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Toward a comprehensive model of face impressions: What we know, what we do not, and paths forward

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Abstract

A person's impression of another depends upon three sources of variance. The characteristics of the target, the characteristics of the perceiver, and the interplay between the two. Researchers have dedicated different amounts of study to these three sources of variance, and therefore they differ in how well they are understood. The present work will first review the portions of the face impression process that are understood well, then identify and discuss portions of the process less well understood. We will then question to what extent the current state of knowledge will generalize to novel targets and populations. Finally, we will review several modeling approaches that can accommodate relatively unexamined yet important sources of variance in impression formation, suggesting a clear path forward toward a comprehensive understanding of face impressions.

1 | INTRODUCTION

Making inferences about other humans' dispositions, and the opportunities and threats they might present us, is central to all human interaction. Accordingly, the manner in which these impressions are formed has been studied from the beginning of empirical psychology. In the intervening century, impressive advances have been made. Some elements of how impressions are formed are now well understood. Yet other important parts of this process are not. The term "impression formation" is quite broad,[1] and the present work limits itself to elements involved in a seemingly simple, specific problem:

> *When a perceiver first sees a target person, can we predict how that perceiver would evaluate that target on any given trait?*

Henceforth, we refer to this as the "impression formation problem," and we argue that several key factors involved in this problem remain poorly understood.

There are three elements to this problem, or rather three unique sources of variance in predicting any impression (Figure 1), represented by the following equation:

$$\text{Impression} = \text{Target Variance} + \text{Perceiver Variance} + [\text{Perceiver} \times \text{Target Interactions}] + \text{error}$$

The first portion of this problem is intuitive, (a) the contribution of any element of the target to the impression, for example, neonatal features leading to impressions of kindness. But these impressions do not occur in a vacuum, and a long-held tenet of social cognition is that perceivers bring a variety of factors to the table when forming impressions. Thus, the second source of variance in this problem is (b) the contribution of perceiver characteristics to the impression. For example, perceivers in a pleasant context (e.g., a room full of puppies) may evaluate all others more positively than perceivers in less enjoyable context (e.g., the department of motor vehicles). Finally, the third source of variance is (c) perceiver × target interactions (Kenny, 1991). One perceiver may favor people with freckles and make more positive impressions of those with freckles than those without. Impressions here depend upon both the characteristics of the perceiver and target. These three unique sources of variance in this problem have received differing amounts of study and not surprisingly, differ in how well they are understood.

Focusing on facial impressions, the present work will first review the portions of target, perceiver, and perceiver × target processes the field understands well and then areas and questions requiring additional research. Given limitations apparent in this review, we will then question to what extent the current state of knowledge will generalize to novel targets and populations. Finally, we will review new types of modeling approaches that can accommodate relatively unexamined yet important sources of variance in impression formation, suggesting a clear path forward toward a comprehensive understanding of impressions.

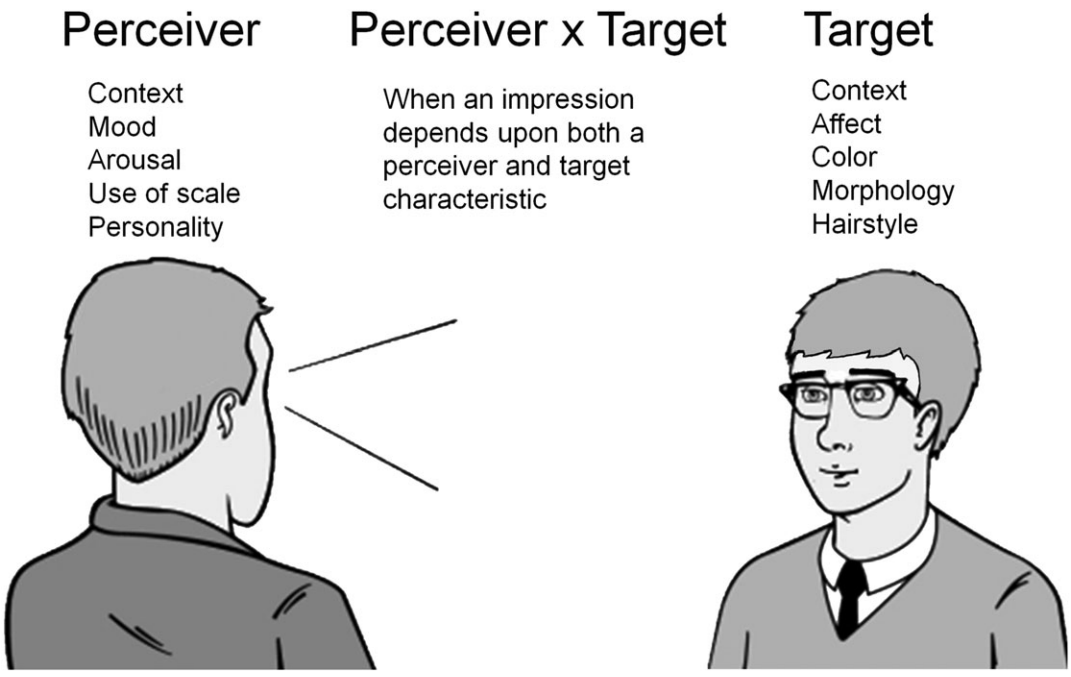

FIGURE 1 Examples of factors that are characteristics of the target, characteristics of the perceiver, and characteristics of the perceiver ×target interaction influencing any given impression

2 | TARGET CONTRIBUTIONS TO IMPRESSIONS

The vast majority of research in impression formation has focused on the first element of our equation—how the appearance of a target contributes to a given impression. Accordingly, it is the best understood portion of the impression formation problem. Researchers have long documented the structural and dynamic aspects of the face linked to impressions, including face-width, skin color, eye size, symmetry, emotional expression, head posture, and more (Adams & Kleck, 2003; Carré, Morrissey, Mondloch, & McCormick, 2010; Han et al., 2018; Hehman, Flake, & Freeman, 2015; Hehman, Leitner, & Gaertner, 2013; Jones, DeBruine, & Little, 2007; Said, Sebe, & Todorov, 2009; Zebrowitz, Fellous, Mignault, & Andreoletti, 2003).

Other characteristics of targets, such as the context or background in which they appear, are likely to influence impressions, though this issue has received less attention. Faces are rarely perceived without context, and some researchers have argued for examining "ambient" images, in which faces are evaluated in context (Jenkins, White, Van Montfort, & Burton, 2011). Indeed, research examining how facial impressions of trustworthiness were formed in threatening versus nonthreatening contexts found an additive effect of both face and context (Brambilla, Biella, & Freeman, 2018). Trustworthiness impressions were facilitated when faces were congruent with context (e.g., trustworthy face—nonthreatening context; untrustworthy face—threatening context). To maximize external validity, future research should continue to consider the influence of context.

Furthermore, recent statistical advances have helped quantify the degree to which between-target differences in appearances shape impressions using cross-classified multilevel models. These models can partition the overall amount of variance into that attributable to characteristics of the target, of the perceiver, and of perceiver × target interactions (Judd, Westfall, & Kenny, 2012; Kenny, 1991; Raudenbush & Bryk, 2002). Recent work using this approach reveals that between 15% and 25% of the variance in any given impression comes from between-target differences in appearance (Hehman, Sutherland, Flake, & Slepian, 2017).

