Mind, Mien, Milieu:

Contextual Influences on the Structure of First Impressions

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TABLE OF CONTENTS

ABSTRACT 5
RÉSUMÉ 8
ACKNOWLEDGEMENTS 12
CONTRIBUTION TO ORIGINAL KNOWLEDGE 15
CONTRIBUTION OF AUTHORS 19

Chapter 1:
GENERAL INTRODUCTION 22
General Introduction 23

Chapter 2:
LITERATURE REVIEW 27
Literature Review 28
Social Impressions from Faces 28
Person Perception in Context 37
The Present Research 51

Chapter 3:
Xie, S. Y., Flake, J. K., Stolier, R. M., Freeman, J. B., & Hehman, E. (2021). Facial impressions are predicted by the structure of group stereotypes. *Psychological Science*, *32*(12), 1979-1993. 54
Abstract 54
Statement of Relevance 55
Introduction 56
Perceiver Variability in Face Impressions 56
The Structuring Role of Stereotypes in First Impressions 58
The Present Research 59
Study 1 59
Methods 59
Results 65
Supplementary Analysis 68
Study 2 71
Methods 71
Results 76
General Discussion 78
Conclusion 81
Transparency 82
Open Practices 82
References 84

Chapter 4:
Preface to Chapter 4 88

Xie, S. Y. & Hehman, E. (in prep). Cultural perceptions of faces reveal consistent racial and gender associations across countries. 91
Introduction 92
Cultural Learning in Facial First Impressions 92
The Present Research 94
Methods 97
Trait Ratings 97
Index of Gender Inequality 97
Analytic Approach 98
Results 100
Preliminary Analysis 100
Main Analysis 101
General Discussion 103
Supplementary Materials 110
Supplementary Analysis 1 111
References 113

Chapter 5:
Preface to Chapter 5 119
Xie, S. Y., Thai, S., & Hehman, E. (in press). Everyday perceiver-context influences on impression formation: No evidence of consistent effects. *Personality and Social Psychology Bulletin.* 122
Abstract 122
Introduction 123
Variability in Facial First Impressions 123
Do Perceiver Contexts Influence Impression Formation? 125
Methods 127
Experience Sampling 127
Participants 128
Procedure 128
Analysis 1 132
Quantifying Perceiver-Context Variability in Face Impressions 132
Latent Profile Analysis of Real-World Contexts 134
Results 136
Analysis 2 141
Which Contexts are Important for Predicting Face Impressions? 141
General Discussion 147
Participant Trait-Level Predictors 150
Limitations 151
Conclusion 153
References 155
Transparency 160

Chapter 6:

Preface to Chapter 6 162
Xie, S. Y., & Hehman, E. (in prep). Situational affordances constrain first impressions from faces. 166
Abstract 166
Introduction 167
Contextualized Impression Formation 167
Situational Affordances 168
The Present Research 170
Methods 172
Procedure 172
Results 181
Hypothesis 1: Face-Trait Space 181
Hypothesis 2: Trait Centrality 184
General Discussion 187
Limitations 192
Conclusion 194
Supplementary Materials 195
Study Instructions and Conditions 195
Example Rating Task 199
References 200

Chapter 7:

GENERAL DISCUSSION 207
General Discussion 208
Summary of Main Findings 209
Theoretical Implications 212
Limitations and Open Questions 218
Conclusion 222
References 223

ABSTRACT

People readily form impressions of each other (e.g., friendly, dangerous) based on facial appearance. Regardless of accuracy, these impressions are pervasive and consequential: predicting who we hire, promote, elect to office, and convict in court. A substantial research effort has focused on understanding how impressions are formed. Modern approaches emphasize the joint contributions of target characteristics (e.g., facial cues, social category) and perceiver characteristics (e.g., motivation, cognition) to impression formation. Although it is increasingly evident that facial impressions vary across diverse contexts, empirical research on the role that context plays in impression formation is scarce. Critically, the field lacks a systematic understanding of how contexts interact with perceiver and target factors to shape impressions, which contexts matter, and to what extent. This dissertation leverages new computational and statistical methods to (1) quantitatively characterize which contexts matter for impression formation, and (2) investigate how the structure of facial impressions ("face-trait space") shifts across contexts.

The first study (Chapter 3) examines how societal and personal stereotypes shape impressions of faces across social groups. Using representational similarity analysis, we found that societal representations of facial impressions map onto the structure of societal stereotypes—shifting across racial and gender categories in stereotype-consistent ways. We also demonstrate this effect for perceivers' own unique, learned associations about these groups. Both cultural learning and personal experiences shape the structure of facial impressions, suggesting that the race and gender of targets contextualize, and constrain, the impression formation process: merely categorizing a face provides context for impressions.

Chapter 4 extends this work by testing whether perceivers from different countries—who have fewer opportunities to acquire shared cultural stereotypes—form impressions differently. Stereotypes about social categories are shaped by cultural products (e.g., knowledge of societal inequalities) and may vary across countries. We operationalized this aspect of cultural context using national indices of gender inequality, as a "ground truth" measure of gender-related outcomes. We found racial and gender differences in the face-trait space across 41 countries (cross-culturally replicating findings from Chapter 3), but national indices of gender inequality did not consistently explain these differences.

Chapter 5 explores the extent to which facial impressions are shaped by day-to-day contexts experienced by people in the real world. We used a novel experience-sampling paradigm to track daily changes in participants' experienced contexts (e.g., mood, environment, physiology, psychological situation) while they formed impressions. We applied latent profile analysis to construct distinct classes of experienced contexts, then built cross-classified models to quantify the contributions of perceiver, target, and contexts to facial impressions. Overall, we found no evidence that these daily contexts are important for shaping facial impressions.

Finally, in Chapter 6, we experimentally test how situational affordances shift the face-trait space. Situational goals may exert strong constraints on impression formation (Hypothesis 1), causing perceivers to attend to goal-relevant traits—which then influence impressions on other, less relevant traits (Hypothesis 2). Somewhat consistent with our hypothesis, the face-trait space became more constrained in contexts where fundamental motives were made salient (e.g., mate-seeking, disease avoidance), compared to a neutral context. However, more research is needed to understand how situationally relevant traits influence downstream impressions on other traits.

Together, this work shows that facial impressions are influenced by perceiver, target, and contextual factors. Stereotype associations and situational affordances are particularly important, shaping the structure of facial impressions—whereas day-to-day, real-world contexts play only a minimal role. This dissertation demonstrates the utility of computational approaches to studying impression formation, by (1) quantitatively disentangling perceiver, target, and context influences on impressions, and (2) testing changes to the structural representation of facial impressions across a variety of contexts. Overall, a socially contextualized theory of perception can fundamentally broaden our understanding of how humans perceive other humans.

RÉSUMÉ

Les gens se font rapidement des idées sur les autres. En l'espace d'un moment et d'un regard, nous formons une image mentale de son caractère (par exemple: amical, dangereux, etc.) et générons des présuppositions sur son état d'âme et son comportement. Quelle que soit leur exactitude, ces premières impressions faciales sont omniprésentes et lourdes de conséquences : elles permettent de prédire qui nous embauchons, promouvons, élisons et condamnons dans les tribunaux. Par conséquent, d'importants efforts de recherche ont été déployés pour comprendre comment ces impressions se forment. Les approches modernes mettent l'accent sur les contributions conjointes des caractéristiques du perçu (par exemple, la morphologie du visage, la catégorie sociale, etc.) et des caractéristiques du percepteur (par exemple, la motivation, la cognition, etc.) quant à la formation des impressions. Bien qu'il soit de plus en plus évident que les impressions faciales varient dans divers contextes, les recherches empiriques sur le rôle que joue le contexte dans la formation des impressions sont rares. Le domaine manque crucialement d'une compréhension systématique de la façon dont les contextes interagissent avec les caractéristiques du percepteur et du perçu pour façonner les impressions, quels contextes sont importants, et dans quelle mesure. Cette thèse s'appuie sur de nouvelles méthodes informatiques et statistique pour (1) caractériser quantitativement les contextes qui importent dans la formation des impressions (et dans quelle mesure), et (2) étudier comment la structure des impressions faciales (c'est-à-dire " l'espace visage-trait ") évolue en fonction des caractéristiques du percepteur, du perçu et du contexte.

La première étude (chapitre 2) examine comment les stéréotypes sociétaux et personnels façonnent les impressions des visages à travers les groupes sociaux. En utilisant l'analyse de la similarité représentationnelle, nous avons découvert que les représentations sociétales des

impressions faciales correspondent à la structure des stéréotypes sociétaux : l'espace visage-trait se déplace à travers les catégories de race et de sexe d'une manière cohérente avec les stéréotypes sociétaux concernant ces groupes. En utilisant des modèles multiniveaux à classification croisée, nous démontrons également cet effet dans les associations uniques et apprises des personnes remarquant ces catégories. Ainsi, l'apprentissage culturel et les expériences personnelles façonnent la structure des impressions faciales. Cela suggère que la race et le sexe des perçus contextualisent et limitent le processus de formation des impressions : le simple fait de catégoriser un visage fournit un contexte pour les impressions.

La deuxième étude (chapitre 3) poursuit ce travail en vérifiant si les personnes qui perçoivent l'origine culturelle d'un pays chez quelqu'un - qui ont plus d'occasions d'acquérir des stéréotypes culturels communs - ont *la structure des traits de visage* plus similaires que les personnes qui perçoivent l'origine culturelle d'un pays chez quelqu'un. Les associations stéréotypées concernant les catégories sociales sont façonnées sont issus de la culture (par exemple, la connaissance des inégalités sociétales) et peuvent varier d'un pays à l'autre. Nous avons opérationnalisé cet aspect du contexte culturel en utilisant des indices nationaux d'inégalité entre les sexes, en tant que "vérité de base" alternative aux stéréotypes de genre entre nations. Bien que nous ayons constaté des différences entre les sexes dans l'espace visage-trait dans 41 pays (ce qui corrobore les résultats du chapitre 2), les indices nationaux d'inégalité entre les sexes n'expliquent pas systématiquement ces différences. Ainsi, « l'espace visage-titre » des femmes et des hommes diffère - et diffère selon les pays - mais pas en fonction des contextes culturels englobe par l'inégalité des sexes dans les pays.

La troisième étude (chapitre 4) explore la mesure dans laquelle les impressions faciales sont influencées par les contextes quotidiens vécus dans le monde réel. Nous avons utilisé un

nouveau paradigme d'échantillonnage d'expériences pour suivre les changements quotidiens des contextes expérimentés des participants (par exemple, l'humeur, l'environnement, la physiologie, la situation psychologique, etc.) pendant qu'ils formaient des impressions des perçus. Nous avons mis en œuvre une analyse de profil latent pour construire des classes distinctes de contextes expérimentés, puis nous avons construit des modèles à classification croisée pour quantifier les contributions relatives des caractéristiques du percepteur, des caractéristiques du perçu, des groupes contextuels et de leurs interactions aux impressions des traits. Dans l'ensemble, nous n'avons trouvé aucune preuve que ces contextes quotidiens sont importants pour façonner les impressions faciales.

Enfin, dans la quatrième étude (chapitre 5), nous testons expérimentalement comment les *affordances* situationnelles déplacent l'espace visage-trait. Les objectifs situationnels peuvent exercer de fortes contraintes sur la formation des impressions (Hypothèse 1), amenant les percepteurs à prêter attention aux indices pertinents à la situation et à former une impression sur un trait pertinent - qui influence ensuite les impressions sur d'autres traits moins pertinents à la situation (Hypothèse 2). Nous avons testé si l'espace visage-trait devient plus restreint dans des contextes où les motifs fondamentaux sont rendus saillants (par exemple, la recherche d'un compagnon, l'autoprotection, l'évitement de la maladie, etc.) par rapport à un contexte neutre. Un peu en accord avec notre hypothèse, « l'espace visage-titre » diffère dans les contextes avec des affordances situationnelles (par rapport à un contexte neutre), devenant plus contraint dans deux des trois contextes. Cependant, d'autres recherches sont nécessaires pour comprendre comment les traits pertinents en situation influencent les impressions en aval sur d'autres traits.

L'ensemble de ces travaux montre que les impressions sociales des visages sont influencées par des facteurs liés à la personne qui perçoit, au perçu et au contexte. Les

associations de stéréotypes et les possibilités offertes par la situation sont particulièrement importantes et façonnent la structure des impressions faciales. Cependant, les contextes quotidiens du monde réel ne jouent qu'un rôle minime dans la formation des impressions. Cette thèse démontre l'utilité des approches computationnelles pour étudier la formation des impressions en (1) démêlant quantitativement les influences du percepteur, du perçu et du contexte sur les impressions et (2) en testant les changements dans la représentation structurelle des impressions faciales. Une théorie de la perception socialement contextualisée peut fondamentalement élargir notre compréhension de la façon dont les humains se perçoivent les uns les autres humains.

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To my parents, Bill and Jane

CONTRIBUTION TO ORIGINAL KNOWLEDGE

To efficiently navigate our social world, we readily infer others' character traits and social category memberships (e.g., "that woman is friendly"), generating predictions about how others might behave. These inferences are powerfully influential, predicting who we date (Finkel et al., 2007), hire (Rudman & Glick, 2001), vote into office (Ballew & Todorov, 2007), and convict in the courtroom (Wilson & Rule, 2015). Given their impact, these impressions have long been the subject of empirical inquiry.

