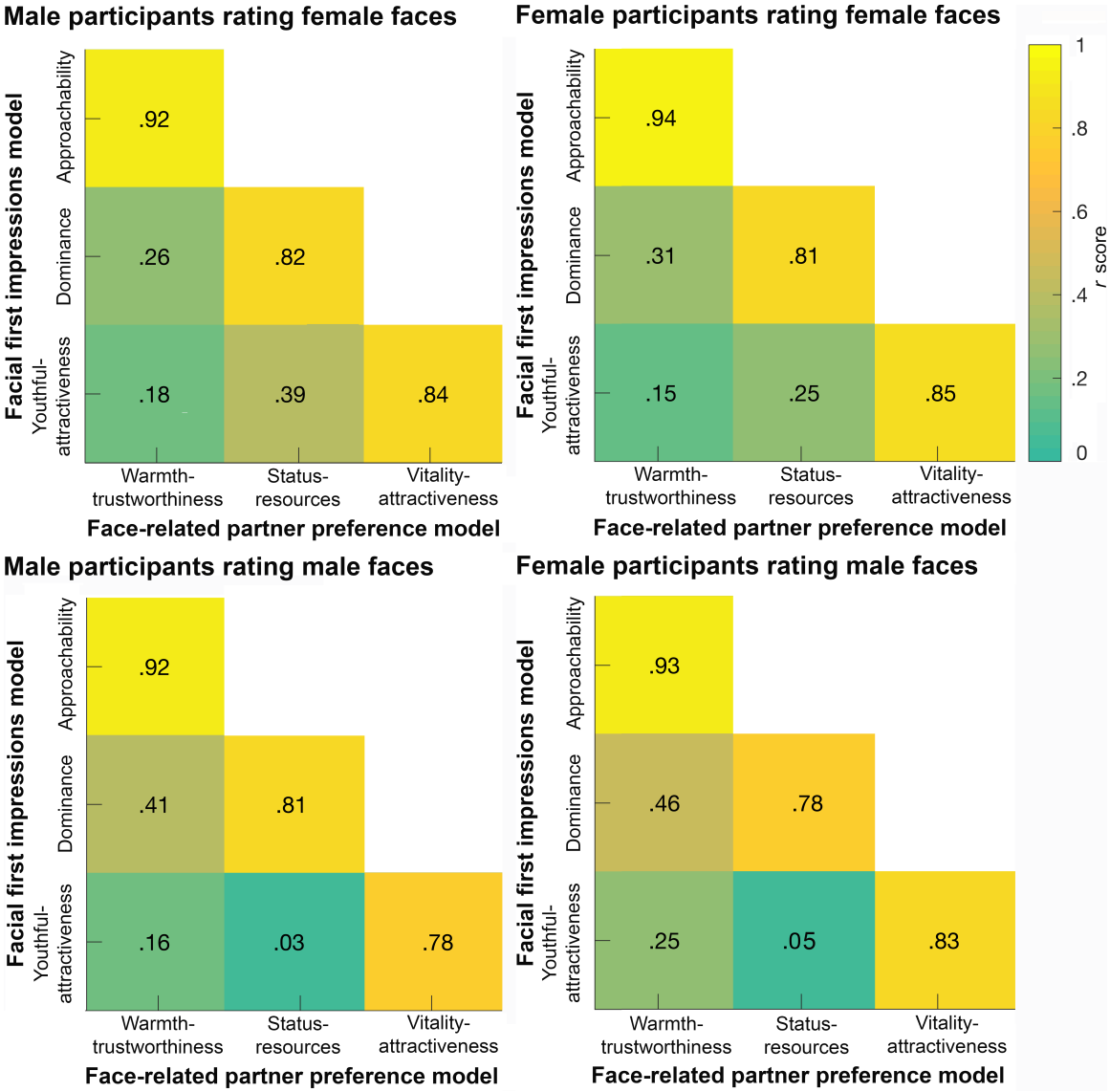

Figure 4. Correlations between the facial first impressions model of Sutherland et al. (2013) and the factor scores for the face-related model derived from potential partner preference-related traits from Fletcher et al. (1999). These are presented in terms of the strength of correlation for male participants rating female faces (top left panel), female participants rating female faces (top right panel), male participants rating male faces (bottom left panel), and female participants rating male faces (bottom right panel). All correlations (N = 500 images in each correlation) were significant at p < .01. Examination of the correlations between each model, independent of participant gender and face image gender, shows the strongest correlations are between (1) warmth-trustworthiness and approachability; (2) status-resources and dominance; and (3) vitality-attractiveness and youthful-attractiveness.