We have excellent theoretical models that explain these links between the appearance of the target and impressions. As one example, overgeneralization theory (Zebrowitz et al., 2003) provides an account for how morphological features give rise to trait impressions. Slight resemblances to emotional expressions or social categories (e.g., infants), either through natural variations in facial structure or temporary muscle contractions, are overgeneralized to corresponding trait inferences due to our associated links between such appearances and corresponding traits. For instance, facial features resembling emotional expressions (e.g., an upturned mouth resembling a smile) are generalized to stable trait inferences congruent with these emotional cues (e.g., a friendly person) due to linked conceptual associations (Adams, Nelson, Soto, Hess, & Kleck, 2012; Oosterhof & Todorov, 2009; Said et al., 2009; Secord, 1958; Secord, Dukes, & Bevan, 1954; Zebrowitz, Kikuchi, & Fellous, 2010; Zebrowitz & Montepare, 2008). For the same reasons, individuals with features resembling infants (e.g., larger eyes) are attributed traits of infants, such as being more gentle (Zebrowitz & Montepare, 1992).

There are numerous features and characteristics within a face that humans attend to. Mapping all of their associations may be challenging, given potential correlations and interactive effects across multiple cues. Computational approaches have proven valuable in this regard. An influential trajectory of research, conducted by Todorov and colleagues, developed models linking morphological features of faces to inferred social traits, which are parsimoniously represented by a two-dimensional trustworthiness/dominance space of impression formation (Oosterhof & Todorov, 2008, 2009; Todorov, Said, Engell, & Oosterhof, 2008). Instead of relying on the traditional, hypothesis-driven approach of testing which specific facial cues (e.g., curved mouth) predict which trait impressions (e.g., friendly), these data-driven models simultaneously model *all* of the cues in a face as vectors correlated with numerical ratings on spontaneously inferred traits. For example, faces that appear to morph from "frowning" to "smiling" may be correlated with perceptions of friendliness ranging from low to high.

In summary, we know a considerable amount about why, and how much, target appearance contributes to impressions. For any given face, if we can measure its morphological structure, color, pose, eye-gaze, texture, etc., the state of the field is such that we can make a reasonable estimate of how that face will be perceived on any given

trait, *on average* across a large number of perceivers. Therefore, the variance in impressions driven by target appearance can largely be explained by what the field currently understands.

2.1 | Limitations

Despite these theoretical and methodological advances, there are limits to our understanding of target contributions to facial first impressions. It is important to briefly discuss the manner in which they have previously been examined. Although there are as many ways to evaluate others as there are adjectives, many of these adjectives are related, such as "attractive" and "pretty." Frequently, social cognitive researchers collect ratings of targets on these various traits and then use data-reduction techniques to map a "face-trait space" underlying impression formation, formed by dimensions on which multiple traits load. This dimensional approach has been utilized since at least the 1930s (Guilford & Guilford, 1934), initially and most frequently by personality psychologists, but has been widely used across psychology in the intervening 90 years.

Researchers utilizing these data reduction techniques have often found two dimensions comprising the impression formation space. Though labeled differently by different researchers, one dimension is thought to reflect whether a target's intentions are positive or negative toward the perceiver. Traits such as trustworthy, friendly, or warm load strongly on this dimension. A second dimension is thought to reflect a target's ability to enact those intentions. Traits such as dominant, competent, or physically strong load on this dimension (Fiske, Cuddy, Glick, & Xu, 2002; Leary, 1957; Leyens et al., 2003; Oosterhof & Todorov, 2008; Sutherland et al., 2018; Todorov & Engell, 2008). Recent research including older targets among those being rated yielded a third dimension of "youthful/attractive" (Sutherland et al., 2013). This dimensional approach has primarily been used to understand how the characteristics of a target give rise to impressions, or the first part of the equation above.

This dimensional approach, which focuses on the characteristics of the target, has been invaluable for advancing our understanding of target contributions to impression formation—at least for certain groups of people (i.e., young White males). Yet there are some presumptions that this same two-dimensional model of warmth and competence underlies the way we perceive *all* targets or that these are "universal" or "fundamental" dimensions (Abele, Cuddy, Judd, & Yzerbyt, 2008; Fiske, Cuddy, & Glick, 2007). But the generality of these models has not been directly tested, and there are growing reasons to doubt universality of two-, three-, or any-dimensional models of face-trait space that are applied consistently across all targets.

For instance, the dominant two-dimensional valence/dominance solution was originally derived from data on ratings of White, male, bald, computer-generated targets of roughly 20–40 years of age (Oosterhof & Todorov, 2008). They were being rated by White undergraduates rather than a representative sample. These decisions were understandably and likely made for purposes of high experimental control, which accompanies its traditional tradeoff with external validity. Because the targets and sample were non-representative of the ways in which humans vary, the extent to which solutions from this data generalize to any other group of targets or perceivers is unknown.

Emerging research is beginning to challenge the universality of these models. Recent work has found that, across all dimensions, between-target variance is higher for ratings of women (~19%) than for men (~11%; Xie, Flake, & Hehman, in press). Other research has found that trustworthiness and dominance dimensions were negatively correlated among women (Sutherland, Young, Mootz, & Oldmeadow, 2015), though these dimensions were orthogonal among men (Oosterhof & Todorov, 2008). Both these studies suggest that the way in which impressions are formed of men and women differ.

Another approach is to more formally quantify the generality of both two- and three-dimensional models using confirmatory factor analysis across different social groups (Xie, Flake, Stolier, Freeman, & Hehman, under review). In contrast to PCA, confirmatory factor analyses provide metrics of model fit or how well the models capture variance in

the data. Ratings were collected of male and female, Black, White, and Asian targets on a wide variety of traits, and two- and three-factor models representing the theorized face-trait space were fit to the data. However, the two- or three-dimensional models for all social groups fit quite poorly (e.g., RMSEAs > 0.5, CFIs < 0.6), indicating that two- and three-factor solutions are not be adequately representing the variance in face-trait space for these groups. Furthermore, these models were quite different from one another, in that how each trait related to other traits differed across social categories—raising questions about whether a universal model for impression formation might be possible (Xie et al., under review).

At this point, it is unclear exactly why these face-spaces vary across gender and racial lines. A possibility consistent with this being a bottom-up target contribution is that the features of the differently gendered and racial faces give rise to different face-spaces. Yet it may be that perceivers' shared stereotypes about these different social groups are causing changes in impressions: a perceiver contribution. Or both: an interaction between target and perceiver contributions. Future research will explore these possibilities, but importantly, these findings indicate that current models for the face-space of target impressions may not extend to novel groups.

In summary, how target appearance contributes to a given impression is the best-understood portion of our impression formation problem. We understand that it happens, have good quantification of how much it happens, and know which characteristics of the face lead to what types of impressions, at least for some categories of faces (e.g., young White males). Remaining questions in this area are to what extent these findings generalize to other social categories and cultures. Furthermore, we note that estimates indicate that target appearance comprises only 15–25% of the overall variance in impressions (Hehman et al., 2017; Xie et al., in press), and therefore, there is a ceiling to how much variance target characteristics can explain overall. To fully understand impressions, we have to turn to other sources of variance.

3 | PERCEIVER CONTRIBUTIONS TO IMPRESSIONS

The second portion of the impression formation problem, that social impressions are partially shaped by perceiver characteristics, is central to most modern models of social cognition (Brewer, 1988; Bruce & Young, 1986; Brunswik, 1952; Correll, Hudson, Guillermo, & Earls, 2016; Fiske & Neuberg, 1990; Freeman & Ambady, 2011; Haxby, Hoffman, & Gobbini, 2000; Kenny & Albright, 1987; Kunda & Thagard, 1996; West & Kenny, 2011). By perceiver characteristics, we mean when a given rating depends only on characteristics of the perceiver (e.g., motivation, emotion), and does not involve characteristics of a target whatsoever.