Until recently, however, two puzzles in the social perception literature had remained unresolved, motivating the foundational work for this dissertation. First, the evolutionary importance of social perception suggests that "first impressions" should be evoked by the appearance and behavior of human targets in a relatively universal manner—yet observers often disagree on their impressions (Hehman et al., 2017), particularly of different people who vary along race and gender (Oh et al., 2019; Xie et al., 2019). What explains these differences in first impressions? Second, modern models of social cognition implicitly support the idea that people are embedded in the broader context of their social world (Barrett & Kensinger, 2010; Freeman et al., 2020; Mesquita et al., 2010; Shoda et al., 2007; Smith & Collins, 2009; Turner et al., 1994). Yet, despite decades of impression formation research, the role that these contextual factors play in shaping impressions has received remarkably little empirical attention.

Critically, the literature lacks basic descriptive research that quantifies (and disentangles) perceiver, target, and contextual influences on social perception. Without this work, it is difficult to clarify how impressions arise from a target's "face", versus a perceiver's "mind", versus interactions with contextual factors. Thus, the overarching aim of this dissertation is to resolve these open questions, by conducting an investigation into how perceiver characteristics (e.g.,

learned associations), target characteristics (e.g., race, gender), and contextual characteristics (e.g., situations, affordances, real-world contexts) interact to shape social impressions. To do this, we leveraged novel statistical and behavioural methods, such as representational similarity analysis, cross-classified multilevel modelling, latent profile analysis, and longitudinal experience-sampling, to quantitatively characterize the impact of contextual factors on facial impressions.

The first study (Chapter 3), published in *Psychological Science,* is the first to empirically connect the face perception and social cognition literatures to examine how stereotypical associations (at the individual and societal level) impact the structure of facial impressions for targets belonging to different racial and gender groups. This study illustrates the use of a novel computational approach to model and compare facial impressions via their multidimensional relations to one another at different levels of representation (e.g., *face-trait space:* the correlational structure between any pair of trait ratings inferred from faces; *stereotype association space:* conceptual representations of how any pair of traits relate to each other for members of a social category)—and lays the groundwork for future investigate on into how the face-trait space varies in other contexts. The results indicate that stereotypical associations unique to each perceiver—and shared across perceivers in North America—predict the structure of facial impressions of different racial and gender targets.

The second study (Chapter 4) serves as a cross-cultural replication of the previous work, and leverages an international, large-scale dataset of ~1.4 million ratings across 41 countries (Jones et al., 2021) to examine how people across different countries form impressions of faces belonging to diverse racial and gender groups. This work reveals (1) some variation in how impressions are formed across countries, (2) cross-cultural consensus in the structure of

impressions of various racial and gender categories, and tentatively (3) that a national index of gender inequality—a "ground truth" measure of cultural context—shapes the structure of these facial impressions. Specifically, we find nuanced patterns at the intersection of race and gender, consistent with contemporary theories of intersectional stereotyping (Petsko et al., 2022; Petsko & Bodenhausen, 2020; Purdie-Vaughns & Eibach, 2008).

The third study (Chapter 5), accepted for publication and now in press at *Personality and Social Psychology Bulletin,* is the first study to examine how day-to-day, real-world contexts experienced by the perceiver (e.g., variations in mood, environment, physiology, psychological situations) impact impression formation in a systematic way. This approach is a significant departure from the majority of first impressions research that is typically conducted in the laboratory, and uses a rigorous analytic approach to disentangle the unique contributions of perceiver characteristics, target characteristics, contextual factors, and their varying interactions on the variance observed in trait impressions. This work demonstrates a novel implementation of latent profile analysis to measuring real-world contexts. Overall, we found no evidence that these daily contexts are important for shaping facial impressions, suggesting that research conducted in laboratory settings may be generalizable to the specific perceiver-contexts examined here.

The final study (Chapter 6) is the first to experimentally test how situational affordances impact the structure of facial impressions. We empirically bridge previously disconnected literatures on impression formation and situational affordances, showing that situations in which fundamental goals are made salient (e.g., mate-seeking, disease avoidance) cause the structure of facial impressions to become more strongly intercorrelated, and tightly constrained, than in neutral contexts absent any strong situational goals. Moreover, we provide tentative evidence for the mechanism underlying this effect: perceivers may initially form an impression on goal-

relevant traits that are central to the situation (e.g., attractiveness in the mate-seeking context), which then influences impressions on other, less-relevant traits.

Together, the studies presented in this dissertation represent a critical first step to understanding how various contexts—learned stereotypes, cultural stereotypes, naturalistic contexts in the real world, and situational goals—influence impression formation. This research extends and demonstrates the application of novel research methodologies to tackle research on contextual influences, and ultimately provides the quantitative groundwork to gain a contextualized understanding of how humans perceive other humans.

CONTRIBUTION OF AUTHORS

Chapters 1, 2, 7: General Introduction, Literature Review, General Discussion

As the author of this thesis, I conceptualized, prepared, wrote, and revised these chapters. As my supervisor, Dr. Eric Hehman provided feedback on these chapters.

Chapter 3: Xie, S. Y., Flake, J. K., Stolier, R. M., Freeman, J. B., & Hehman, E. (2021). Facial impressions are predicted by the structure of group stereotypes. *Psychological Science, 32*(12), 1979-1993.

As the first author, I was primarily responsible for most aspects of the research process. I performed background research on face perception and stereotyping, designed the studies, collected the stimuli, programmed the experiment, applied for and secured Research Ethics Board approval, recruited participants, curated and analyzed all data, interpreted the results, prepared all figures, and drafted, wrote, and revised the manuscript for publication.

As second author, Jessica Flake aided in the analyses and interpretation of the results of confirmatory factor analyses and multilevel models, reviewed and edited the manuscript, and aided in the revision.

As third author, Ryan Stolier aided in the design and interpretation of representational similarity analysis, reviewed and edited the manuscript, and aided in the revision.

As fourth author, Jon Freeman aided in the task design of Study 2 and provided expertise on social-cognitive models of person perception, reviewed and edited the manuscript, and aided in the revision.

As senior author, Eric Hehman aided and supervised the research process, including study conceptualization, data analytic procedures, and manuscript preparation and revision. Eric Hehman also provided the funding to carry out the research.

Chapter 4: Xie, S. Y. & Hehman, E. (in prep). Cultural perceptions of faces reveal consistent racial and gender associations across countries.

As the first author, I was primarily responsible for most aspects of this research process. I performed all background research on cultural context and impression formation, designed the studies, applied for and secured Research Ethics Board approval, recruited and tested participants in Montréal, managed and analyzed all data, interpreted the results, prepared all figures, and drafted, wrote, and revised the manuscript to be submitted for publication. The data used in the study were collected for the Psychological Science Accelerator 001 study, a large-scale, international research effort in which we had participated (Jones et al., 2021). Thus, the curation of stimuli, programming of the task, and task design were carried out by the senior authors on that project.

As senior author, Eric Hehman aided and supervised the research process, including data analytic procedures, and manuscript editing and revision. Eric Hehman also provided the funding to carry out this research.

Chapter 5: Xie, S. Y., Thai, S., & Hehman, E. (in press). Everyday perceiver-context influences on impression formation: No evidence of consistent effects. *Personality and Social Psychology Bulletin.*

As the first author, I was primarily responsible for most aspects of this research process. I performed all background research on contextual influences on impression formation, designed the study, collected the stimuli, applied for and secured Research Ethics Board approval, recruited participants, curated and analyzed all data, interpreted the results, prepared all figures, and drafted, wrote, and revised the manuscript for publication.

As second author, Sabrina Thai aided in study conceptualization, programmed the Experience-Sampler smartphone application that was used to deliver the surveys, reviewed and edited the manuscript, and aided in the revision.

As senior author, Eric Hehman aided and supervised the research process, including study conceptualization, data analytic procedures, and manuscript preparation and revision. Eric Hehman also provided the funding to carry out the research.

Of note, former undergraduate research assistants Alana Bertin, Elodie Audet, Nabil Bettira, Chevieve Heri, Jax Norman, Hannah Schiller, and Isabella Tangorra assisted in data collection and pilot testing the smartphone application. Graduate student Eugene Ofosu assisted in pilot testing the smartphone application.

Chapter 6: Xie, S. Y., & Hehman, E. (in prep). Situational affordances constrain first impressions from faces.

As the first author, I was primarily responsible for most aspects of this research process. I performed all background research on situational affordances on impression formation, designed the study, collected the stimuli, programmed the experiment, applied for and secured Research Ethics Board approval, recruited participants, curated and analyzed all data, interpreted the results, prepared all figures, and drafted, wrote, and revised the manuscript to be submitted for publication.

As senior author, Eric Hehman aided and supervised the research process, including study conceptualization, data analytic procedures, and manuscript preparation and revision. Eric Hehman also provided the funding to carry out the research.

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CHAPTER 1

GENERAL INTRODUCTION

General Introduction

People form impressions of one another at a glance. These intuitions, although imperfect, are crucial for reasoning about our social world, allowing us to predict others' mental states and behaviours (Asch, 1946; Bar et al., 2006; Cloutier et al., 2005; Todorov et al., 2009). We owe this feat to a cognitive system that has evolved to meet the demands of group living (Gibson, 1979; Zebrowitz, 2004), from evaluating strangers (friend or foe) to acting on these evaluations (approach or avoid). But where do our impressions come from? One salient source of information is the human face: from a split-second glance at a face, observers can infer a remarkable variety of socially relevant attributes about that person, such as whether they are moral (G. P. Goodwin et al., 2014), sincere (Zebrowitz et al., 1996), competent (Todorov et al., 2005), shy (Collova et al., 2019), prejudiced (Hehman et al., 2013), formidable (Wilson, Hugenberg, et al., 2017), aggressive (Valentine et al., 2014), gay or straight (Freeman, Johnson, et al., 2010; Rule et al., 2009), reproductively fit (Rhodes, 2006), high or low in status (Bjornsdottir & Rule, 2017), or even more or less human (Deska et al., 2018).

Regardless of accuracy (Bonnefon et al., 2015; Jaeger et al., 2020; Todorov et al., 2015), these facial first impressions are powerfully influential—shaping the cognition, behaviour, and downstream outcomes of perceivers and targets across diverse contexts (Freeman & Ambady, 2011; Galdi et al., 2012; Harris & Garris, 2008; Kenny, 1991; Olivola & Todorov, 2010a; Porter et al., 2010; Rule et al., 2013; Tingley, 2014; Todorov et al., 2005, 2015). For instance, inferences drawn from faces can bias the type of information that perceivers seek out about a target (Brannon & Gawronski, 2017; De Bruin & Van Lange, 2000; Galdi et al., 2012), shape interpretations of targets' behaviour (Macrae & Bodenhausen, 2000; Zebrowitz & Montepare, 2008), and guide decision-making even when superior diagnostic information is available

(Graham et al., 2016; Olivola et al., 2018). These effects cascade downstream into real-world consequences, influencing critical societal outcomes such as election results (Ballew & Todorov, 2007; Carpinella et al., 2015; Hehman, Carpinella, et al., 2014; Rule et al., 2010), financial lending rates (Duarte et al., 2012), and sentencing decisions in the criminal justice system (Blair et al., 2004; Porter et al., 2010; Wilson & Rule, 2015; Zebrowitz & McDonald, 1991). Given their impact, a clear theoretical understanding of how such impressions are formed is crucial.

Naturally, impression formation does not occur in a vacuum. Every act of perceiving requires a perceiver and a target, and both are embedded within the broader context of one's culture, milieu, and current situation (Over & Cook, 2018; Smith & Collins, 2009; Turner et al., 1994). Yet despite decades of impression formation research, the role that these contextual factors play in shaping impressions has received remarkably little empirical attention. There are several reasons for this gap. First, most of this literature has focused on how target characteristics (e.g., morphological features) evoke impressions, typically in controlled laboratory settings (for review, see Hehman et al., 2018; Todorov et al., 2015). In these studies, perceiver and contextual factors are treated as random variability, methodological artefacts, or constraints on the generality of a study's findings. Second, most studies examining contextual effects in social perception focus on a few specific trait impressions (e.g., trustworthiness, dominance) in a specific context (e.g., voting), but do not test how contexts generally influence impression formation. Third, "context" is broadly construed, and there is little explicit discussion about which kinds of contexts influence which aspects of the impression formation process, or to what extent context shifts impressions in a domain-general manner. Critically, the field lacks basic descriptive research that quantifies (and disentangles) perceiver, target, and contextual influences

on social perception (Figure 1). Without this work, it is difficult to clarify how impressions arise from a target's "face", versus a perceiver's "mind", versus interactions with contextual factors.