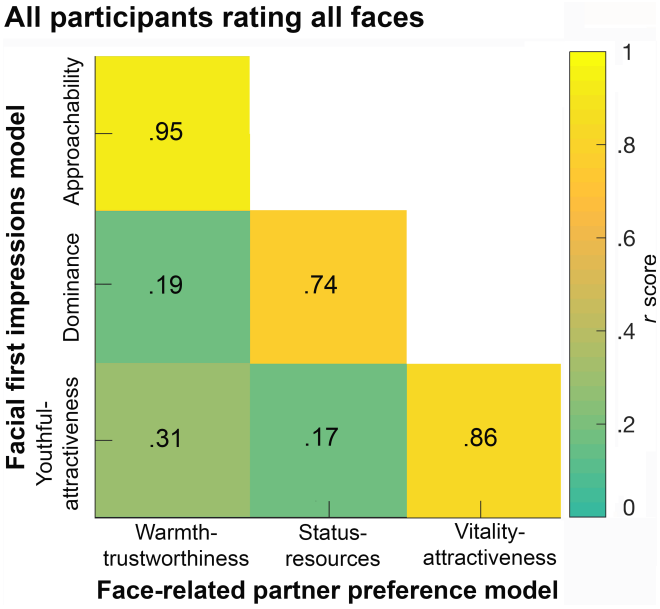

Figure 5. Correlations between the facial first impressions model of Sutherland et al. (2013) and the factor scores for the face-related model derived from potential partner preference-related traits from Fletcher et al. (1999). These are presented in terms of the strength of correlation for all participants rating all faces. All correlations (N = 1,000 images in each correlation) were significant at p < .01. Examination of the correlations between each model shows the strongest correlations are between (1) warmth-trustworthiness and approachability; (2) status-resources and dominance; and (3) vitality-attractiveness and youthful-attractiveness.

These data are sufficient to establish a clear correspondence between the factors underlying these models. However, a stronger test of the overlap between the facial impression and partner preference-related models would be to demonstrate greater correspondence between putative similar factors across models (e.g. warmth-trustworthiness versus approachability) than between any *other* pairs of factors across models (e.g. warmth-trustworthiness versus dominance). Thus, we used William's *t*-tests to put this idea to the test by comparing the strength of the correlations between similar factors across models for all

participants rating all face images (see Table 4). The three correlations between the model factor scores we considered to be related (warmth-trustworthiness and approachability; status-resources and dominance; and vitality-attractiveness and youthful-attractiveness) were significantly larger than the remaining correlations represented in Figures 4 and 5 and in Table 4. These findings represent a strong test of the observation that these models are largely equivalent.

Although the models are clearly closely comparable, then, we can ask how far this comparability extends for each factor across the models shown in Table 4. Differences in the magnitude of the correlations between similar factors across models for all participants rating all face images were tested with correlational contrasts designed to examine correlated but non-overlapping correlations using a meta-analytic statistic (*ZPF*; Raghunathan, Rosenthal, & Rubin, 1996). The differences in the magnitude between the three correlations were significant (ps < .001). Hence, warmth-trustworthiness/approachability was most robust across models, followed by vitality-attractiveness/youthful-attractiveness and, then, by status-resources/dominance.

Discussion

Partner preference models based on verbal evaluations have been highly influential, yet their potential applicability to non-verbal sources of information has not been explored. In most romantic contexts, people make partner selections based on a rich wealth of information that includes facial appearance (Fletcher et al., 2014; Sritharan, Heilpern, Wilbur, & Gawronski, 2010; Walster et al., 1966). Hence, our research provides an important test of the more general viability of the verbal partner preference model developed by Fletcher and colleagues (Fletcher et al., 2000a, 2000b, 1999).