Despite inclusion in theoretical models, there is far less evidence of perceiver effects in the published literature than that of target appearance. Some notable exceptions are evident, most of which are effects induced by a specific condition during an experiment. For instance, manipulations to encourage perceived competition with a target changed impressions of the target's warmth and competence (Russell & Fiske, 2008). Similarly, individuals who were physically restrained judged others to be more threatening (Fessler & Holbrook, 2013a), whereas individuals who were in a group judged others to be less threatening (Fessler & Holbrook, 2013b). In this research, perceivers' ability to respond to potential threat or perceived competition with the target influenced their impressions, independent of the target's actual appearance.

Other perceiver effects may involve individuals' prior experience and what sort of faces they are familiar with or chronically exposed to. Rhodes, Jeffery, Watson, Clifford, and Nakayama (2003) demonstrated this effect by showing participants numerous odd-looking faces, varying along a continuum from the eyes very close together versus the eyes very far apart. Participants experimentally adapted to either side of the continuum (e.g., far-apart eyes) rated normal faces (average eye distance) as less typical and less attractive (Rhodes et al., 2003). The researchers argued that more naturalistic forms of adaptation, in which individuals are chronically exposed to certain types of faces through everyday encounters or media depictions, are likely to determine what is typical and thus what is attractive (and in turn related trait dimensions).

Other state-like effects, such as mood, appear to have an influence on the impression formation process. Researchers manipulated participants' mood by giving bogus positive or negative feedback on a psychological test of personality, prior to forming impressions of different targets. Participants in a happy mood generally formed more favorable impressions of targets than those receiving negative feedback (Forgas & Bower, 1987). To the extent that mood is consistently negative, such as in clinical depression, more negative impressions of others might be more of a trait- than state-like characteristic. There is at least some evidence supporting this possibility, as depressed patients evaluated social interactions more negatively than controls (Hoehn-Hyde, Schlottmann, & Rush, 1982).

Additionally, stable psychological characteristics might influence impressions more consistently across the lifespan. For instance, some research has found that social anxiety leads to more negative or threatening evaluations of faces in general (Dimberg & Thunberg, 2007; Goldin, Manber, Hakimi, Canli, & Gross, 2009; Schofield, Coles, & Gibb, 2007) consistent with the idea that socially anxious people construe other people and other people's reactions to the self more negatively (Pozo, Carver, Wellens, & Scheier, 1991), but we note other research has not found such an effect (see Staugaard, 2010, for review). There are rich trajectories of research documenting the association between more extreme psychological abnormalities (e.g., schizophrenia and bipolar disorder) with difficulty identifying and evaluating emotional faces (Edwards, Pattison, Jackson, & Wales, 2001; Rubinow & Post, 1992). Though this research was not specifically conducted in an impression formation context, it is likely that such conditions exert consistent effects on other impressions as well.

Research has quantified to what extent between-perceiver differences impact impressions. Surprisingly, across all dimensions, early evidence suggests that impressions are more driven by perceiver characteristics (~23%) than target characteristics (~15%; Xie et al., in press). This is particularly the case regarding impressions of youthful/attractiveness relative to trustworthiness and dominance dimensions (Germine et al., 2015; Hehman et al., 2017; Hönekopp, 2006; Xie et al., in press).

3.1 | Limitations

Thus, for this second part of the impression formation problem, we know that it happens, how much it happens, and social-cognitive models expect it to happen. Yet there is a limited amount of research focusing on perceiver effects in impression formation, and there are currently no comprehensive models of which perceiver characteristics might influence which impressions, why, and to what extent. This problem is difficult. There are innumerable characteristics upon which perceivers might differ, even from moment to moment within the same perceiver.

Promising places to begin would be the major personality (e.g., narcissism), cognitive (e.g., motivation to understand target), and affective factors (e.g., arousal) that may influence the process of impression formation. Many of these perceiver characteristics have been thoroughly investigated on their own, and the challenge is to incorporate them into models of impression formation. In sum, while we know that perceiver contributions to impressions occur, and have a sense of how much they occur, the field does not yet have good theoretical accounts of the major factors contributing to this portion of impression formation.

4 | PERCEIVER × TARGET INTERACTIONS

The third portion of the impression formation problem is that characteristics of both perceivers and targets interact to uniquely influence any given impression. As mentioned previously, one perceiver may find people with freckles particularly friendly but not people without freckles; another perceiver might feel the opposite. In this example, friendliness depends on both the characteristics of the target (being freckled or not) and individual differences between perceivers (freckle–friendly associations). These interactions between perceivers and targets are some of

the most interesting and important to intergroup and social-cognitive researchers, often at the core of various models and hypotheses throughout the field.

We do know such interactions regularly occur, and there is extensive evidence of their existence across the impression formation literature. For instance, idiosyncratic experiences across different perceivers, such as how much a target resembles the self or one's family members influence impressions of a target (DeBruine, 2002; DeBruine, Jones, Little, & Perrett, 2008; Verosky & Todorov, 2013). Additionally, personality characteristics of the perceiver interact with target characteristics to influence preferences. For example, individuals with a greater need to belong had greater preferences for extraverted faces, and women with greater neuroticism had stronger preferences for agreeable male faces (Sacco & Brown, 2018a, 2018b).

Further, perceiver × target interactions are at the heart of cross-cultural and intergroup research. For instance, research examining preferences for face-coloration revealed that Chinese perceivers preferred faces with less yellow pigmentation, whereas perceivers from the United Kingdom preferred faces with more yellow pigmentation (Han et al., 2018). In the intergroup domain, prejudiced people evaluate own- and other-group individuals differently, unprejudiced people to a lesser extent (Hugenberg & Bodenhausen, 2004; Hutchings & Haddock, 2008). For example, Black male targets are perceived as larger and more threatening by non-Black and high-prejudice perceivers (Wilson, Hugenberg, & Rule, 2017). These are but just a sampling of the wide array of perceiver × target interactions reported in the literature. In these examples, both the culture or prejudice of the perceiver and the physical characteristics of the target together inform impressions.

Numerous impression formation theories present models for how perceiver × target interactions occur (Freeman & Ambady, 2011; Rhodes, 2006; Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2015; Webster & MacLeod, 2011; Zebrowitz & Montepare, 2005). A modern example is the dynamic interactive model of person perception, which suggests that the processing of bottom-up facial features may be altered by top-down constraints (e.g., emotion, stereotypes, goals; Freeman & Ambady, 2011) or in other words, perceivers who varied in top-down characteristics would have different impressions of the same bottom-up information. Yet without isolating and quantifying the variance that uniquely comes from perceiver × target interactions, it is difficult to explain that variance, and currently, it is unknown to what extent various perceiver and target characteristics explain this space.

4.1 | Limitations

We believe perceiver × target interactions are the least understood source of variance in the impression formation problem. Quantifying the degree to which perceiver × target interactions are involved in any given impression requires an uncommon data structure: At least two ratings of a single target by a perceiver are needed to disentangle the interaction variance from the overall residual variance (Beretvas, 2008; Raudenbush & Bryk, 2002). This data structure is not present in the vast majority of first impression research, in which participants typically rate targets only once. Accordingly, it is rare to be able to model these interactions, and the field does not have good estimates of how much they contribute to impressions.