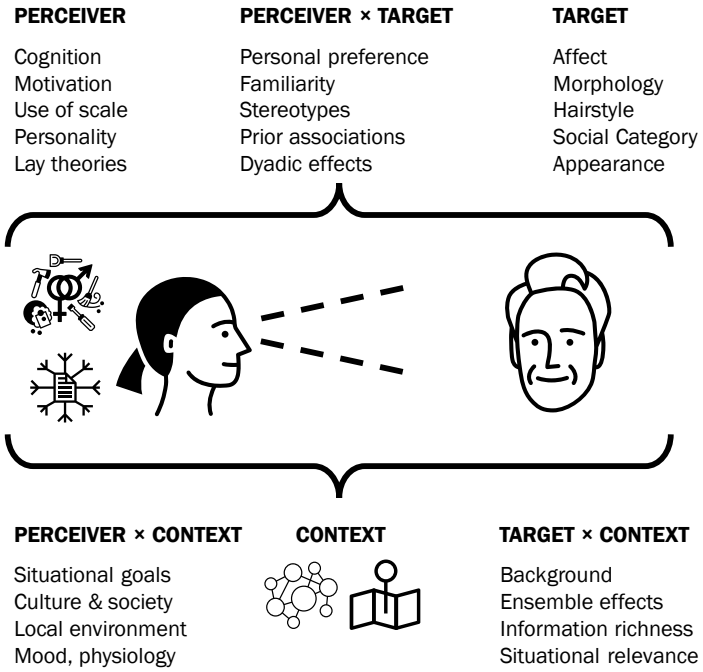


Figure 1. Examples of factors that are characteristics of the perceiver, characteristics of the target, characteristics of the context, and their interactions influencing any given impression.

Given that between 40-60% of the variance in facial trait impressions remains unexplained after accounting for the contribution of perceiver and target characteristics (Hehman et al., 2017; Xie et al., 2019), a comprehensive understanding of impression formation requires the consideration of perceivers, targets, and contexts in tandem. Fortunately, the limitations outlined above can be overcome with novel computational and behavioural research methods that sample (and compare) the space of trait impressions formed in a variety of naturalistic and experimental contexts. To that end, this dissertation investigates how the structure and formation of facial trait impressions shifts across perceiver, target, and context characteristics. I examine and quantify how impression formation is influenced by societal and individual stereotypes about social categories (Chapter 3), regional and cultural factors (Chapter 4), day-to-day real-world

contexts experienced by perceivers (Chapter 5), and situational affordances salient to the perceiver (Chapter 6).

The objective of this dissertation is to **(1) quantitatively characterize which contexts matter for impression formation (and to what extent), and (2) systematically examine how the structure of facial impressions shifts across perceiver, target, and contextual factors.** I focus on the general structure of facial impressions rather than a few specific trait impressions and examine the impact of different contexts (naturalistic and experimentally induced). In the following section I begin with a comprehensive review of the literature on impression formation, which spans the functional theory of face perception, the role of social categorization processes, and the relevance of situational affordances. Finally, I describe the computational approach that I adopt to model the representational structure of trait impressions inferred from faces.

CHAPTER 2

LITERATURE REVIEW

Literature Review

Social Impressions from Faces

Faces are a rich source of information for social attributions, informing our expectations of other people's mental states and behaviours (Zebrowitz, 1997; Zebrowitz & Montepare, 2008). Within 100 milliseconds of exposure to a face, perceivers spontaneously form trait impressions (e.g., trustworthy, aggressive) of the target that are relatively stable (Engell et al., 2007; Klapper et al., 2016; Willis & Todorov, 2006). These inferences may not be accurate (for review, see Jaeger et al., 2020; Todorov et al., 2015), but they are pervasive, automatic, and consequential. For example, the propensity to infer attributes from faces is conserved in children and adults across many cultures (Cogsdill et al., 2014; McArthur & Berry, 1987; Montepare & Zebrowitz-McArthur, 1989; Zebrowitz & Montepare, 1992), and persists even when people engage in activities that do not require character evaluations (Engell et al., 2007; Klapper et al., 2016). In fact, some work suggests that people form trait impressions even before they consciously register seeing a face (Hung et al., 2016; Stewart et al., 2012; Winston et al., 2002).

Modern perspectives situate theories of person perception (Adolphs et al., 2016; Brewer, 1988; Freeman & Ambady, 2011; Smith & Collins, 2009; Stolier, Hehman, Keller, et al., 2018; Todorov et al., 2008; Zebrowitz, 2006) and social cognition (Fiske et al., 2007; Freeman & Johnson, 2016; Hehman, Carpinella, et al., 2014; Kawakami et al., 2017; Macrae & Bodenhausen, 2000; Ratner & Amodio, 2013; Rogers & Biesanz, 2014) within an ecological framework to understand how and why humans reflexively infer social attributes from faces (Berry et al., 1993; Gibson, 1979; McArthur & Baron, 1983; Oosterhof & Todorov, 2008; Sacco & Brown, 2018; Zebrowitz & Montepare, 2008). Across this rich body of work, certain facets of the impression formation process are now well understood.

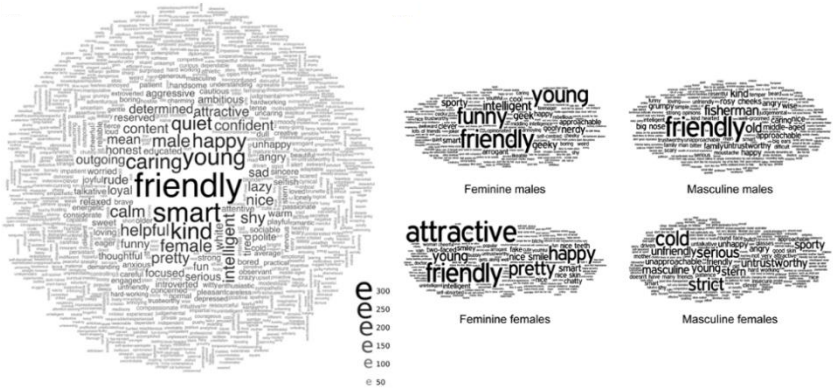
Target Characteristics

Much of the literature within this framework has focused on the contribution of targets' facial appearance to trait impressions. From a functional perspective, humans preferentially attend to faces because faces convey adaptive information about the social interactions that a target affords, providing visual cues of a target's attention (Haxby et al., 2000; Mason et al., 2005), intent (Oosterhof & Todorov, 2008; Zebrowitz & Montepare, 2008), social identity (Bruce & Young, 1986; Freeman, Pauker, et al., 2010; Freeman & Ambady, 2011; Freeman & Johnson, 2016; Hehman, Ingbretsen, et al., 2014; Kubota & Ito, 2007), and emotional state (Adams et al., 2012; Darwin, 1872; Ekman & Friesen, 1971; Hehman, Flake, et al., 2015).

Given the functional significance of the information communicated through faces, humans (even newborns; Farroni et al., 2005) preferentially orient to and process facial information (Farah et al., 1998; Freeman et al., 2014; Hansen & Hansen, 1988; Hehman, Carpinella, et al., 2014; Ratner & Amodio, 2013; Ro et al., 2001; Theeuwes & Van der Stigchel, 2006; Todorov et al., 2009; Willis & Todorov, 2006). Consequently, morphological features which resemble emotional expressions in an emotionally-neutral face (e.g., a slightly upturned mouth resembling a smile) are overgeneralized to stable trait attributions about the target (e.g., friendly), explaining the propensity to infer trait characteristics from faces (Adams et al., 2012, 2016; Carré et al., 2010; Keating et al., 1981; Knutson, 1996; Montepare & Dobish, 2003; Oosterhof & Todorov, 2008, 2009; Zebrowitz et al., 2010). Even young children reliably form impressions from faces, suggesting that the cognitive architecture for inferring traits from facial appearance is innate or acquired early in development (Cogsdill et al., 2014).

Many studies have focused on identifying features of the target (e.g., skin colouration, facial width-to-height ratio, social identity) that elicit specific trait impressions (for review, see

Kawakami et al., 2017; Todorov et al., 2015; Zebrowitz & Montepare, 2008). Although this approach has been fruitful, features are hard to define (e.g., “baby-faced”? Lip curvature? Pixels on a screen?) and often correlate with multiple trait impressions (e.g., baby-faced adults are perceived as warm, honest, and weak; McArthur & Apatow, 1984; McArthur & Berry, 1987). Modern approaches have therefore shifted away from hypotheses about which specific facial cues drive which trait impressions, toward modelling and explaining the underlying variation in the entire ‘space’ of trait impressions inferred from faces (Oosterhof & Todorov, 2008; Sutherland et al., 2013; Todorov et al., 2008; Todorov & Oosterhof, 2011; Vernon et al., 2014). Using various exploratory and data-driven techniques, researchers have identified a wide variety (see Figure 2) of trait impressions that spontaneously emerge from faces, many of which (e.g., competent, intelligent) are highly correlated with one another (Oosterhof & Todorov, 2008; Stolier, Hehman, Keller, et al., 2018; Sutherland et al., 2013, 2018).



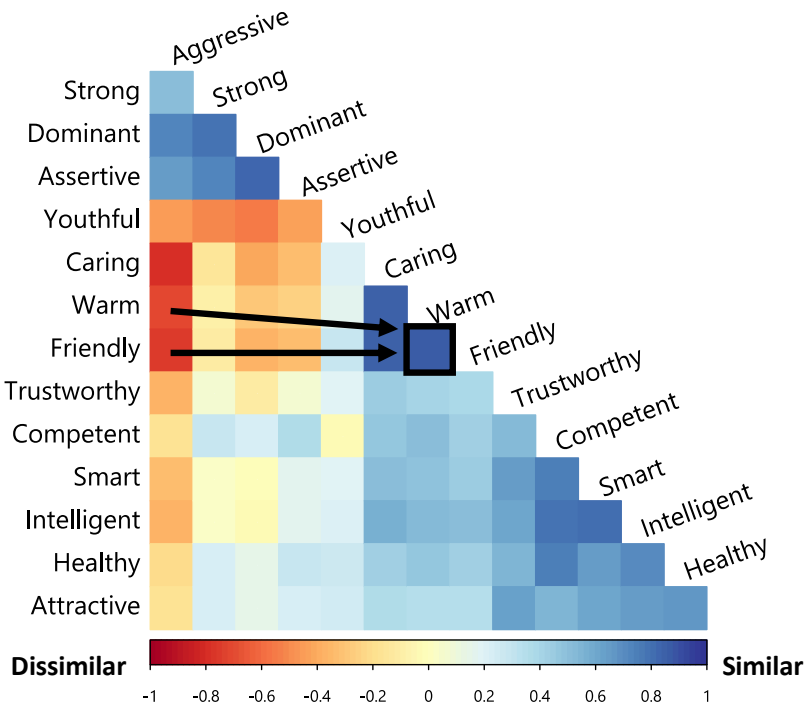


Figure 2. Word cloud of trait impressions inferred from faces, from Lin et al. (2021) (top left) and Sutherland et al. (2015) (top right). Word frequency scales with size. The *face-trait space* (bottom) is modelled as correlational structures representing the perceived relationships between trait ratings from faces, across different targets. For example, ratings of warmth and ratings of friendliness in facial impressions are strongly positively correlated.

Many of these trait impressions are highly correlated, such that a person deemed 'warm' based on their facial appearance is likely to also be perceived as 'friendly' (Figure 2, bottom). This representation of the space of facial impressions (i.e., *face-trait space*) has been conceptualized in previous work as a correlation matrix of weighted relationships (i.e., correlations) between traits that are commonly spontaneously inferred from faces (Stolier, Hehman, & Freeman, 2018; Stolier, Hehman, Keller, et al., 2018). Although this representation is model-free, statistical models that summarize the face-trait space into a few latent dimensions have become widely adopted. These dimensional models aim to capture most of the variance in facial trait impressions with a few components or factors, which presumably reflect general dimensions of social perception (A. E. Abele et al., 2008; Fiske et al., 2002; Jones et al., 2021; Oosterhof & Todorov, 2008; Sutherland et al., 2013, 2015; Walker & Vetter, 2016). For

example, Oosterhof and Todorov (2008) propose that morphological variation in faces elicit trait judgments that fall along two components, valence and dominance, whereas Sutherland and colleagues (2013) contend that trait judgments are formed along three factors of trustworthiness, competence, and youthful-attractiveness. More recent computational models find four dimensions along warmth, competence, femininity, and youth (Lin et al., 2021). These models offer theoretical explanations for correlations within the space of facial trait impressions: each face, with its unique appearance, falls somewhere along those orthogonal dimensions, and where a face is positioned along each of these dimensions jointly determines the final impression that perceivers form of that face.

These models, though influential, have become controversial because of their limited generalizability to different stimuli and participant samples (e.g., varying across race and gender; (Jones et al., 2021; Sutherland et al., 2018; Xie et al., 2021). Critically, this indicates that the structure of the face-trait space varies across perceivers. Contrary to the theoretical explanation offered by dimensional models, wherever a face (with its own unique appearance) falls along those dimensions *does not* consistently predict trait impressions of that face across different observers. In other words, the underlying assumption that perceivers have consensus in their trait impressions of different targets—such that target appearance is the primary contributor of variance in trait impressions—does not hold. This suggests that existing dimensional models do not adequately capture the representation of the face-trait space, partly due to perceiver differences.