We found that individuals can reliably form impressions of traits included in models of verbally expressed partner preferences, even from highly varied images of faces. Although

it was uncertain whether the structure of the verbally derived partner preference model would be applicable to face images, our findings demonstrated that impressions of partner preference-related traits derived from faces have an underlying three-factor structure that largely corresponds to the verbal partner preference model described by Fletcher et al. (1999). Importantly, the structure of this model of facial impressions derived from partner preference traits remained largely unchanged when examining the data separated by participant gender and face gender. Hence, even with these relatively small numbers of participants, we can demonstrate that men and women mostly agree (at the group level) on their evaluations of warmth-trustworthiness, status-resources, and vitality-attractiveness in faces. Nonetheless, this is not to deny the extensive evidence of gender-differentiated partner preferences (e.g., Buss, 1989; Dunn, Brinton, & Clark, 2010; Fisman, Iyengar, Kamenica, & Simonson, 2006; Fletcher, Tither, O'Loughlin, Friesen, & Overall, 2004) and of differences in how male and female faces are evaluated (Sutherland, Young, Mootz, & Oldmeadow, 2015). Our findings only show that such differences are likely to be built upon a core of underlying similarities.

Of course, the current research did not ask participants to rate faces based on their own romantic preferences, given that we needed to first establish whether partner preference-related traits can reliably be seen in faces and whether the underlying factor structure of such evaluations might be shared with that for verbally expressed preferences. A timely next step would therefore be to examine the correspondence between verbal partner preferences and preferences for faces, in terms of partner preference traits/factors.

Our study also tested the correspondence between the factor structure of traits derived from Fletcher et al.'s (1999) partner preference model as applied to face images and Sutherland et al.'s (2013) facial first impressions model. We found high overlap between (1) the warmth-trustworthiness partner preference-related factor and the approachability facial

first impressions factor; (2) the vitality-attractiveness partner preference-related factor and the youthful-attractiveness facial first impressions factor; and (3) the status-resources partner preference-related factor and the dominance facial first impressions factor. These findings show strong similarity between the partner preference-related factors and the facial first impressions factors.

These are compelling observations because these two models have been derived in such different ways from entirely separate literatures. The highly influential verbal partner preference model is based on a specific romantic context involving thinking about hypothetical ideal partners, leading to verbally derived partner preference traits (Campbell et al., 2001; Fletcher et al., 2000a, 1999). In contrast, the facial first impressions model has been grounded in a data-driven approach to first impressions of any type, from facial cues, and was not restricted to romantic partner contexts (Oosterhof & Todorov, 2008; Sutherland et al., 2013). This finding of a close correspondence has important implications for theory in facial impressions as well as partner preferences research, as discussed below. Our study was innovative in both respects: firstly, that it was unclear whether the verbal partner preference model would reveal a similar structure when applied to face images and, secondly, the relationship between the partner preference-related and facial first impressions models has not been examined previously.

Wider implications

The demonstration of corresponding three-dimensional structures across traits related directly to partner preferences and facial first impressions more generally strongly suggests that common factors are being used for evaluations linked to these different contexts. This finding was by no means inevitable. Although we noted that some other studies have also found three dimensions underlying impressions of faces (Olivola, Eubanks, et al., 2014; Sutherland, Liu, et al., 2017; Wolffhechel et al., 2014), major models of facial first

impressions are often couched in terms of two underlying dimensions (Oosterhof & Todorov, 2008; Walker & Vetter, 2009), as is a leading model of inter-group perception (Fiske et al., 2007). Moreover, whilst a comparable two-dimensional structure has been found for voice perception (McAleer, Todorov, & Belin, 2014), it was not so clearly evident in a study of impressions based on bodies, where one general valence dimension appeared to be sufficient (Morrison, Wang, Hahn, Jones, & DeBruine, 2017). In parallel, there is currently a debate in the social psychological literature as to whether two or three dimensions (morality, competence and/or sociability) best describe interpersonal and intergroup relationships outwith face perception (Brambilla, Rusconi, Sacchi, & Cherubini, 2011; Fiske et al., 2007).