To our knowledge, only one study has quantified this interaction across multiple trait ratings, and the results indicate perceiver × target interactions play a large role. Across youthful/attractive, dominance, and trustworthiness dimensions of face-trait space, perceiver × target interactions were responsible for between 30% and 40% of the overall variance (Hehman et al., 2017), though these estimates were from a smaller sample and need to be replicated. We note this is a larger percentage than either between-target or between-perceiver variance, meaning that these perceiver × target interactions may play the *largest* role in impressions, though they are the least understood. In sum, while we know that perceiver × target interactions do occur, we have only tentative evidence regarding how much they occur and have not yet begun to explain variance in these interactions.

5 | MOVING FORWARD

5.1 | Limitations of past methodological approaches

Some methodological approaches have become common practice in understanding impression formation. While these approaches have been invaluable, to move forward, it is critical to understand their limitations. For instance, dimensional models of face-trait space have most frequently been derived from data-reduction techniques like principle components analysis (PCA). PCA was developed to maximize variance explained in the observed data—accurately representing the relationships between variables was secondary (Widaman, 2018). Because it prioritizes variance explained, rather than accuracy regarding relationships, it can return highly variable solutions across similar samples and misrepresent the correlations between variables (Widaman, 2018). This is perhaps not surprising, as solutions from PCA explicitly are not intended to generalize to beyond the sample data (Tinsley & Tinsley, 1987), and are less accurate than estimates from factor analyses, which do allow for generalization (Widaman, 2018). Further, extractions of components from PCA based on Eigenvalues > 1 has been criticized for not indicating the optimal number of components, as well as producing unreliable components (Cliff, 1988). This is particularly the case when a smaller number of variables are involved in the analysis, as is typical in the measurement of face-trait space (Guadagnoli & Velicer, 1988; Stevens, 2002).

Compounding these limitations is how the face-trait space is measured. Ratings of targets' traits provide the measurement from which face-trait spaces are formed. Yet research has long demonstrated that the meaning and interpretation of traits can change dramatically across contexts and targets (Hamilton & Zanna, 1974; Uleman, 2005; Wright & Mischel, 1987). Uleman (2005) quips, "the 'warmth' of a lover and the 'warmth' of a parent should be quite different (pg. 255)." Similarly, "dominant" when evaluating spelling bee contestants is not used or based off the same cues as when evaluating mixed martial arts fighters. Trait words do not have a fixed meaning without context and will be used differently across different social categories. If measurement is different across these social categories and contexts (i.e., violating the assumption of measurement invariance), then the face-trait dimensions derived from these ratings will not be generalizable or comparable.

Consistent with these limitations, different research using PCA to examine dimensions finds substantially different dimensional solutions depending on the stimuli, perceivers, contexts, or traits used in measurement. For instance, while the original stimuli in the classic work were targets aged between 20 and 40 (Oosterhof & Todorov, 2008), recent research including older targets among those being rated yielded a third dimension of "youthful/attractive" (Sutherland et al., 2013). Additional information about targets allows trait dimensions of sociability and morality, typically linked to one another (Fiske et al., 2002; Oosterhof & Todorov, 2008), to vary independently (Brambilla, Rusconi, Sacchi, & Cherubini, 2011). Other research examining British and Chinese perceivers evaluating British and Chinese targets found face-trait space differences across cultures (Sutherland et al., 2018). Three dimensions emerged when British perceivers evaluated British faces but only two when evaluating Chinese faces. Three dimensions emerged when Chinese perceivers evaluated British faces, versus four when evaluating Chinese targets (Sutherland et al., 2018).

Emerging research across different perceivers, social categories, contexts, and cultures suggest that the way in which impressions are formed is nuanced, complex, and variable across different situations (Stolier, Hehman, & Freeman, 2018). In other words, a universal *n*-dimensional model of target face-trait space may not exist. While PCA has facilitated understanding of how variables in an observed dataset cluster together, it can mask and misrepresent differences across different datasets. This makes it difficult to compare the way in which impressions are formed across these different situations. To the extent that one's research question requires accurately capturing the relationships between variables, alternative techniques such as factor analysis (e.g., principle axis factoring) are more appropriate than PCA in service of this goal (Widaman, 2018).

Beyond the technical limitations of PCA, the interrelated nature of traits will limit clear dimensional solutions. Even in the seminal work in which the two dimensions underlying impression formation space were originally defined

(Oosterhof & Todorov, 2008), there is a great deal of cross-loading, meaning that traits attributed to one dimension (e.g., dominance) were strongly loading on the other dimension as well. Given this cross-loading, it is not surprising the confirmatory factor models (Xie et al., under review) described above fit poorly. The use of factor analysis will not resolve this complicated underlying structure, and clean *n*-dimensional solutions of the impression formation space may not be a viable pursuit. In addition, the averaging required for dimensional approaches (e.g., collapsing across all perceivers) removes a substantial source of meaningful variance that may be better explored and explained. Accordingly, results averaging across these different levels may not generalize to other participants and other stimuli (Judd et al., 2012).

Furthermore, most research on impression formation to date has focused on targets, which is only one component of the total process. If we wish to fully predict any given rating, the field might focus on the remaining two components of the process as well. Early evidence suggests that between-perceiver differences are responsible for more variance in impressions than between-target differences, in general (Xie et al., in press). Models not accommodating these between-perceiver differences may be ignoring a substantial source of variance, and making a functional assumption this variance does not exist, which we now know is incorrect. Researchers attempting to fully and accurately model these processes may wish to adopt new techniques that build on the rich history of statistical modeling in impression formation.

5.2 | Applying new techniques

New approaches and techniques continue to uncover more meaningful and substantial sources of variance in the process of impression formation. These techniques might be utilized to improve prediction. Here, we discuss some approaches that appear promising for moving forward.

Modeling approaches have been developed that can both accommodate the full sources of variance in impression formation and variance from different levels (i.e., perceiver vs. target), circumventing some of the limitations presented above regarding PCA and dimensional approaches. One is that of cross-classified multilevel models (Judd et al., 2012; Raudenbush & Bryk, 2002). This approach treats both participants and stimuli as random factors, allowing for generalization beyond the participants and stimuli used in the specific sample (Judd et al., 2012), and can

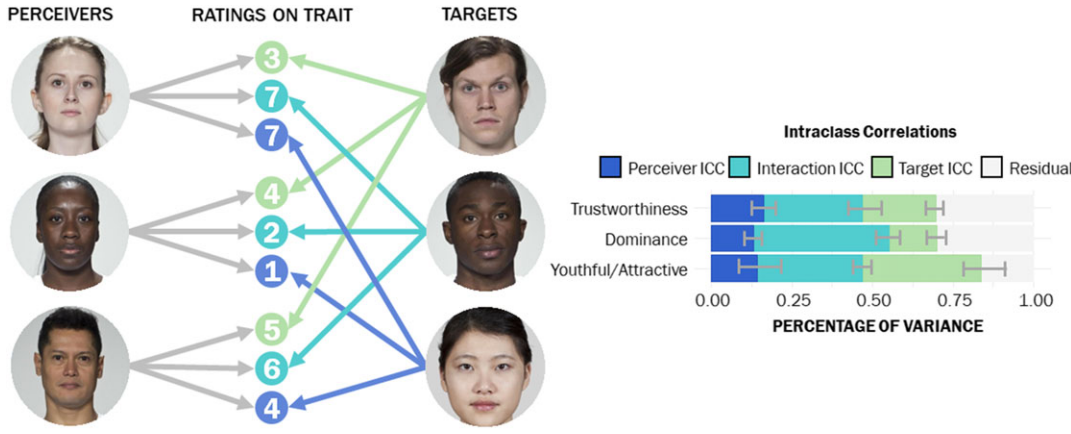

FIGURE 2 An example of cross-classified multilevel models. Ratings are nested both within perceivers and targets (left). From these models, intraclass correlation coefficients, representing the percentage of variance existing at each level of the model, can be calculated (right). Further, variables included in these models can specifically explain variance at the perceiver, target, or perceiver × target interaction levels. *Note.* Error bars represent 95% confidence intervals around ICC estimates. See http://hehmanlab.org/toolbox for R code

accommodate explaining variance between targets, between perceivers, and in perceiver × target interactions (Figure 2).