Perceiver Characteristics

Perceivers are not objective observers engaged in the passive processing of sensory stimuli. Modern theoretical perspectives contend that person perception is an active mental

interpretation of the external world, during which perceivers ascribe meaning to targets (Brewer, 1988; Bruce & Young, 1986; Brunswik, 1952; Correll et al., 2016; Fiske & Neuberg, 1990; Freeman & Ambady, 2011; Haxby et al., 2000; Kenny & Albright, 1987; Kenny & West, 2011; Kunda & Thagard, 1996; Neuberg & Fiske, 1987; Stolier, Hehman, Keller, et al., 2018). Across perceivers varying along social identity (Kawakami et al., 2017; Rule, 2011; Stolier & Freeman, 2016; Sutherland et al., 2018; Zebrowitz et al., 1993), motivation (Hughes et al., 2017; Pendry & Macrae, 1994; Plaks et al., 2005; Reynolds & Oakes, 2000; Ruscher et al., 2000; Sinclair & Kunda, 2000), stereotype associations (Holbrook et al., 2016; Kunda & Thagard, 1996; Oh et al., 2019; Stolier, Hehman, Keller, et al., 2018), cognitive processing capacity (Barrett et al., 2004; Macrae et al., 1999), political ideology (Vigil, 2010), prejudicial attitudes (Devine, 1989; Gawronski, Geschke, et al., 2003; Li et al., 2016; Stecker et al., 2020), and parental status (Fessler et al., 2014), the same target may elicit very different impressions, suggesting considerable variability in how such impressions are formed. For a given target, any variability in trait impressions across perceivers may reflect idiosyncratic differences in how those perceivers are processing, representing, and interpreting features of the target's face (Sacco & Brown, 2018; Todorov et al., 2015)—and any consensus may reflect a shared social reality (Hehman et al., 2017; Sutherland et al., 2019; Xie et al., 2019).

A central goal of impression formation research is to understand how perceiver characteristics interact with target characteristics to produce first impressions. Dual-process and connectionist models of social cognition offer insight into how "top-down" social-cognitive and motivational processes might fundamentally constrain perception (Brewer, 1988; Freeman et al., 2020; Freeman & Ambady, 2011). Across different theoretical frameworks, one common theme emerges: social-categorical knowledge plays a prominent role in the perception of human faces,

which signal social categories that are perceptually salient (Cohen, 1981; Freeman et al., 2014; Kubota & Ito, 2007). For instance, race, gender, and even sexual orientation are readily identifiable from faces within hundreds of milliseconds of exposure (Adolphs et al., 2016; Calder & Young, 2005; Freeman, Johnson, et al., 2010; Rule & Ambady, 2008). Because social categories are resolved early in the perceptual process, modern models of person perception posit that "top-down" social-categorical knowledge dynamically interacts with "bottom-up" perceptual cues of the face to shape an inchoate impression of the target (Brewer, 1988; Freeman et al., 2020; Freeman & Ambady, 2011).

Social Categorization and Stereotyping. The mind fundamentally relies upon categorization to efficiently process novel stimuli, grouping stimuli that share similar characteristics into meaningful categories (Anderson, 1991; Rosch & Lloyd, 1978). People categorize themselves and others into social groups (e.g., parent, woman; Cohen, 1981; Tajfel et al., 1971; Turner et al., 1987), generalize learned associations about individual exemplars (e.g., mom is nurturing) to categorical attributes, and apply these *stereotypes* to novel targets belonging to those categories (e.g., women are nurturing; Banaji & Hardin, 1996; Gawronski, Ehrenberg, et al., 2003; Hugenberg & Sacco, 2008; Kawakami et al., 2017; Mason et al., 2006). The oldest study demonstrating this effect in faces, by Secord and Bevan (1956), found that perceivers apply stereotypes to faces classified as Black no matter how "race-typical" (i.e., prototypically Black) the faces appear. This elegantly demonstrates that once a social category is inferred from perceptual cues in the face, categorical stereotypes can influence trait impressions in a manner that is subsequently independent of other morphological cues in the face.

With some exceptions, the stereotyping literature has traditionally examined stereotypes in the form of semantic representations (Eckes, 2002; Fiske et al., 2002; Kunda & Thagard,

1996). For example, traditional women (i.e., homemakers) are perceived as warmer but less competent compared to professional women, in line with gender role stereotypes (Cuddy et al., 2004; Fiske et al., 2002). However, research bridging insights from the domains of face perception and social cognition has proliferated in recent years. These insights can best be summarized as follows: when encountering individual exemplars (i.e., faces) that activate a salient social category such as gender or race, culturally-learned gender and racial stereotypes automatically activate regardless of the perceiver's personal endorsement (Kawakami et al., 2017; Macrae & Bodenhausen, 2000). On average, these stereotypical associations shift impressions of the target in stereotype-congruent ways. For example, Black men who appear physically larger are perceived as more threatening compared to White men of similar size (Hester & Gray, 2018a; Holbrook et al., 2016), in line with racial stereotypes associating Blackness with threat (Devine, 1989). Other examples abound in recent literature: facial impressions of warmth and dominance predict leadership judgments (Wilson, Hugenberg, et al., 2017) and career outcomes (Livingston & Pearce, 2009a) in a differential manner for White versus Black targets. Some research has found that racial stereotypes influence even basic sex categorization of faces (Johnson et al., 2012), demonstrating that stereotypes influence impressions regardless of conscious beliefs about social categories.

Despite these empirical advances, research connecting stereotypes to impression formation has not considered how stereotypical associations shape the structure of facial impressions more generally. A key assumption underlying existing dimensional models is that the face-trait space is invariant across perceiver characteristics (such as group memberships or stereotypical associations). The body of work that I have summarized above, along with recent research that tests dimensional models with different participant samples (Jones et al., 2021; Xie

et al., 2021), suggests that this assumption is untenable. To the contrary, stereotypes may play a structuring role in first impressions, serving as a template for perceivers to map perceptual cues in the target's face onto their own learned associations about various social categories.

Moreover, stereotypical associations can arise from personal experiences (idiosyncratic) or from experiences shared between people in the same culture and milieu (shared context). Yet current models of impression formation are largely agnostic to this distinction. Understanding the unique contributions of perceiver characteristics (e.g., personal associations) versus characteristics shared across perceivers (e.g., cultural stereotypes) would provide novel insight into the relative importance of these factors in structuring facial first impressions.

Recent work has begun to disentangle the contributions of the perceiver versus the target on social perceptions. Two studies formally quantified these contributions (Hehman et al., 2017; Xie et al., 2019). Across various trait impressions, ~23% of the variance in perceivers' ratings of targets were explained by perceiver idiosyncrasies, and the other ~15% by target characteristics. Even after accounting for perceivers' and targets' race and gender, ~62% of variance in trait impressions remained unexplained (Xie et al., 2019). This residual variance may be measurement error, the interplay between perceiver × target characteristics, or other unexamined contextual factors that influence impression formation. To the extent that these contextual factors are psychologically meaningful, they may influence the way that people process, interpret, and represent facial features to arrive at an impression of that target. This dissertation therefore investigates the extent to which contextual factors influence impression formation, given extensive evidence that social judgments and many other cognitive and motivational processes are context-dependent (Beck & Jackson, 2019; Berry & Zebrowitz, 1988; Carpinella et al., 2015; Converse et al., 2013; Fleeson, 2004; Guinote, 2007; Hehman, Carpinella, et al., 2014; Hehman,

Leitner, et al., 2015; Horstmann et al., 2017; Mesquita et al., 2010; Olivola et al., 2014; Plaks et al., 2009; Re et al., 2013; Shoda et al., 2007; Turner et al., 1994).

Person Perception in Context

People form impressions of one another within the broader context of one's culture, current situation, and social environment. To the extent that these contextual factors are psychologically meaningful, they may shape the impression formation process. For example, consider the contrast between seeing a person for the first time in a bar versus an interrogation room—a target with a certain set of characteristics (e.g., confident, high-status, socially dominant) may appear attractive in a dimly-lit bar that affords romantic opportunities, but may appear to the same perceiver as threatening in an interrogation room with obstacles to self-protection. These contextual differences can impact how perceivers process, represent, and interpret observable cues in the target. Further, these impressions may additionally be shaped by perceiver × target interactions (e.g., gender, race, sexual orientation), by context × target interactions specific to that target in that context (e.g., cultural stereotypes about women or men in bars), and by perceiver × context interactions idiosyncratic to that perceiver in that context (e.g., personal associations about interrogation rooms).

Although it seems intuitive that facial impressions are multiply determined—and may be formed differently across perceiver, target, and contextual characteristics—a systematic investigation of how these factors interact to influence impressions does not exist. Critically, almost all existing research on impression formation comes from participants embedded in the context of a social psychology experiment, sitting in front of a computer and rating faces. There are limits to what we can learn about person perception from research conducted in such environments, and a multimodal approach is needed to tackle this gap in the literature. In the

next section, I highlight the literature on situational affordances as a promising direction for research on contextual influences in impression formation.

Situational Affordances

Situations—such as being in a sunny park or on a rickety suspension bridge—vary in psychologically meaningful ways. People find themselves in situations that provide different opportunities and obstacles (i.e., *affordances*; Gibson, 1979; McArthur & Baron, 1983) relevant to one's goals (Brown et al., 2015; Kenrick et al., 2010; Neel et al., 2017). For instance, being in a sunny park affords opportunities to relax, socialize, and enjoy oneself, whereas being in a dark alley at night creates obstacles to one's self-protection motive (Schaller et al., 2017). The psychological properties of situations are implicitly and explicitly processed (i.e., inferred, interpreted, and represented) by perceivers (Rauthmann et al., 2015; Rauthmann & Sherman, 2019; Schellenberg, 2008; Sherman et al., 2015; Yang et al., 2009), shaping their construal of the situation and guiding subsequent behaviour (Mischel, 1968; Neel et al., 2017; Rauthmann, 2016; Rauthmann & Sherman, 2019; Ross & Nisbett, 1991). Thus, situations vary in how they are mentally construed as a function of the opportunities and adaptive problems that they afford.

In the real world, people are embedded within situations when they form impressions of one another (Ittelson & Cantril, 1954; Kenrick et al., 2010; Rauthmann & Sherman, 2019; Schellenberg, 2008), suggesting that situational affordances may influence how such impressions are formed. For example, in contexts that afford harm (e.g., weapons are present)—and when evaluating racialized targets heuristically associated with harm (e.g., Black or Arab men)—observers readily perceive targets as angrier (Holbrook et al., 2014; Maner et al., 2005), larger (Fessler et al., 2012), and more physically threatening (Wilson, Hugenberg, et al., 2017)

compared to neutral contexts. These findings may emerge due to shifts in multiple levels of processing.

Theorized Mechanisms. A broad, high-level explanation is that in threatening contexts, perceivers engage in more extreme responding, evaluating strangers more strongly on any trait related to harm (i.e., threat, aggression). Since functional accounts of perception posit that it is better to be safe than sorry in threatening situations, then as a risk management strategy, perceivers may readily evaluate targets as more threatening to avoid costly mistakes (Bar et al., 2006; Haselton & Nettle, 2006; Holbrook et al., 2014). However, this does not explain why perceivers in threatening contexts also evaluate targets as taller and physically larger (Fessler et al., 2012; Maner et al., 2005; Wilson, Hugenberg, et al., 2017). This is important because it suggests that mental relations between physical features (e.g., height, size) and trait inferences (e.g., threat) become stronger in a threat context versus a neutral context.

Mapping the Face-Trait Space. To clarify why this occurs, mental relations between representations of facial features can be mapped onto representations of trait concepts. This idea is not novel: similar theoretical frameworks have been developed independently in research on face perception (Stolier, Hehman, & Freeman, 2018; Stolier, Hehman, Keller, et al., 2018), social learning (Over & Cook, 2018), and theory of mind (Conway et al., 2019). Scholars within these disciplines use different definitions (e.g., Trait Inference Mapping; Over & Cook, 2018), but converge on the idea that spontaneous trait inferences from faces can be understood as mappings between positions in ‘morphological feature space’ and positions in ‘conceptual trait space’ arising from learned face–trait experiences. For example, perceivers who learn that two traits are strongly associated (e.g., aggressiveness and physical strength) should infer a trait from a face

(e.g., aggressive) to the extent that they infer the other trait simultaneously from that face (e.g., physically strong). See Figure 3 for examples of this framework from different literatures.