Models of facial first impressions have tended speculatively to link the two most consistently noted factors (trustworthiness and dominance) with an evaluation of threat (Oosterhof & Todorov, 2008) and to link a third, youthful-attractiveness factor, to sexual selection (Sutherland et al., 2013; Sutherland, Young, et al., 2017). In this respect, the sexual selection factor might have been assumed to be the most closely related to partner preferences. However, by investigating the parallel to traits from partner preference theory, the present study strongly implies that all three factors may be relevant to understanding how people judge potential partners in everyday contexts. This represents a significant change in emphasis from the overall theoretical focus on judgment of threat in prominent models of facial impressions (Todorov, 2011; Walker & Vetter, 2009). In emphasising this point, we draw on many other studies in face perception that have also adduced evidence of the importance of trustworthiness and dominance evaluations, as well as facial attractiveness, to partner suitability (DeBruine et al., 2010; DeBruine, Jones, & Perrett, 2005; Jones et al., 2013; Rhodes et al., 2011).

The overlap across models indicates that the underlying structure of trait impressions relevant to partner preferences is applicable to contexts well beyond the romantic domain,

offering an important theoretical extension of the underlying structure of partner preference models. It seems likely that the traits underlying partner preferences may correspond to a structure that underlies person perception in general. Parallels between the facial first impressions factors and partner preference-related factors suggest that much the same evaluations are needed across different types of context.

Whilst there may in part be evolutionary reasons for the importance of these judgements, linked to the appraisal of conspecifics among primates (cf. Todorov, 2011; Todorov & Oosterhof, 2011; Todorov, Said, Engell, & Oosterhof, 2008), a large body of work in social psychology based on intergroup perception (Cuddy, Fiske, & Glick, 2008; Fiske et al., 2007; Fiske, Cuddy, Glick, & Xu, 2002) and even on attitudes to objects and animals (Osgood, 1964) also finds that similar warmth (i.e. trustworthiness) and competence (i.e. dominance) factors emerge, although these models do not emphasise attractiveness *per se*. For instance, Osgood (1964) investigated cross-cultural linguistic factors, revealing a tripartite structure involving evaluation (i.e. good versus bad), potency (strong versus weak), and activity (active versus passive, which is conceptually similar to vitality and is empirically linked to youthfulness; Kervyn, Fiske, & Yzerbyt, 2013). Osgood's tripartite structure bears a conceptual resemblance to Fletcher et al.'s (1999) partner preference factors and to the facial first impressions factors (Sutherland et al., 2013; Sutherland, Oldmeadow, et al., 2016). Hence, partner evaluations may form part of a wider set of techniques for making social - or sometimes even non-social - inferences necessary for adaptive human behaviour. This point is consistent with ecological approaches to facial first impressions that emphasise the role of overgeneralisation of everyday environmental contingencies (Zebrowitz, 2011, 2017; see also Vernon, Sutherland, Young, & Hartley, 2014).

Differences between models

Relationship researchers have mainly used verbal measures of partner preferences that typically ask participants for their hypothetical romantic choices (e.g., Buss & Barnes, 1986; Fletcher et al., 1999; Simpson & Gangestad, 1992). By linking these romantic partner preference-related traits to everyday face images we have demonstrated that the underlying structure of the partner preference model is not just applicable to abstract conceptual judgements, but is still relevant to real life impressions made when visual information is present. However, the structure of the partner preference model differed slightly when applied to face images (relative to verbal measures). For face stimuli, unlike in verbal models, the traits adventurous and outgoing loaded strongly on both vitality-attractiveness and warmth-trustworthiness and this was again evident in the factor analyses separated by participant and face image gender. This is similar to Sutherland et al.'s (2015) finding that facial impressions of the Big Five trait open-mindedness aligned with the facial first impressions approachability factor. Thus, people may be using warmth-trustworthiness cues (e.g., smiling) in addition to vitality-attractiveness cues to judge the partner preference traits adventurous and outgoing in faces.

Although we found that the partner preference and facial first impressions models are closely related, recent research (e.g. Sutherland, Oldmeadow, & Young, 2016) has suggested that competence may be a better approximation than dominance for the third facial first impressions factor. In this respect, we note that competence may be conceptually closer to the status-resources partner preference factor than is dominance *per se,* and that face-based judgements of competence are important in other contexts too (Olivola & Todorov, 2010). Although we found a strong relationship between the status-resources partner preference factor and the dominance facial first impressions factor, this was significantly weaker than between the other factors that seemed to correspond in each model. Further studies that look more carefully at competence-related (rather than dominance-related) impressions of faces

may therefore reveal even closer comparability. Alternatively, competence and dominance may reflect two relatively independent routes to achieving high status or capturing resources (see Cheng, Tracy, Foulsham, Kingstone, & Henrich, 2013; Henrich & Gil-White, 2001).