The utility of this approach has already been demonstrated in some of the research reviewed above, which quantified the percentages of overall variance at different levels of a model (Hehman et al., 2017; Hönekopp, 2006; Xie et al., in press). Because of the regression framework, this approach will be most useful in developing models and identifying variables that explain the maximum amount of variance in impression formation outcomes. For a tutorial of how to build and apply these models in R using the lme4 package, see Hehman et al. (2017).

Another potentially promising approach is representational similarity analysis (RSA; Kriegeskorte, 2008). RSA is an approach borrowed from systems neuroscience but recently applied to impression formation (Stolier, Hehman, & Freeman, 2018) and is ideal for combining and comparing distinct yet related variance from different levels of measurement. It does so by comparing similarity (e.g., correlation) matrices from one source of variance with matrices from another. A strength of this approach is it accommodates a dynamic face-trait space across different perceivers and contexts. Rather than a fixed solution derived from averaging across numerous participants or targets (i.e., like PCA), trait spaces can be combined to better represent a face-trait space on a participant-by-participant basis (Figure 3).

For a concrete example, recent research used this approach to compare the participants' structure of face-trait space (e.g., "How intelligent is this face?") with their structure of conceptual-trait space (e.g., "If a person is intelligent to what extent are they dominant?"; Stolier, Hehman, Keller, Walker, & Freeman, 2018). This research indicated that for those with stronger conceptual associations between, for example, intelligence and dominance, the same morphological cues would give rise to each evaluation. For those who do not have conceptual associations between intelligence and dominance, faces embodying these traits will look different (Stolier et al., 2018). In other words, between-perceiver idiosyncrasies will reshape face-trait space on a perceiver by perceiver basis, and this is some evidence that we might not expect a face-trait space to hold universally.

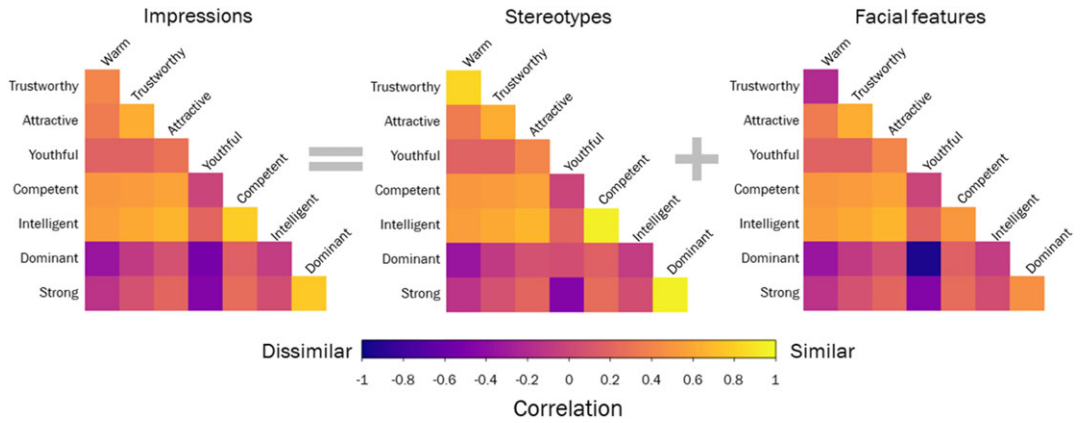

FIGURE 3 An example of Representational Similarity Analysis (RSA). Each space represents a correlation matrix collected under different circumstances, which can be used as variables in subsequent analyses. In the example here, an impressions space (correlation in judgments of how "youthful" and "dominant" faces are rated across perceivers) is predicted by the combination of a conceptual stereotype space (e.g., "If a person is youthful, to what extent are they dominant?") and a facial features space (e.g., the overlap in how much a specific facial metric ["jaw-width"] correlates with both youthful and dominant judgments). Thus, impressions are a linear combination of bottom-up and top-down associations of the multidimensional relationships between traits. For instance, a strong negative association of youthfulness and dominance in facial features combines with the mild conceptual association of youthfulness and dominance in stereotypes, to create a slight negative relation between youthful and dominant judgments of faces

RSA allows a customized face-trait space for each participant, which can then be compared across different participants (or cultures, social categories, targets, etc.). This approach can therefore help to counter the issue of polysemy above, in which different perceivers use trait words differently depending on context. An additional advantage of this approach is that it reduces the degree of data reduction inherent in other approaches. An overview and how it can be applied to impression formation can be found here (Stolier, Hehman, & Freeman, 2018).

Considered together, the primary strength of the cross-classified approach is allowing researchers to partition the overall variance into that attributable to the target, perceiver, and perceiver × target interactions. In contrast, the advantage of RSA is that it allows researchers a way of examining and accounting for how different traits interrelate.

6 | CONCLUSION

We began this article with a seemingly simple problem: with our current models and understanding, can researchers predict a perceiver's rating of a target on any given trait? While past research has brought us dramatically closer to being able to answer this question, more research is needed. Fortunately, tools have emerged that researchers can use to eventually provide the needed information. The past several decades of impression formation research has focused on characteristics of the target, and because of this impressive effort, we now understand this portion of the problem well. Yet this is only roughly 1/3 of the overall variance, and more research is needed to well understand the other 2/3. Further, there remain open questions as to what extent what we know of the target characteristics will generalize to ratings of non-White males. Using some of the techniques laid out above, and with further research on perceiver-level and perceiver × target interactions, we believe it will be possible to have highly accurate predictive models of impression formation.

While the work reviewed above makes it seem unlikely there is a universal face-trait space, elements of these spaces may consistently be present across contexts, cultures, social categories, and perceivers. Indeed, to the extent that the way in which we evaluate others is based off functional needs and concerns consistent across all humans in our evolutionary history, it would be surprising if there was no commonality. More specifically, there may be some trait words, and therefore some impression formation dimensions, that vary to a lesser extent across social categories and contexts. For instance, while the dominance or ability dimension varied quite dramatically across British and Chinese perceivers, youthful/attractiveness and trustworthy dimensions were more consistent (Sutherland et al., 2018). A rich trajectory of research would be to focus on which elements are consistent, and which vary, and why. The first project of the Psychological Science Accelerator, a very large multisite study initiative, intends to examine the generalizability of the two-dimensional model of face-trait space (Oosterhof & Todorov, 2008) with data collected from hundreds of different labs around the world, and will generate an exciting set of data in which to begin asking such questions (Jones et al., in principle acceptance; Chawla, 2017).

In conclusion, we offer several recommendations. When the goal is to understand the relationships between variables, factor-analysis is an approach preferable over PCA. Further, we encourage researchers to examine the process of impression formation beyond of one level of the impression formation problem in isolation (e.g., target-level only). We have mentioned several alternative approaches, though others exist and more will be developed over time. A broadened focus and their application may be ideal at this point in time, to gain a more complete picture of the impression formation process, and may pave the way to comprehensive models and understanding of this process in the future.

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ENDNOTE

[1] Research on the accuracy of impressions is a broad area of research in social cognition. A review additionally encompassing accuracy is beyond the scope of the present review, but see the following for excellent articles and reviews (Human & Biesanz, 2013; Olivola & Todorov, 2010; Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2015; Tskhay & Rule, 2013).