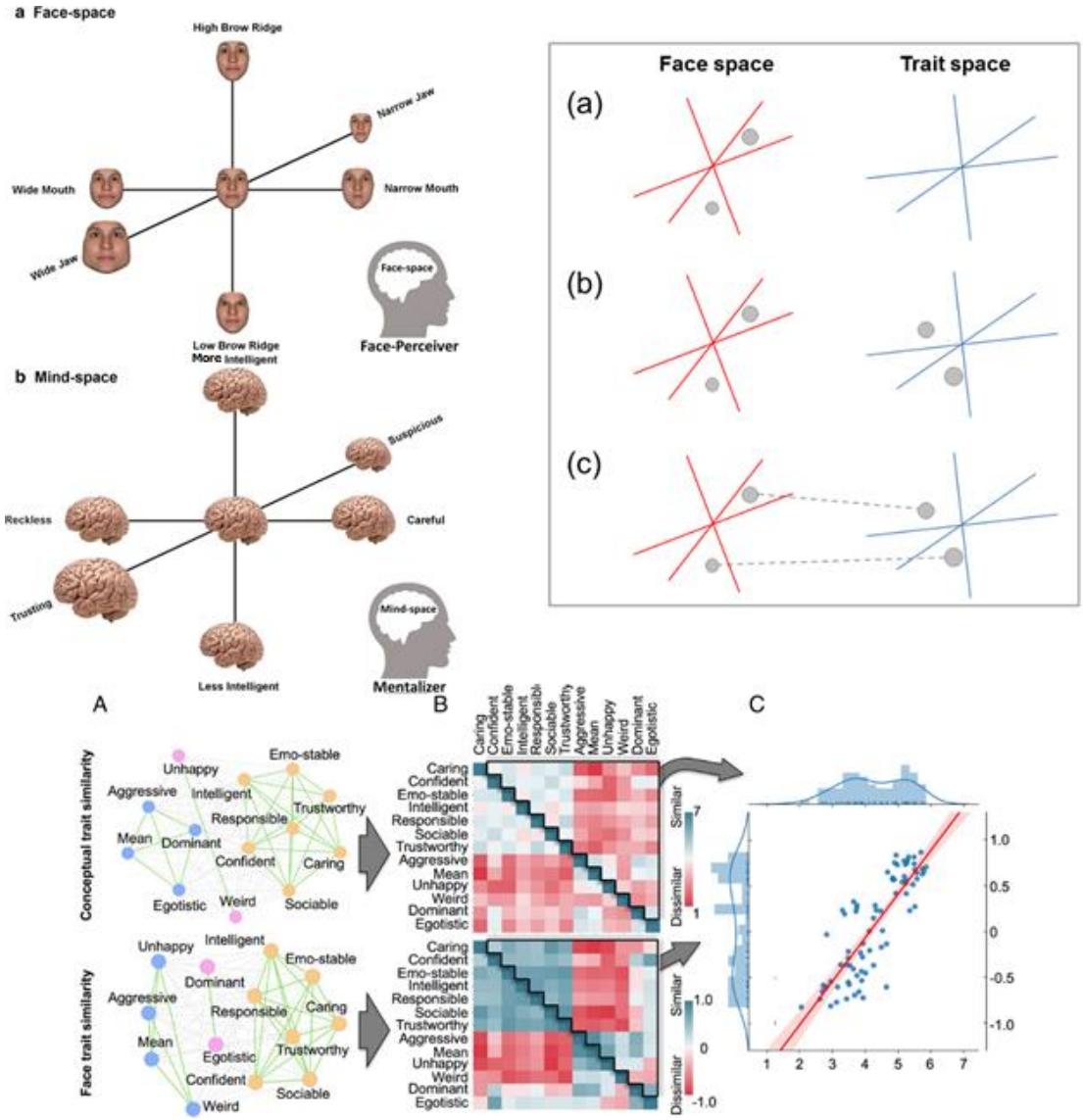


Figure 3. Top left: multidimensional representational spaces for the 'face-space' and 'mind-space' (Conway et al., 2019). *Top right:* a depiction of how trait mappings are learned, according to the Trait Inference Mapping framework (Over & Cook, 2018). Face-trait mappings emerge as the excitation of representations in face space become associated with representations in trait space. *Bottom center:* conceptual trait associations relate to visual similarity in facial features used to infer trait impressions (Stolier, Hehman, Keller, et al., 2018), illustrated with (A) multidimensional scaling and (B) correlation matrices. (C) Depicts the Spearman correlation between the face-trait space (i.e., how inter-correlated facial impressions are) and conceptual trait-pair similarity (i.e., "how likely is a person with one trait to have another?") in (B).

To expand on this framework, perceivers may have prior beliefs about the relationship between threat and physical size, and this belief changes when perceivers are in contexts where threat is relevant. That is, the information that perceivers use to inform their judgments may be constrained by its relevance to the context—when people *do* get hurt (i.e., threat context), the level of threat scales with the aggressor's size, whereas when people go about their daily lives (i.e., neutral context), threat and physical size are less correlated.

Thus, mappings between 'face space' and 'trait space' may dynamically shift across different contexts, such that prior expectations for the associations among features and traits shift when various threats or opportunities become salient. Because decision-making in these situations hinges on rapidly assessing many features of the self, other, and the situation, it may be adaptive to streamline the impression formation process by negotiating a large number of features using this simpler heuristic representation (Bar et al., 2006; Becker et al., 2010; Freeman & Johnson, 2016; Markman & Otto, 2011; Nobandegani et al., 2018; Oosterhof & Todorov, 2008). That is, when certain fundamental motives (e.g., self-protection) are made salient due to the affordances of the situation (e.g., being in a dark alley), then cognitive systems may shift to favour rapid, actionable judgments over accuracy (Tversky & Kahneman, 1974; Willis & Todorov, 2006). Consequently, the impression formation process may become constrained (Assor et al., 1981; Fiske & Neuberg, 1990; Hughes et al., 2017; Smith & Collins, 2009; Van Overwalle & Labiouse, 2004) to produce impressions that are *(a)* more strongly inter-correlated and *(b)* centered on goal-relevant traits—trading nuance and cognitive complexity (e.g., the stranger is a tall, funny, gentle, and muscular man) for speed and interpretability (e.g., the stranger is tall, male, and muscular, hence threatening).

To put it formally, in the relatively automatic initial stage of impression formation, critical dynamic processes may shift face-trait mappings to meet the opportunities or demands of the situation (Freeman & Ambady, 2011; Smith & Collins, 2009; Van Overwalle & Labiouse, 2004). Perceivers in these situations attend to traits or attributes that are relevant to their goals, and their evaluation of the target on these relevant traits would strongly influence their overall impression of the target. Critically, given limited information about the target, the perceiver's evaluation of the target on these 'relevant traits' serves as a heuristic to inform their evaluations of the target on other attributes for which they lack more diagnostic information.

For example, in a situation which affords mating opportunities, attractiveness (or reproductive fitness) may be a highly relevant attribute (Sacco & Brown, 2018; Schaller et al., 2017). Perceivers in this situation—attending to the mate-seeking motive—may readily evaluate strangers on observable features (e.g., facial symmetry) that are diagnostic of the relevant trait according to the perceiver's prior beliefs (e.g., that facial symmetry is related to reproductive fitness). The perceiver thereby forms an impression of the target's attractiveness. Given lack of diagnostic information about the target's other attributes (e.g., trustworthiness, competence), this initial 'attractiveness' impression may then spread to other, less situationally-relevant trait impressions (e.g., trustworthy, competent) that are nonetheless correlated with attractiveness according to mappings in the perceiver's mental trait space (Freeman & Ambady, 2011; Goldman et al., 1983; Nisbett & Wilson, 1977; Verhulst et al., 2010; Zebrowitz et al., 2003). This connectionist perspective is helpful for understanding impression formation because it illustrates that mappings in face space (e.g., symmetry, eye shape) and trait space (e.g., attractive, trustworthy) dynamically influence one another (Freeman & Ambady, 2011; Monroe & Read, 2008; Over & Cook, 2018; Read et al., 1997; Stolier, Hehman, & Freeman, 2018)—and

converges with the well-documented finding that facial trait impressions are highly intercorrelated (Goldman et al., 1983; Nisbett & Wilson, 1977; Oosterhof & Todorov, 2008; Sutherland et al., 2013) and highly variable across perceivers (Hehman et al., 2017; Hönekopp, 2006; Ito & Urland, 2005; Kenrick et al., 2010; Mesquita et al., 2010; Smith & Collins, 2009).

In addition to the examples discussed above, humans have a number of other fundamental social motives, including disease avoidance, affiliation, status, mate seeking, mate retention, and kin care (Kenrick et al., 2010; Neel et al., 2016; Schaller et al., 2017). Situations that afford opportunities or obstacles to achieving these motives may influence impression formation by shifting face-trait mappings. Critically, I predict that perceivers evaluate their targets in a more intercorrelated manner when situational affordances are present (Figure 4B and 4C), by overweighing the associations between situationally-relevant traits and other, less relevant, traits. To date, however, no research has examined whether (and to what extent) situational affordances constrain the space of trait impressions.

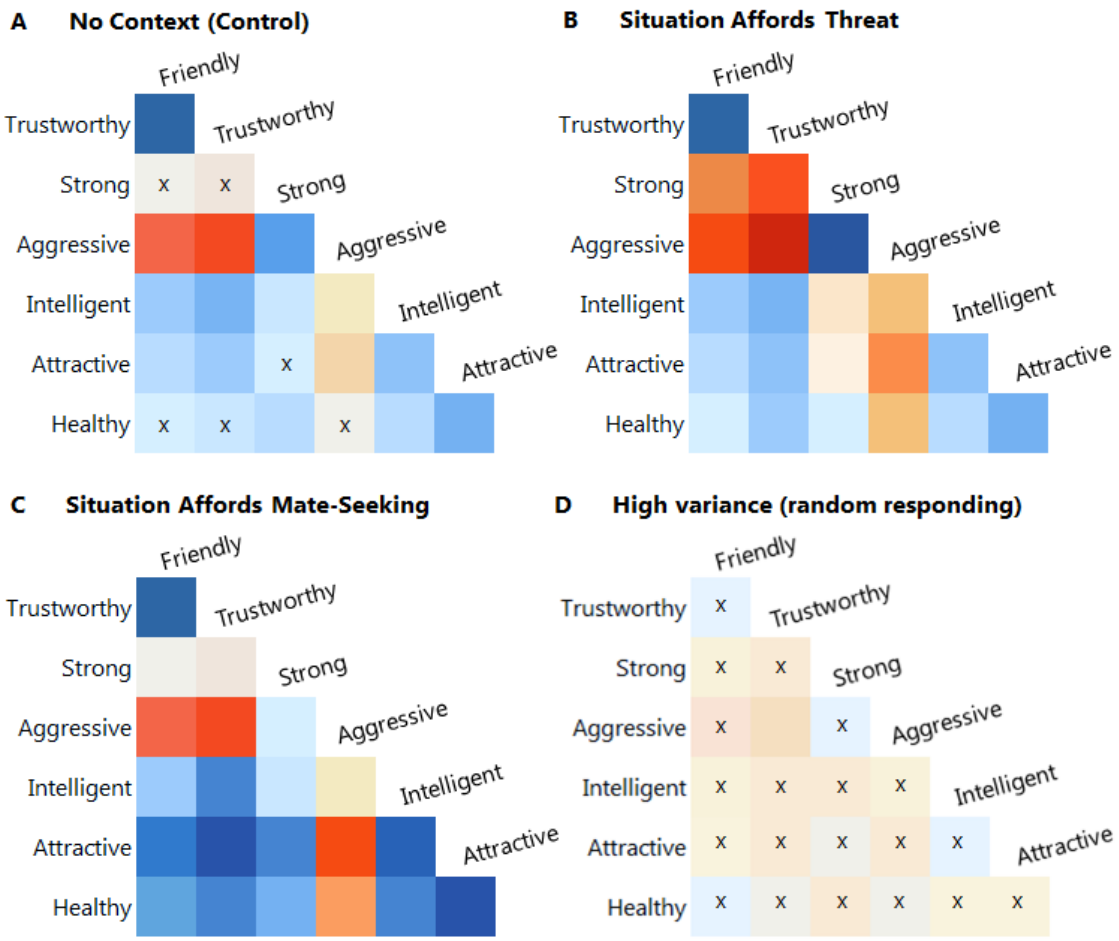


Figure 4. Hypothetical examples of the face-trait space in situations (A) absent any context (unconstrained), versus situations that afford (B) threats to self-protection and (C) opportunities for mate-seeking. The magnitude of the average trait-pair correlation should be higher in (B) and (C) compared to (A). If perceivers are responding randomly, then the face-trait space will be uncorrelated (D).

Building on the theoretical framework that mappings between 'face space' and 'trait space' guide facial first impressions, I propose that different contexts elicit different face-trait mappings. Just as travelers navigating unfamiliar physical environments use maps specific to those regions, perceivers in different psychological situations rely upon different conceptual maps—with face-trait mappings relevant to each situation—to infer attributes about strangers from their physical appearance. Because there is already a vast literature that focuses on mapping facial features to trait attributes (Stolier, Hehman, Keller, et al., 2018; Todorov et al., 2015;

Zebrowitz, 1997), in this thesis I focus solely on how context shifts perceivers' face-trait mappings, rather than emphasizing the mappings between face space and trait space themselves. To examine to what extent face-trait mappings change across contexts, I adopt previous models representing the face-trait space as a correlation matrix of weighted relationships between traits that are commonly spontaneously inferred from faces (Over & Cook, 2018; Stolier, Hehman, & Freeman, 2018; Stolier, Hehman, Keller, et al., 2018). For example, if the traits 'caring' and 'friendly' inferred from a face are more strongly associated than 'caring' and 'strong', then the former trait-pair has more weight. Across several studies, I plan to (1) quantitatively examine how context interacts with perceiver characteristics to influence impression formation, and (2) estimate a face-trait space for various contexts and compare face-trait spaces across contexts. I discuss these contexts in the following sections.