Trait impressions from ambient images

Ambient face images constitute an essential element of a data-driven approach to first impressions (Sutherland, Rhodes, et al., 2017; Todorov et al., 2015) by including the facial cues involved in trait evaluations that may be 'controlled out' of standardised images in the process of removing differences between images (e.g. lighting, pose, expression; Burton, Jenkins, & Schweinberger, 2011; Jenkins et al., 2011). Ambient images facilitate the investigation of image properties involved in specific trait evaluations and offer improved ecological validity by underscoring the relevance of variability through retaining the multiple cues present in the photographs people view daily and allowing images to reflect the cues that may be overgeneralised from everyday experience (cf. Zebrowitz, Fellous, Mignault, & Andreoletti, 2003; Zebrowitz, Kikuchi, & Fellous, 2010).

By using ambient images, we were able to create face-like averaged images to visualise facial cues underlying each factor, revealing that each factor involves multiple interacting cues (as noted in previous work by Sutherland et al., 2013; Sutherland, Young, et al., 2016; Vernon, Sutherland, Young, & Hartley, 2014). For example, averaged high warmth-trustworthiness images depict smiling individuals, whereas low warmth-trustworthiness images contain more neutral or even slightly hostile expressions, consistent with previous research (Hess, Adams Jr, & Kleck, 2004; Said, Sebe, & Todorov, 2009; Sutherland et al., 2013). However, the face-like averages also show clearly that smiling does not constitute an exclusive cue to warmth-trustworthiness. Instead, each factor involves differences in smiling. What is important is possibly the type of smile, and certainly the way smiling is combined with other cues such as skin tone, age, and face shape. To understand

first impressions from faces, then, we will need to understand how different cues are interpreted in combination with each other (Santos & Young, 2011; Vernon et al., 2014) instead of investigating each cue in isolation. Indeed, classic work by Secord (1953) had originally noted that facial impressions are likely to represent a holistic and complex combination of social cues, and that investigating individual cues in a piecemeal fashion is unlikely to be sufficient for understanding the facial impression process.

Conclusions

To conclude, relationship researchers have primarily used verbal measures of partner preferences, even though relationships often begin in environments in which facial evaluations are a rich and a salient source of information (e.g., online dating sites). In contrast, our research used naturally occurring facial images as a novel approach to examine traits identified from verbal models of partner preferences. We found that verbally derived partner preference traits can be evaluated in face images. Crucially, the underlying structure of these traits when seen in faces largely fitted Fletcher et al.'s (1999) tripartite structure for verbal partner preferences, even when the analyses were separated by participant gender and by face gender. These findings imply that the verbal partner preference model can be applied to the pervasive romantic contexts that contain facial information. Our findings further indicated that the face-related partner preference model corresponds strongly with a more general three-factor model of facial first impressions (Sutherland et al., 2013), which underscores the relevance of these models to both romantic and non-romantic contexts. The recent rise in online dating, in which individuals are likely to approach potential partners based largely on initial impressions from facial photographs, make these findings particularly timely and significant.

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Tables

Table 1. Structure matrix of a principal axis factor analysis with a direct oblimin rotation for ratings of face images on 12 traits from Fletcher et al.'s (1999) Ideal Partner Scale.

Trait	Warmth-trustworthiness	Status-resources	Vitality-attractiveness
Kind	**.96**	.36	.29
Supportive	**.91**	.35	.32
Understanding	**.87**	.42	.25
Considerate	**.82**	.38	.33
Financially secure	.27	**.91**	.05
Nice house or apartment	.42	**.88**	.30
Successful	.49	**.87**	.36
Good job	.31	**.82**	.34
Good lover	.40	.27	**.92**
Sexy	.28	.32	**.91**
Adventurous	**.67**	.24	**.73**
Outgoing	**.81**	.25	**.56**

Note: substantial loadings (over .50) are in bold.