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REFERENCES

Abele, A. E., Cuddy, A. J. C., Judd, C. M., & Yzerbyt, V. Y. (2008). Fundamental dimensions of social judgment. *European Journal of Social Psychology*, *38*(7), 1063–1065. https://doi.org/10.1002/ejsp.574

Adams, R. B., & Kleck, R. E. (2003). Perceived gaze direction and the processing of facial displays of emotion. *Psychological Science*, *14*(6), 644–647. https://doi.org/10.1046/j.0956-7976.2003.psci_1479.x

Adams, R. B., Nelson, A. J., Soto, J. A., Hess, U., & Kleck, R. E. (2012). Emotion in the neutral face: A mechanism for impression formation? *Cognition and Emotion*, *26*(3), 431–441. https://doi.org/10.1080/02699931.2012.666502

Beretvas, S. N. (2008). Cross-classified random effects models. In A. A. O'Connell, & D. B. McCoach (Eds.), *Multilevel modeling of educational data*. Information Age publishing.

Brambilla, M., Biella, M., & Freeman, J. B. (2018). The influence of visual context on the evaluation of facial trustworthiness. *Journal of Experimental Social Psychology*, *78*(March), 34–42. https://doi.org/10.1016/j.jesp.2018.04.011

Brambilla, M., Rusconi, P., Sacchi, S., & Cherubini, P. (2011). Looking for honesty: The primary role of morality (vs. sociability and competence) in information gathering. *European Journal of Social Psychology*, *41*(2), 135–143. https://doi.org/10.1002/ejsp.744

Brewer, M. B. (1988). A dual process model of impression formation. In *Advances in social cognition* (ed., Vol. 1) (pp. 1–36). https://doi.org/10.1521/soco.1993.11.1.150

Bruce, V., & Young, A. (1986). Understanding face recognition. *British Journal of Psychology*, *77*(Pt 3), 305–327. https://doi.org/10.1111/j.2044-8295.1986.tb02199.x

Brunswik, E. (1952). The conceptual framework of psychology. *Journal of Consulting Psychology*. Chicago: University of Chicago Press. https://doi.org/10.1037/h0053448, *16*, 475.

Carré, J. M., Morrissey, M. D., Mondloch, C. J., & McCormick, C. M. (2010). Estimating aggression from emotionally neutral faces: Which facial cues are diagnostic? *Perception*, *39*(3), 356–377. https://doi.org/10.1068/p6543

Chawla, D. S. (2017). A new 'accelerator' aims to bring big science to psychology. Science Magazine. Retrieved from https://www.sciencemag.org/news/2017/11/new-accelerator-aims-bring-big-science-psychology

Cliff, N. (1988). The eigenvalues-greater-than-one rule and the reliability of components. *Psychological Bulletin*, *103*(2), 276.

Correll, J., Hudson, S. M., Guillermo, S., & Earls, H. A. (2016). Of kith and kin: Perceptual enrichment, expectancy, and reciprocity in face perception. *Personality and Social Psychology Review* https://doi.org/10.1177/1088868316657250, *21*, 336–360.

DeBruine, L. M. (2002). Facial resemblance enhances trust. *Proceedings of the Royal Society B: Biological Sciences*, *269*(1498), 1307–1312. https://doi.org/10.1098/rspb.2002.2034

DeBruine, L. M., Jones, B. C., Little, A. C., & Perrett, D. I. (2008). Social perception of facial resemblance in humans. *Archives of Sexual Behavior*, *37*(1), 64–77. https://doi.org/10.1007/s10508-007-9266-0

Dimberg, U., & Thunberg, M. (2007). Speech anxiety and rapid emotional reactions to angry and happy facial expressions: Personality and social sciences. *Scandinavian Journal of Psychology*, *48*(4), 321–328. https://doi.org/10.1111/j.1467-9450.2007.00586.x

Edwards, J., Pattison, P. E., Jackson, H. J., & Wales, R. J. (2001). Facial affect and affective prosody recognition in first-episode schizophrenia. *Schizophrenia Research*, *48*(2–3), 235–253. https://doi.org/10.1016/S0920-9964(00)00099-2, 253

Fessler, D. M. T., & Holbrook, C. (2013a). Bound to lose: Physical incapacitation increases the conceptualized size of an antagonist in men. *PLoS One*, *8*(8), e71306. https://doi.org/10.1371/journal.pone.0071306

Fessler, D. M. T., & Holbrook, C. (2013b). Friends shrink foes: The presence of comrades decreases the envisioned physical formidability of an opponent. *Psychological Science*, *24*(5), 797–802. https://doi.org/10.1177/0956797612461508

Fiske, S. T., Cuddy, A. J. C., & Glick, P. (2007). Universal dimensions of social cognition: Warmth and competence. *Trends in Cognitive Sciences*, *11*(2), 77–83. https://doi.org/10.1016/j.tics.2006.11.005

Fiske, S. T., Cuddy, A. J. C., Glick, P., & Xu, J. (2002). A model of (often mixed) stereotype content: Competence and warmth respectively follow from perceived status and competition. *Journal of Personality and Social Psychology*, *82*(6), 878–902. https://doi.org/10.1037//0022-3514.82.6.878

Fiske, S. T., & Neuberg, S. L. (1990). A continuum of impression formation, from category based to individuating processes: Influences of information and motivation on attention and interpretation. *Advances in Experimental Social Psychology*, *23*, 1–74.

Forgas, J., & Bower, G. (1987). Mood effects on person-perception judgements. *Journal of Personality and Social Psychology*, *53*(1), 53–60. https://doi.org/10.1037/0022-3514.53.1.53

Freeman, J. B., & Ambady, N. (2011). A dynamic interactive theory of person construal. *Psychological Review*, *118*(2), 247–279. https://doi.org/10.1037/a0022327

Germine, L., Russell, R., Bronstad, P. M., Blokland, G. A. M., Smoller, J. W., Kwok, H., … Wilmer, J. B. (2015). Individual aesthetic preferences for faces are shaped mostly by environments, not genes. *Current Biology*, *25*(20), 2684–2689. https://doi.org/10.1016/j.cub.2015.08.048

Goldin, P. R., Manber, T., Hakimi, S., Canli, T., & Gross, J. J. (2009). Neural bases of social anxiety disorder. *Archives of General Psychiatry*, *66*(2), 170. https://doi.org/10.1001/archgenpsychiatry.2008.525–180.

Guadagnoli, E., & Velicer, W. F. (1988). Relation of sample size to the stability of component patterns. *Psychological Bulletin*, *103*(2), 265–275. https://doi.org/10.1037/0033-2909.103.2.265

Guilford, J. P., & Guilford, R. B. (1934). An analysis of the factors in a typical test of introversion-extroversion. *Journal of Abnormal and Social Psychology*, *28*(4), 377–399. https://doi.org/10.1037/h0069917

Hamilton, D. L., & Zanna, M. P. (1974). Context effects in impression formation: Changes in connotative meaning. *Journal of Personality and Social Psychology*, *29*(5), 649–654. https://doi.org/10.1037/h0036633

Han, C., Wang, H., Hahn, A. C., Fisher, C. I., Kandrik, M., Fasolt, V., … Jones, B. C. (2018). Cultural differences in preferences for facial coloration. *Evolution and Human Behavior*, *39*(2), 179–190. https://doi.org/10.1016/j.evolhumbehav.2017.11.005

Haxby, J., Hoffman, E., & Gobbini, M. (2000). The distributed human neural system for face perception. *Trends in Cognitive Sciences*, *4*(6), 223–233. https://doi.org/10.1016/S1364-6613(00)01482-0