Context Shapes the Structure of Facial Impressions

Structure of the Face-Trait Space. To that end, in this dissertation I investigate (1) how perceiver, target, and context characteristics interact to shift the representational structure of the face-trait space, and (2) to what extent context impacts the impression formation process relative to the target's "face" versus the perceiver's "mind". There are three key challenges. First, how should the face-trait space be represented? I adopt the framework used in previous work, which models this space as a correlation matrix of the relationships between pairs of traits that are commonly spontaneously inferred from faces (Stolier, Hehman, & Freeman, 2018; Stolier, Hehman, Keller, et al., 2018). Unlike dimensional models which summarize this matrix into latent factors or components, this approach does not combine traits to form a set of static factors. Thus, independent of how traits are theorized to cluster together, facial impressions are represented in a manner that allows for statistical comparisons of the relationships between trait

impressions across different perceiver, target, and contextual factors. This approach is useful for comparing the face-trait space across different contexts (Figure 4) and for testing whether the associations between different traits become stronger or weaker on average (i.e., more constrained versus differentiated) across contexts.

The second challenge concerns the mechanism underlying this effect. Why might the face-trait space become more constrained in certain contexts, such that evaluations of a target on different characteristics (e.g., trustworthy, competent, attractive) are more strongly intercorrelated? Formally, I hypothesize that perceivers attend to the most 'relevant' traits in each context (varying across contexts), which informs their evaluation of the target on other, less relevant traits (for which perceivers lack more diagnostic information).

Trait Centrality. Specifically, if trait inferences from faces can be understood as mappings between positions in face space and positions in trait space, how or why might these mappings shift across contexts? To gain deeper insight into this process, I integrate research modeling the face-trait space as the interrelationships between trait impressions with the idea that certain traits are more central or relevant to impression formation than others. The concept of trait centrality is the foundation of modern theories of impression formation, and dates to classic findings that Gestalt principles of clustering could be applied to social impressions (Asch, 1946; Goldman et al., 1983; Kelley, 1950). Defined succinctly by Orehek and colleagues (Orehek et al., 2010), *"a trait is central to the extent it implies other traits, thereby affording generalized social judgment."* Because many facial trait inferences are highly interrelated, identifying central traits can provide insight into how people process and interpret facial features to form an impression (Oosterhof & Todorov, 2008; Orehek et al., 2010), which traits tend to be central across different settings (e.g., politics, courtrooms; Ballew & Todorov, 2007; Blair et al., 2004;

Hehman, Carpinella, et al., 2014; Todorov et al., 2005; Wilson & Rule, 2015), and which traits are likely to influence people's decision-making in these contexts (Graham et al., 2016; Olivola et al., 2018; Olivola & Todorov, 2010b).

Scholars disagree on how best to measure trait centrality. Although latent variable models have been influential (for review, see Todorov et al., 2015), the number of latent dimensions and which traits load or cross-load on those dimensions—and to what extent—have been shown to vary across different stimuli sets, participant samples, and statistical representations (Jones et al., 2021; Lin et al., 2021; Oh et al., 2019; Sutherland et al., 2013, 2015, 2018; Xie et al., 2021). This makes it difficult to test whether the centrality of traits changes across different contexts, as multiple interpretations are available to account for any differences in the latent variable structure and the loadings (or cross-loadings) on the latent variables.

The face-trait mapping framework offers a more plausible and parsimonious account of the impression formation process, and a more interpretable way to identify central traits. Because this framework represents the face-trait space as the interrelationships between pairs of trait impressions (without any latent variables), one solution to the challenge of assessing trait centrality is to directly model these interrelationships as outcome variables in predictive models. This enables multimodal analyses within the same model. For instance, variables indicating the central trait in each context can be used to predict changes in the face-trait space, allowing me to estimate how different traits (e.g., central versus non-central) differentially shift the trait space.

A Continuum of Contexts. Finally, the third challenge is to consider which contexts shift the structure of facial impressions. Situational affordances may constrain the face-trait space to be more intercorrelated and goal-relevant. However, the space may also exhibit variability in the absence of strong goal affordances. In the absence of meaningful goals, the perceiver's prior

knowledge about any available information (e.g., arising from learned associations, culture, identity, or current circumstances) provides context. Any prior representations in the perceiver's mind linking specific traits and social categories (e.g., associating women with attractiveness) or between multiple traits (e.g., associating attractiveness with competence) may be relied upon to guide trait impressions of different targets (Over & Cook, 2018; Stolier, Hehman, Keller, et al., 2018; Xie et al., 2021).

Chapter 3 examines how social identities observed in faces provide context. When perceivers observe a face, perceptually salient social categories (e.g., race, gender) activate related stereotypes. Perceivers may draw upon these stereotypical associations (idiosyncratic or shared with others in their society) to form impressions of the target. Using representational similarity analysis, I quantify the similarity between face-trait ratings and stereotypical representations of each social category (Figure 5). Formally, I test to what extent perceivers' learned stereotypes predict differences in their facial impressions across race and gender, examining both societal stereotypes (Study 1) and perceivers' own unique associations (Study 2).

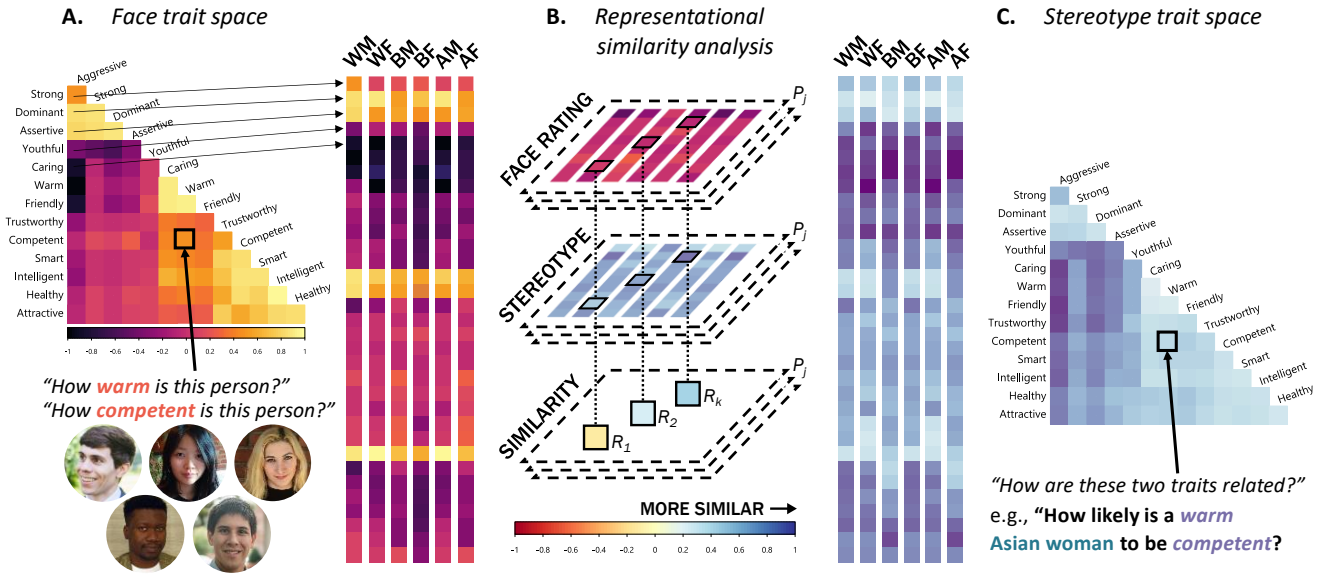


Figure 5. Example representational similarity analysis connecting perceivers' (A) correlation matrices from trait ratings of faces to their (C) correlation matrices from stereotype associations

of race × gender categories. The hypothetical similarity analysis (B) depicts this analytic framework. For each trait-pair *k* (bottom layer), I compute the similarity between participant *j*'s face-trait space across different social categories (top layer) and their stereotypical representations of these social categories (middle layer).

Extending this work, Chapter 4 examines whether perceivers from the same culture—who have more opportunities to acquire shared cultural associations (Over & Cook, 2018; Sutherland et al., 2015, 2019)—show greater similarity in face-trait mappings compared to perceivers from other cultures. Lay theories about trait relationships (e.g., a competent woman is a trustworthy woman) are the products of one's culture and social environment (Over & Cook, 2018; Plaks et al., 2009). As such, perceivers from different countries may draw upon different lay theories to inform their trait inferences. Mappings between face space and trait space—as well as the associations among different trait concepts within the trait space—may be relatively different for people living in different countries. Chapter 4 tests how the face-trait space differs across countries. Here, I operationalize gender inequality as a cultural variable that might induce people from different cultures to hold different prior beliefs about men and women. I examine whether gender differences in the face-trait space vary across countries as a function of each country's gender inequality.

In Chapter 5, I leverage a novel experience-sampling paradigm to explore how perceivers—going about their daily lives and experiencing different contexts in a naturalistic manner—form impressions of targets. In this study, I quantify the impact of naturally varying, real-world contexts on the variance in facial trait impressions, and compare its impact to other known sources of variance (e.g., perceiver and target characteristics), by incorporating a sufficiently diverse number of contexts without manually recruiting participants into different contexts in the lab. This presents advantages over previous research on contextual influences, which are limited to a few contexts experimentally induced in the lab. Furthermore, it represents

the first descriptive study of its kind, quantitatively characterizing the relative importance of contextual, perceiver-level, and target-level characteristics on impression formation.

Finally, in Chapter 6 I experimentally test how situational goals shape impression formation. Situations with salient goal affordances may exert strong constraints on impression formation (e.g., the self-protection goal is highly relevant when people are in a dark alley at night), causing trait impressions to be more inter-correlated (and the trait space to be more tightly constrained). When goal affordances are salient, perceivers given limited information about a target (e.g., a glimpse of a face) may attend to situationally relevant traits (e.g., threat, aggression) to form an impression. This relevant trait is hypothesized to become 'central' to the overall impression, shaping the perceiver's evaluations of the target on other, less situationally relevant traits (e.g., attractive, trustworthy) for which the perceiver lacks more diagnostic information. This may occur because the perceiver has prior expectations of the relations between trait concepts (e.g., threatening people are untrustworthy). Therefore, in the presence of strong situational affordances, trait impressions should be more strongly inter-correlated overall. To test this theory, in Chapter 6 I examine whether situations with a relevant goal (e.g., mate-seeking, disease avoidance, self-protection) cause face-trait spaces to be more intercorrelated on average (Hypothesis 1), and whether the most central trait changes across these situations (Hypothesis 2).

In the absence of strong situational constraints on impression formation, the face-trait space may become more differentiated (i.e., less intercorrelated). For example, perceivers may evaluate targets in a more deliberative manner, taking the time to assess whether a target is trustworthy, attractive, or competent by using different evaluative criteria for each of those evaluations (Sritharan et al., 2010; Uleman, 1999; Zelli et al., 1996). Even if perceivers do not

engage in this type of deliberative reasoning, the impression formation process may become more idiosyncratic because the most 'relevant' or 'central' trait would vary across perceivers. For example, certain perceivers may attend more strongly to trustworthiness which shapes their impression of the target, whereas others may attend more strongly to competence. Furthermore, individuals' prior associations among trait concepts (e.g., believing that attractive women are competent) or among facial features (e.g., believing that symmetrical faces are attractive) may vary. Because perceivers have different prior associations, I expect the face-trait space to be less intercorrelated on average in the absence of strong contextual influences (i.e., neutral context).

In summary, perceivers' lay theories and prior experiences may serve as templates to map traits onto faces during the impression formation process (Over & Cook, 2018; Stolier, Hehman, Keller, et al., 2018; Xie et al., 2021). This account is consistent with the well-documented finding that many trait impressions are highly intercorrelated (e.g., friendly, warm; Oosterhof & Todorov, 2008; C. A. M. Sutherland et al., 2013), that the relative importance of perceiver vs. target factors varies across race and gender categories (Xie et al., 2019), and that facial impressions are influenced by stereotypes about social categories (Johnson et al., 2012; Kawakami et al., 2017). Taken together, these factors may result in different mappings between 'face space' and 'trait space' across different contexts, leading to differences in the structure of the face-trait space.

The Present Research

Building on a rich theoretical literature integrating ecological perspectives on impression formation, social-cognitive models of face perception, and emerging research on motivated situation perception, the present research aims to answer five key questions. Are facial impressions shaped by (personal and societal) stereotypical representations of racial and gender

categories (Chapter 3)? Using large-scale regional data, do perceivers in different cultures, experiencing different situations, exhibit variation in the way that they perceive female and male faces (Chapter 4)? To what extent do day-to-day, real-world contexts impact impression formation, compared to the appearance of different targets (or the idiosyncrasies of different perceivers; Chapter 5?) And finally, do situational affordances constrain the impression formation process, such that impressions are more inter-correlated (i.e., tightly constrained) and centered on goal-relevant traits (Chapter 6)?

The proposed research empirically bridges multiple literatures to provide an overarching view of contextual influences on facial first impressions. By implementing sophisticated statistical models, a large quantity of trait inferences can be used to investigate how various contexts—such as social category cues (Chapter 3), gender inequality across countries (Chapter 4), and situational affordances related to perceiver motives (Chapter 6) guide facial first impressions. Together, this dissertation shows that contextual factors, specifically perceiver stereotypes and situational affordances relevant to fundamental motives, shape the structure of facial first impressions—and provide novel insights into the process of human perception.