Table 2. Structure matrices of four separate principal axis factor analyses with a direct oblimin rotation for ratings of face images of 12 traits from Fletcher et al.'s (1999) Ideal Partner Scale: male participants rating female faces (top left), female participants rating female faces (top right), male participants rating male faces (bottom left), and female participants ratings male faces (bottom right).

	Male participants rating female faces			Female participants rating female faces		
Trait	Warmth-trustworthiness	Vitality-attractiveness	Status-resources	Warmth-trustworthiness	Vitality-attractiveness	Status-resources
Kind	**.88**	.33	.34	**.92**	.32	.02
Supportive	**.76**	.27	.19	**.87**	.34	.18
Understanding	**.78**	.26	.14	**.80**	.40	.13
Considerate	**.63**	.24	-.04	**.73**	.37	.34
Financially secure	.20	**.79**	.24	.33	**.87**	.01
Nice house or apartment	.36	**.77**	.23	.30	**.71**	.42
Successful	.46	**.74**	.36	.32	**.78**	.33
Good job	.13	**.65**	.49	.36	**.62**	.40
Good lover	.27	.37	**.81**	.20	.30	**.86**
Sexy	.12	.48	**.87**	.14	.36	**.85**
Adventurous	**.60**	.28	**.61**	.49	.28	**.71**
Outgoing	**.71**	.31	**.54**	**.74**	.26	.38
	Male participants rating male faces			Female participants rating male faces		
	Warmth-trustworthiness	Status-resources	Vitality-attractiveness	Warmth-trustworthiness	Status-resources	Vitality-attractiveness
Kind	**.84**	.24	.20	**.92**	.45	.16
Supportive	**.74**	.29	.24	**.87**	.34	.23
Understanding	**.68**	.34	.11	**.81**	.46	.21
Considerate	**.66**	.37	.09	**.79**	.33	.42
Financially secure	.30	**.91**	.08	.31	**.92**	-.05
Nice house or apartment	.40	**.85**	.12	.35	**.81**	.22
Successful	.43	**.82**	.27	.38	**.82**	.21
Good job	.17	**.74**	.22	.37	**.86**	.16
Good lover	.45	.15	**.69**	.33	.17	**.85**
Sexy	.18	.32	**.82**	.27	.17	**.91**
Adventurous	**.62**	.05	.47	**.64**	.19	**.73**
Outgoing	**.72**	.18	.48	**.72**	.14	.47

Note: substantial loadings (over .50) are in bold.

Table 3. Variance accounted for by each factor from separate PCA analyses across participant gender and face image gender.

	Warmth-trustworthiness	Status-resources	Vitality-attractiveness
Male participants rating female faces	42%	18%	12%
Female participants rating female faces	43%	18%	13%
Male participants rating male faces	42%	18%	12%
Female participants rating male faces	46%	20%	14%

Table 4. William's t-tests were used to test for divergent validity (i.e. whether the overlap in similar factors was greater than between all other factor pairs). 'First pair' listings are those for factors likely to be equivalent across models, whereas 'second pair' listings show factors that should not be equivalent. The correlations between (1) warmth-trustworthiness and approachability, (2) status-resources and dominance, and (3) vitality-attractiveness and youthful-attractiveness (all 'first pair' correlations) were, indeed, significantly larger than the remaining correlations shown in the table when a Bonferroni correction was used.

First Pair	Second Pair	William's T
Warmth-trustworthiness and approachability	Warmth-trustworthiness and dominance	41.08***
	Warmth-trustworthiness and youthful-attractiveness	37.29***
	Status-resources and approachability	47.05***
	Vitality-attractiveness and approachability	51.43***
Status-resources and dominance	Status-resources and approachability	14.55***
	Status-resources and youthful-attractiveness	18.06***
	Warmth-trustworthiness and dominance	23.00***
	Vitality-attractiveness and dominance	18.02***
Vitality-attractiveness and youthful-attractiveness	Vitality-attractiveness and approachability	25.16***
	Vitality-attractiveness and dominance	23.71***
	Warmth-trustworthiness and youthful-attractiveness	29.13***
	Status-resources and youthful-attractiveness	32.15***

$N = 1{,}000$. *** $p < .001$