Hehman, E., Flake, J. K., & Freeman, J. B. (2015). Static and dynamic facial cues differentially affect the consistency of social evaluations. *Personality and Social Psychology Bulletin*, *41*(8), 1123–1134. https://doi.org/10.1177/0146167215591495

Hehman, E., Leitner, J. B., & Gaertner, S. L. (2013). Enhancing static facial features increases intimidation. *Journal of Experimental Social Psychology*, *49*(4), 747–754. https://doi.org/10.1016/j.jesp.2013.02.015

Hehman, E., Sutherland, C. A. M., Flake, J. K., & Slepian, M. L. (2017). The unique contributions of perceiver and target characteristics in person perception. *Journal of Personality and Social Psychology: Attitudes and Social Cognition*, *113*, 513–529. https://doi.org/10.1037/pspa0000090

Hoehn-Hyde, D., Schlottmann, R. S., & Rush, A. J. (1982). Perception of social interactions in depressed psychiatric patients. *Journal of Consulting and Clinical Psychology*, *50*(2), 209–212. https://doi.org/10.1037/0022-006X.50.2.209

Hönekopp, J. (2006). Once more: Is beauty in the eye of the beholder? Relative contributions of private and shared taste to judgments of facial attractiveness. *Journal of Experimental Psychology: Human Perception and Performance*, *32*(2), 199–209. https://doi.org/10.1037/0096-1523.32.2.199

Hugenberg, K., & Bodenhausen, G. V. (2004). Ambiguity in social categorization: The role of prejudice and facial affect in race categorization. *Psychological Science*, *15*(5), 342–345. https://doi.org/10.1111/j.0956-7976.2004.00680.x

Human, L. J., & Biesanz, J. C. (2013). Targeting the good target: An integrative review of the characteristics and consequences of being accurately perceived. *Personality and Social Psychology Review*, *17*(3), 248–272. https://doi.org/10.1177/1088868313495593

Hutchings, P. B., & Haddock, G. (2008). Look Black in anger: The role of implicit prejudice in the categorization and perceived emotional intensity of racially ambiguous faces. *Journal of Experimental Social Psychology*, *44*(5), 1418–1420. https://doi.org/10.1016/j.jesp.2008.05.002

Jenkins, R., White, D., Van Montfort, X., & Burton, A. M. (2011). Variability in photos of the same face. *Cognition*, *121*(3), 313–323. https://doi.org/10.1016/j.cognition.2011.08.001

Jones, B. C., DeBruine, L., Flake, J., Aczel, B., Adamkovic, M., Alaei, R., … Chartier, C. (in principle acceptance). *Social perception of faces around the world: How well does the valence-dominance model generalize across world regions? Nature Human Behavior*.

Jones, B. C., DeBruine, L. M., & Little, A. C. (2007). The role of symmetry in attraction to average faces. *Perception & Psychophysics*, *69*(8), 1273–1277. https://doi.org/10.3758/BF03192944

Judd, C. M., Westfall, J., & Kenny, D. A. (2012). Treating stimuli as a random factor in social psychology: A new and comprehensive solution to a pervasive but largely ignored problem. *Journal of Personality and Social Psychology*, *103*(1), 54–69. https://doi.org/10.1037/a0028347

Kenny, D. A. (1991). A general model of consensus and accuracy in interpersonal perception. *Psychological Review*, *98*(2), 155–163. https://doi.org/10.1037/0033-295X.98.2.155

Kenny, D. A., & Albright, L. (1987). Accuracy in interpersonal perception: A social relations analysis. *Psychological Bulletin*, *102*(3), 390–402. https://doi.org/10.1177/026540758800500207

Kriegeskorte, N. (2008). Representational similarity analysis—Connecting the branches of systems neuroscience. *Frontiers in Systems Neuroscience*, *2*(November), 1–28. https://doi.org/10.3389/neuro.06.004.2008

Kunda, Z., & Thagard, P. (1996). Forming impressions from stereotypes, traits, and behaviors: A parallel-constraint-satisfaction theory. *Psychological Review* https://doi.org/10.1037/0033-295X.103.2.284, *103*, 284–308.

Leary, T. F. (1957). *The interpersonal diagnosis of personality: A functional theory and methodology for personality evaluation*. Eugene: Resource Publications.

Leyens, J. P., Cortes, B., Demoulin, S., Dovidio, J. F., Fiske, S. T., Gaunt, R., … Vaes, J. (2003). Emotional prejudice, essentialism, and nationalism: The 2002 Tajfel Lecture. *European Journal of Social Psychology*, *33*(6), 703–717. https://doi.org/10.1002/ejsp.170

Olivola, C. Y., & Todorov, A. (2010). Fooled by first impressions? Reexamining the diagnostic value of appearance-based inferences. *Journal of Experimental Social Psychology*, *46*(2), 315–324. https://doi.org/10.1016/j.jesp.2009.12.002

Oosterhof, N. N., & Todorov, A. (2008). The functional basis of face evaluation. *Proceedings of the National Academy of Sciences*, *105*(32), 11087–11092. https://doi.org/10.1073/pnas.0805664105

Oosterhof, N. N., & Todorov, A. (2009). Shared perceptual basis of emotional expressions and trustworthiness impressions from faces. *Emotion*, *9*(1), 128–133. https://doi.org/10.1037/a0014520

Pozo, C., Carver, C. S., Wellens, A. R., & Scheier, M. F. (1991). Social anxiety and social perception: Construing others' reactions to the self. *Personality and Social Psychology Bulletin*, *17*(4), 355. https://doi.org/10.1177/0146167291174001–362.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. London: Sage

Rhodes, G. (2006). The evolutionary psychology of facial beauty. *Annual Review of Psychology*, *57*(1), 199–226. https://doi.org/10.1146/annurev.psych.57.102904.190208

Rhodes, G., Jeffery, L., Watson, T. L., Clifford, C. W. G., & Nakayama, K. (2003). Fitting the mind to the world: Face adaptation and attractiveness aftereffects. *Psychological Science*, *14*(6), 558–566. https://doi.org/10.1046/j.0956-7976.2003.psci_1465.x

Rubinow, D. R., & Post, R. M. (1992). Impaired recognition of affect in facial expression in depressed patients. *Biological Psychiatry*, *31*(9), 947–953. https://doi.org/10.1016/0006-3223(92)90120-O

Russell, A. N. N. M. T., & Fiske, S. T. (2008). It's all relative: Competition and status drive interpersonal perception. *European Journal of Social Psychology*, *1201*(April), 1193–1201. https://doi.org/10.1002/ejsp

Sacco, D. F., & Brown, M. (2018a). Preferences for facially communicated big five personality traits and their relation to self-reported big five personality. *Personality and Individual Differences*, *134*(June), 195–200. https://doi.org/10.1016/j.paid.2018.06.024

Sacco, D. F., & Brown, M. (2018b). The face of personality: Adaptive inferences from facial cues are moderated by perceiver personality and motives. *Social and Personality Psychology Compass*, *12*(8), 1–15. https://doi.org/10.1111/spc3.12410

Said, C. P., Sebe, N., & Todorov, A. (2009). Structural resemblance to emotional expressions predicts evaluation of emotionally neutral faces. *Emotion*, *9*(2), 260–264. https://doi.org/10.1037/a0014681

Schofield, C. A., Coles, M. E., & Gibb, B. E. (2007). Social anxiety and interpretation biases for facial displays of emotion: Emotion detection and ratings of social cost. *Behaviour Research and Therapy*, *45*(12), 2950–2963. https://doi.org/10.1016/j.brat.2007.08.006

Secord, P. F. (1958). Facial features and inference processes in interpersonal perception. *Person Perception and Interpersonal Behavior*, 300–315.