CHAPTER 3

Facial impressions are predicted by the structure of group stereotypes

(Xie, Flake, Stolier, Freeman, & Hehman, 2021, *Psychological Science*)

Xie, S. Y., Flake, J. K., Stolier, R. M., Freeman, J. B., & Hehman, E. (2021). Facial impressions are predicted by the structure of group stereotypes. ***Psychological Science, 32*****(12), 1979-1993.**

Abstract

Facial impressions (e.g., trustworthy) have long been thought to be evoked by morphological variation (e.g., upturned mouth) in a universal, fixed manner. However, recent research suggests that these impressions vary considerably across perceivers and targets' social group memberships. We investigated whether racial and gender stereotypes may be a critical factor underlying this variability in facial impressions, across 4,247 U.S. adults recruited online. In Study 1, we found that not only did facial impressions vary by targets' gender and race, but the structure of these impressions was associated with the structure of stereotype knowledge. Study 2 extended these findings by demonstrating that individual differences in perceivers' own unique stereotype associations predicted the structure of their own facial impressions. Together, the findings suggest that the structure of our impressions of others' faces is driven not only by the morphological variation of the face, but also our own learned stereotypes about social groups.

Keywords: face perception, individual differences, intergroup dynamics, social cognition, open data, preregistered

Statement of Relevance

People are quick to form snap judgments about others based on facial appearance, such as whether a stranger is trustworthy or competent. The prevailing view is that these first impressions are evoked by physical features of the face (e.g., upturned mouth, downturned eyebrows) in a way that is consistent for all people. However, most of this research has focused on White targets. Instead, we find that people form impressions differently depending on the target's race and gender category—partly due to stereotype knowledge unique to each group. Our own learned stereotypes about each social group (e.g., "attractive Asian women are friendly") individually influence the social impressions that we make of people from these groups. These results indicate that impression formation processes are not agnostic to social identities, with implications for the differential relationships that arise between facial appearance and important outcomes (e.g., hiring, sentencing) for targets belonging to different groups.

Introduction

First impressions are powerfully influenced by faces. From a split-second glance at a person's face, people readily make socially relevant inferences about that individual (Willis & Todorov, 2006), such as whether they are confident (Oh et al., 2019) or approachable (Oldmeadow et al., 2013). These snap judgments have the ability to influence critical outcomes, from election results (Hehman, Carpinella, et al., 2014; Todorov et al., 2005) to sentencing decisions in the criminal justice system (Blair et al., 2004; Wilson & Rule, 2015). Given their impact, a clear theoretical understanding of how such impressions are formed is crucial.

Following decades of research, certain aspects of the impression formation process are reasonably well understood. Modern models of face perception largely focus on morphological variation in the target's face, and propose that morphological differences elicit trait judgments along two or three fundamental dimensions of evolutionary significance (Oosterhof & Todorov, 2008; Sutherland et al., 2013). Each face, with its unique appearance, falls somewhere along those dimensions, and where a face is positioned along each dimension jointly determines the final impression that perceivers form of that face.

Perceiver Variability in Face Impressions

Yet the literature focusing on morphological influence on impressions has generally remained agnostic to perceiver and target identities. This is a problem given that recently, the universality of these models has been challenged on their limited generalizability to other stimuli and participant samples (Jones et al., 2021). Some research suggests that idiosyncratic experiences induce differences in the face-trait space (Stolier, Hehman, & Freeman, 2018; Sutherland et al., 2018) that perceivers use when forming impressions (Over & Cook, 2018). Namely, people who learn that two traits are associated (e.g., aggression and physical strength)

should infer one trait from a face (e.g., aggression) to the extent that they infer the other trait from that face (e.g., physical strength). Because perceivers differ in these learned associations between facial features and trait concepts, the face-trait space likely varies across perceivers, such that the same face elicits a different impression from one perceiver to the next.

This emerging perspective contends that top-down processes and particularly social-categorical knowledge fundamentally constrain how people perceive faces (Freeman et al., 2020). Different perceivers with different social identities (Kawakami et al., 2017; Sutherland et al., 2018) and stereotypical associations (Kunda & Thagard, 1996; Stolier, Hehman, Keller, et al., 2018) can evaluate the same target very differently, facilitating considerable variability in how perceivers form impressions. Consistent with these findings, recent work partitioning the variance in face impressions found that perceiver idiosyncrasies contribute a large proportion of variance across many traits (Hehman et al., 2017; Xie et al., 2019). These idiosyncrasies may reflect differences in how perceivers process, represent, and interpret features of the target's face. Further, they may not be fully idiosyncratic, stemming from systematic differences in perceivers' cognitive representations of groups.

Although the stereotyping literature has traditionally studied stereotypes in terms of semantic representations (Eckes, 2002; Fiske et al., 2002; Kunda & Thagard, 1996), the past few decades have seen a proliferation of research bridging face perception, categorization, and stereotyping. When encountering individuals or faces from a given group, culturally-learned gender and racial stereotypes automatically activate, regardless of personal endorsement (Kawakami et al., 2017; Macrae & Bodenhausen, 2000). Yet the literature on stereotyping has generally not considered how stereotypic associations about social groups affect face-trait space specifically. Further, the literature on face impressions has generally focused on an invariant

face-trait space regardless of group memberships or perceivers' associations. Here, we take a novel approach to empirically connect these research traditions, testing to what extent perceivers' learned stereotypes underlie individual differences in facial impressions of various group members.

The Structuring Role of Stereotypes in First Impressions

Stereotypes about different social groups may give rise to distinct face-trait spaces for different groups through learned associations. Modern social-cognitive models posit that the processing of bottom-up facial features is dynamically constrained by top-down cognition, such as stereotype information (Freeman et al., 2020; Stolier, Hehman, & Freeman, 2018). Individuals have expectations about members of social categories (Fiske et al., 2002; Kawakami et al., 2017) and use this information as a template when forming impressions. For instance, Black men who appear physically larger are perceived as more threatening compared to White men of similar size given racial stereotypes that associate Black men with aggression (Hester & Gray, 2018b; Holbrook et al., 2016). Impressions of women are more homogeneous and valence-laden when perceivers strongly endorse gender stereotypes (Oh et al., 2019), consistent with classic stereotyping work that finds warmth and competence judgments to be more negatively related for female than male subgroups (Eckes, 2002).

Other examples abound in recent literature: White, Black, and East Asian faces with neutral expressions are perceived to subtly resemble different emotions (Zebrowitz et al., 2010). Facial perceptions of warmth and dominance differentially predict leadership judgments (Wilson, Remedios, et al., 2017) and career outcomes (Livingston & Pearce, 2009b) for White vs. Black targets. (Oldmeadow et al., 2013) found that facial cues and occupational stereotypes are integrated through shared cognitive representations of groups, in a differential manner across

gender and age. Critically, racial stereotypes influence even basic sex categorization of faces (Johnson et al., 2012), suggesting that regardless of one's conscious beliefs about these groups, learned associations have the potential to influence impressions (Macrae & Bodenhausen, 2000).

Together, these findings suggest that trait impressions from faces are correlated in stereotype-consistent ways across multiple social categories (Stolier, Hehman, Keller, et al., 2018). To the extent that perceivers combine stereotype information about the target with the target's facial appearance to form impressions, we would expect the conceptual structure of different impressions to vary across social categories consistent with stereotypes. For example, if a perceiver believes 'attractive' and 'competent' are strongly associated for women but not for men, then that perceiver is more likely to evaluate women with attractive faces as competent, relative to men.

The Present Research

The current research is the first to formally test the similarity of the structure of group stereotypes and the structure of facial impressions that vary by group membership. In Study 1 we found that, on average, gender and racial stereotypes are associated with trait impressions inferred from others' faces. In Study 2, we examined the role of individual differences, finding that idiosyncratic differences in a perceiver's stereotypes about social groups predict how that perceiver forms impressions of faces belonging to different groups. The Ryerson University Research Ethics Board approved Study 1, and the McGill University Research Ethics Board approved Study 2.

Study 1

Methods

Study 1 tested whether stereotypes about gender and racial groups are reflected in participants' face impressions of people in those different social groups. To create the data structure necessary for this test, we collected data from two sets of participants. One set of participants formed impressions of faces belonging to six different race × gender groups along 14 traits (e.g., assertive). A separate set of participants were assessed on their stereotypical associations regarding these social groups (e.g., Black men, White women) along these same traits. We tested the overlap between impressions and stereotypes aggregated across participants.

Participants and Procedure

Facial Impressions. For impressions from faces, 5,040 participants from the United States and Canada completed ratings through Amazon Mechanical Turk for monetary compensation. Data were cleaned in accordance with our pre-registered data cleaning procedure based on response time and frequency of repeated ratings [bit.ly/65tpb]. Participants were 72.6% non-Hispanic White, 10.4% Black, 5.6% Asian, and 11.4% other ethnic minorities which include mixed-race. Because our analyses involved aggregating across perceivers, we analyzed ratings from White participants only to control for perceiver variability due to race, resulting in 290,641 ratings of trait impressions across 3,619 participants aged 18 to 80 (M_{age} = 37.44, SD_{age} = 12.27, 69.2% female) of 873 stimuli. To test whether conclusions were robust to this specification, we repeated all analyses while making no race-based exclusions (see Supplementary Materials for full description).

These participants rated faces on 14 traits regularly used in the face impressions literature: aggressive, assertive, attractive, caring, competent, dominant, friendly, healthy, intelligent, smart, physically strong, trustworthy, warm, and youthful (Oosterhof & Todorov, 2008; Sutherland et al., 2013). Each participant rated 60-90 different faces (all male or all female), of

which an equal proportion were White, Black, and East Asian. Extant evidence indicates that these traits are used spontaneously when people form impressions. Ratings on these 14 trait impressions were made on 1-"Not at all" to 7-"Very much" Likert scales (e.g., "How trustworthy is this person?"). Stimuli were presented in random order, and participants rated each target on only one trait such that all ratings were between-subjects.

Group Stereotypes. For ratings of the social group stereotypes, 360 participants were recruited from Mechanical Turk. Data were again cleaned in accordance with our pre-registered cleaning procedure [bit.ly/65tpb]: 10 participants were removed for no variation in their responses, and 8 participants were removed for indicating that we should not use their data. Participants who self-reported as non-Hispanic White (73.0%) were included in analyses, resulting in n = 252 participants aged 18 to 80 (M_{age} = 34.91, SD_{age} = 11.28, 47.2% female).

These participants were assessed on their stereotypical associations about the social groups themselves (e.g., Asian men, Black women), absent any facial stimuli. Participants were asked to rate their associations with all crossed gender and race categories on the same 14 traits as above, using 1-"Not at all" to 7-"Very much" Likert scales (e.g., "Please indicate how people in society see Black men [on trustworthiness]"). Consistent with previous research, stereotypical associations were asked in this manner to mitigate social desirability bias (Devine & Elliot, 1995). Thus, this measure reflects participants' learned associations about these groups and not what they personally endorse or believe. Order of group and trait presentation was randomized. Each participant rated each target group on each trait.

Stimuli

Our research design required a large number of stimuli. In total, stimuli consisted of 299 White (49.8% female), 295 Black (49.2% female), and 279 East Asian (46.2% female) faces.

The participants reporting face impressions rated real facial stimuli from a variety of standardized databases, including the Chicago Face Database (Ma et al., 2015) and the Face Research Lab London Set (DeBruine & Jones, 2017), among many others. See Supplementary Materials for full list. All stimuli depict frontal views of faces with neutral expressions. Faces were resized to 611px (wide) x 430px (high) and presented against a plain background.

Analytic Approach

Our goal was to examine the relationship between group stereotypes and impressions of individual faces. We used representational similarity analysis (RSA), an approach previously used to compare inferential relationships between trait adjectives and social impressions (Lay & Jackson, 1969), which has recently been applied to impressions of faces (Stolier, Hehman, Keller, et al., 2018). This approach conceptualizes the face-trait space as a matrix of weighted relationships between traits (e.g., correlations) that are commonly spontaneously inferred from faces (Stolier, Hehman, & Freeman, 2018; Stolier, Hehman, Keller, et al., 2018) and does not combine traits to form a set of static factors. Therefore, independent of how traits correlate differently across social groups, we test whether correlations among face impressions are related to correlations among stereotypes within each social group.

In a supplementary analysis, we confirmed an assumption of our statistical approach, which was that the face-space varied across different race × gender groups. Accordingly, we fit three-, two-, and one-factor models consistent with previous research (Oosterhof & Todorov, 2008; Sutherland et al., 2013) for all race and gender groups using a confirmatory factor analysis in a structural equation framework. Results indicated poor fit, and differential fit across race and gender groups, supporting our assumption that these models were non-invariant by target group. Results from an exploratory parallel analysis were consistent with this result, revealing that

different race and gender groups had a different number of factors underlying their impressions (i.e., they were not equivalent). Full descriptions and results of these analyses are available in the Supplementary Materials.

Because different groups exhibited different numbers of factors and patterns of traits mapped to factors, it was appropriate to adopt our model-free approach to comparing race and gender groups, allowing for comparisons at the trait level.

Restructuring Face Ratings. To this end, we followed the procedure from Stolier et al. (Stolier, Hehman, Keller, et al., 2018) to restructure the data for this analysis. We created a 14 × 14 trait correlation matrix for each of the 6 groups, producing separate correlation matrices for ratings of female and male White, Black, and East Asian faces (Figure 1). We removed repeated trait-pair correlations from the upper diagonal of each matrix. Values were Fisher-*z* transformed to allow for comparison across social groups. Each matrix was converted to a single column vector with 91 rows of trait-pair correlations in which each row represented a single trait-pair relationship (e.g., strong-aggressive) within a single social group (e.g., the correlation between ratings of "strong" and "aggressive" when viewing Black male faces). These 91 x 1 vectors for each social group were then combined into a single 546 x 1 vector representing all the correlations from ratings of faces. Data available at [bit.ly/dytxs].