Secord, P. F., Dukes, W. F., & Bevan, W. (1954). Personalities in faces: I. An experiment in social perceiving. *Genetic Psychology Monographs*, *49*(2), 231–279.

Staugaard, S. R. (2010). Threatening faces and social anxiety: A literature review. *Clinical Psychology Review*, *30*(6), 669–690. https://doi.org/10.1016/j.cpr.2010.05.001

Stevens, J. P. (2002). *Applied multivariate statistics for the social sciences*. Mahwah: Lawnrence Erlbaum.

Stolier, R. M., Hehman, E., & Freeman, J. B. (2018). A dynamic structure of social trait space. *Trends in Cognitive Sciences*, *22*(3), 197–200. https://doi.org/10.1016/j.tics.2017.12.003

Stolier, R. M., Hehman, E., Keller, M. D., Walker, M., & Freeman, J. B. (2018). The conceptual structure of face impressions. *Proceedings of the National Academy of Sciences*, 201807222. https://doi.org/10.1073/pnas.1807222115

Sutherland, C. A. M., Liu, X., Zhang, L., Chu, Y., Oldmeadow, J. A., & Young, A. W. (2018). Facial first impressions across culture: Data-driven modeling of Chinese and British perceivers' unconstrained facial impressions. *Personality and Social Psychology Bulletin*, *44*, 521–537. https://doi.org/10.1177/0146167217744194

Sutherland, C. A. M., Oldmeadow, J. A., Santos, I. M., Towler, J., Michael Burt, D., & Young, A. W. (2013). Social inferences from faces: Ambient images generate a three-dimensional model. *Cognition*, *127*(1), 105–118. https://doi.org/10.1016/j.cognition.2012.12.001

Sutherland, C. A. M., Young, A. W., Mootz, C. A., & Oldmeadow, J. A. (2015). Face gender and stereotypicality influence facial trait evaluation: Counter-stereotypical female faces are negatively evaluated. *British Journal of Psychology*, *106*(2), 186–208. https://doi.org/10.1111/bjop.12085

Tinsley, H. E., & Tinsley, D. J. (1987). Uses of factor analysis in counseling psychology research. *Journal of Counseling Psychology*, *34*(4), 414–424. https://doi.org/10.1037//0022-0167.34.4.414

Todorov, A., & Engell, A. D. (2008). The role of the amygdala in implicit evaluation of emotionally neutral faces. *Social Cognitive and Affective Neuroscience*, *3*(4), 303–312. https://doi.org/10.1093/scan/nsn033

Todorov, A., Olivola, C. Y., Dotsch, R., & Mende-Siedlecki, P. (2015). Social attributions from faces: Determinants, consequences, accuracy, and functional significance. *Annual Review of Psychology*, *66*(1), 519–545. https://doi.org/10.1146/annurev-psych-113011-143831

Todorov, A., Said, C. P., Engell, A. D., & Oosterhof, N. N. (2008). Understanding evaluation of faces on social dimensions. *Trends in Cognitive Sciences*, *12*(12), 455–460. https://doi.org/10.1016/j.tics.2008.10.001

Tskhay, K. O., & Rule, N. O. (2013). Accuracy in categorizing perceptually ambiguous groups: A review and meta-analysis. *Personality and Social Psychology Review*, *17*(1), 72–86. https://doi.org/10.1177/1088868312461308

Uleman, J. S. (2005). On the inherent ambiguity of traits and other mental concepts. In B. F. Malle, & S. D. Hodges (Eds.), *Other minds: How humans bridge the divide between self and others* (pp. 253–267). New York: Guilford Press.

Verosky, S. C., & Todorov, A. (2013). When physical similarity matters: Mechanisms underlying affective learning generalization to the evaluation of novel faces. *Journal of Experimental Social Psychology*, *49*(4), 661–669. https://doi.org/10.1016/j.jesp.2013.02.004

Webster, M. A., & MacLeod, D. I. A. (2011). Visual adaptation and face perception. *Philosophical Transactions of the Royal Society, B: Biological Sciences*, *366*(1571), 1702–1725. https://doi.org/10.1098/rstb.2010.0360

West, T. V., & Kenny, D. A. (2011). The truth and bias model of judgment. *Psychological Review*, *118*(2), 357–378. https://doi.org/10.1037/a0022936

Widaman, K. F. (2018). On common factor and principal component representations of data: Implications for theory and for confirmatory replications. *Structural Equation Modeling*, (in Advance). https://doi.org/10.1080/10705511.2018.1478730, *25*, 829–847.

Wilson, J. P., Hugenberg, K., & Rule, N. O. (2017). Racial bias in judgments of physical size and formidability: From size to threat. *Journal of Personality and Social Psychology*, *113*(1), 59–80. https://doi.org/10.1037/pspi0000092

Wright, J. C., & Mischel, W. (1987). A conditional approach to dispositional constructs: The local predictability of social behavior. *Journal of Personality and Social Psychology*, *53*(6), 1159–1177. https://doi.org/10.1037/0022-3514.53.6.1159

Xie, S. Y., Flake, J. K., & Hehman, E. (in press). Perceiver and target characteristics contribute to impression formation differently across race and gender. *Journal of Personality and Social Psychology*.

Xie, S. Y., Flake, J. K., Stolier, R. M., Freeman, J. B., & Hehman, E. (under review). The generality of two-dimensional face space across social categories.

Zebrowitz, L. A., Fellous, J. M., Mignault, A., & Andreoletti, C. (2003). Trait impressions as overgeneralized responses to adaptively significant facial qualities: Evidence from connectionist modeling. *Personality and Social Psychology Review*, *7*(3), 194–215. https://doi.org/10.1207/S15327957PSPR0703_01

Zebrowitz, L. A., Kikuchi, M., & Fellous, J. M. (2010). Facial resemblance to emotions: Group differences, impression effects, and race stereotypes. *Journal of Personality and Social Psychology*, *98*(2), 175–189. https://doi.org/10.1037/a0017990

Zebrowitz, L. A., & Montepare, J. M. (1992). Impressions of babyfaced individuals across the life span. *Developmental Psychology*, *28*(6), 1143–1152. https://doi.org/10.1037//0012-1649.28.6.1143

Zebrowitz, L. A., & Montepare, J. M. (2005). Appearance DOES matter. *Science*, *308*(5728), 1565–1566. https://doi.org/10.1126/science.1114170

Zebrowitz, L. A., & Montepare, J. M. (2008). Social psychological face perception: Why appearance matters. *Social and Personality Psychology Compass*, *2*(3), 1497–1517. https://doi.org/10.1111/j.1751-9004.2008.00109.x

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Ryan Stolier is a doctoral student at NYU working with Jon Freeman. He is broadly interested in how we represent social perceptions and concepts. His research concerns how bottom-up perceptual (e.g., face perception) and top-down social factors (e.g., prejudice, motivation) influence and structure these representations. He is interested in understanding these processes at both psychological and neural levels of analysis. His research primarily applies implicit behavioral and fMRI pattern analysis methods to these questions.

Jon Freeman is an Associate Professor at New York University. He studies split-second social perception—how we use facial cues to categorize other people into social groups and perceive their personality traits and emotion. He treats this as a fundamentally dynamic process and is interested in how basic visual perception of other people may be shaped by stereotypes and biases, prior knowledge, and other aspects of social cognition. He received his PhD from Tufts University.

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