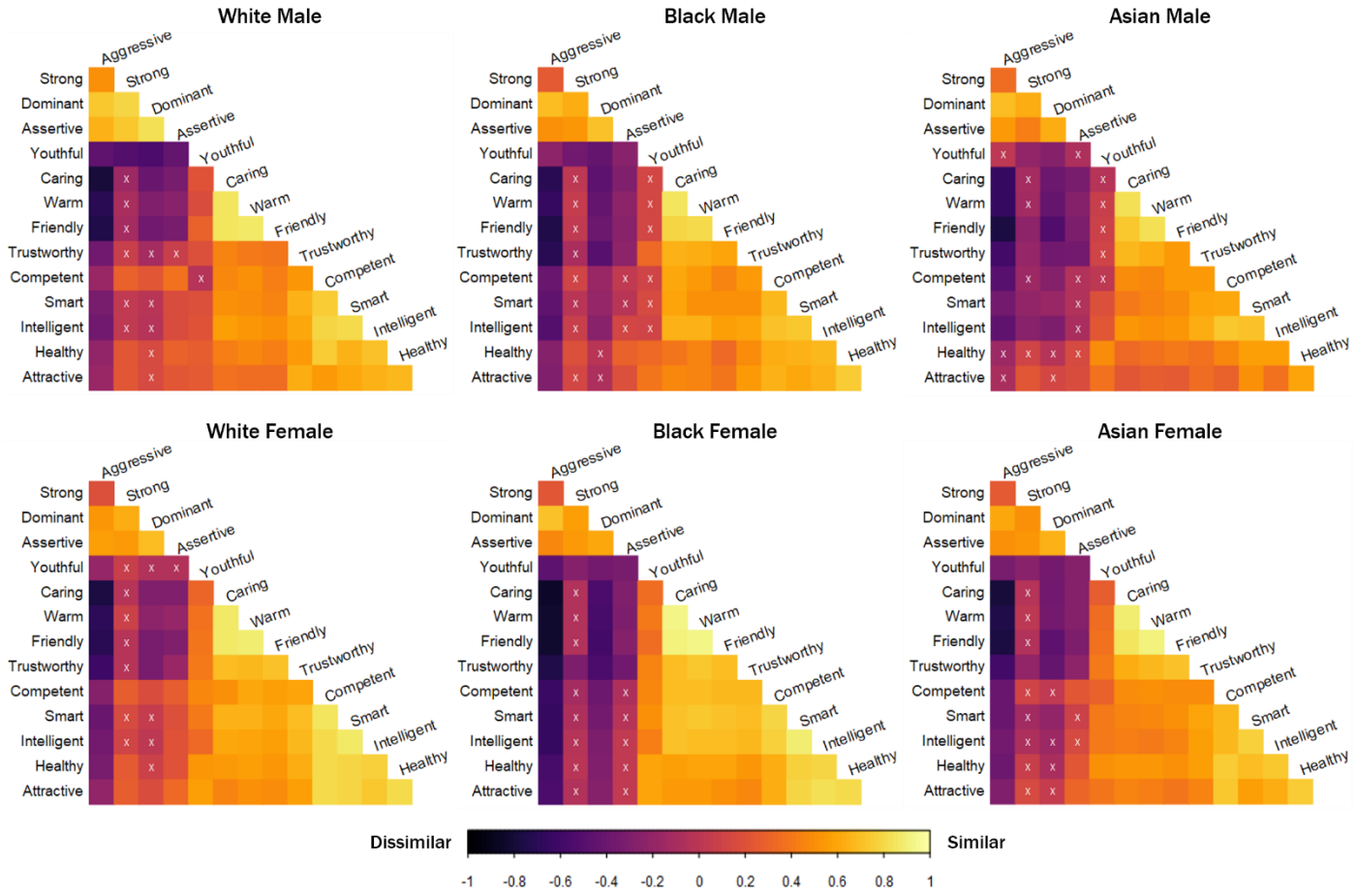


Figure 1. Pearson correlation matrices for White participants' trait impressions of male and female White, Black, and East Asian faces. "X" denotes a non-significant relationship at $\alpha = .05$. Matrices are sorted using the hierarchical clustering order based on the White Male matrix.

Restructuring Group-Stereotype Ratings. We restructured the group-stereotype data from the second group of participants in an identical manner. 14 × 14 Pearson correlation matrices of stereotypical trait ratings of each social category in the abstract (Figure 2) were converted to 91 x 1 single column vectors, and then combined into a 546 x 1 vector. Correlations were Fisher-*z* transformed for comparison. Again, each matrix contains inter-correlations between pairs of trait ratings. For example, for White male targets, the correlation between 'warm' and 'caring' represents the average association between participants' ratings of White

men (as a group) on warmth and caring. Thus, these matrices represent stereotypical representations of the social categories aggregated across perceivers.

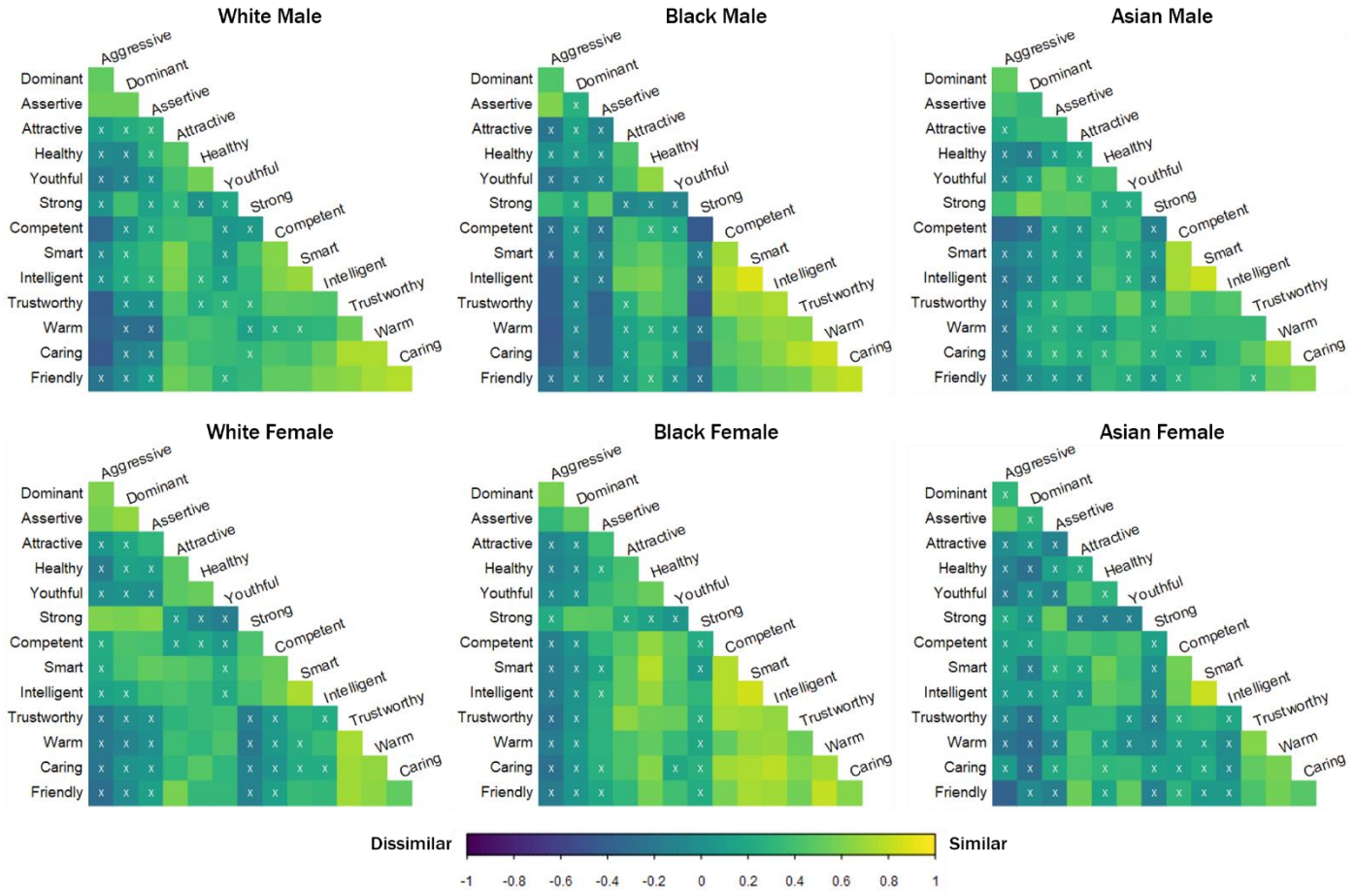


Figure 2. Pearson correlation matrices of 14 traits for White participants' abstract impressions of female and male Whites, Blacks, and East Asians. "X" denotes non-significant relationship at α = .05. Matrices are sorted using the hierarchical clustering order based on the White Male matrix.

Results

Similarity of Face-Trait and Group-Trait Spaces Across Groups. Our primary goal was to compare the spaces of face impressions with group stereotypes. A positive relationship between the face impressions and the group impressions would indicate the group-level stereotypes are associated with impressions of faces. The face-trait ratings and the group-trait ratings were combined into a 546 x 2 matrix to examine this relationship. As we were now

correlating correlation matrices, Spearman's *rho* was used instead of Pearson's *r* to evaluate the Fisher-*z* transformed correlations (Kriegeskorte, 2008; Stolier, Hehman, & Freeman, 2018). Critically, to ensure that mean relationships between traits were not driving effects (e.g., dominance and physical strength have a more positive correlation than dominance and friendliness across all social categories), we subtracted out the average correlation of each trait-pair across all 6 social categories. Thus, the final Spearman coefficient captures the extent to which group-level stereotypic associations uniquely relate to shifts in the facial trait space.

Supporting our hypothesis that group stereotypes shape the impression formation space, trait-pair correlations from ratings of faces were positively correlated with trait-pair correlations of abstract ratings of groups, $\rho = .164$, $p < .001$, 95% CI [.082, .245], suggesting that the trait space of stereotypic associations for a particular group (e.g. to what extent "Black men" as a social category are rated similarly on trustworthiness and dominance) is significantly similar to the 'space' of our facial impressions of people from that group (e.g., to what extent Black male faces are rated similarly on trustworthiness and dominance). See Figure 3.

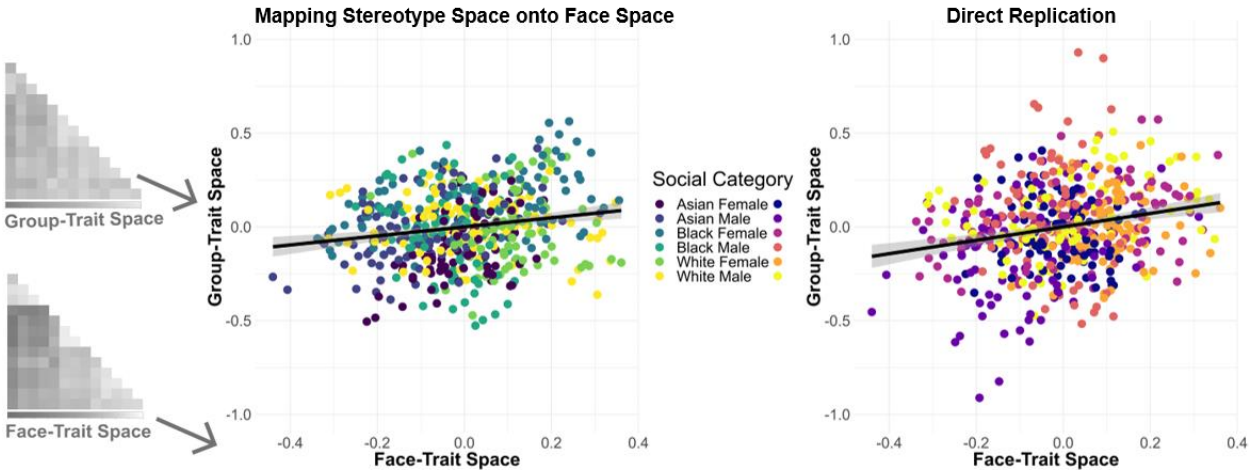


Figure 3. Comparison of the face-trait space with the stereotypical group-trait spaces (from a separate sample), after subtracting out the average correlation between Trait A and Trait B across

all 6 social categories. The slope therefore depicts the extent to which differences in group-trait spaces uniquely overlap with differences in face-trait spaces.

Direct Replication. We conducted a pre-registered direct replication [bit.ly/vzb48] to increase our confidence in the relationship. Data collection and cleaning were identical to the previous analysis: we recruited 304 additional participants who evaluated social categories in abstract terms, removing 20 participants for no variation in their responses, and 7 participants for indicating that we should not use their data. Analyses included participants who self-reported as non-Hispanic White (71.2%), resulting in n = 195 participants aged 19 to 70 (M_{age} = 39.69, SD_{age} = 12.47, 53.1% female). Data available at [bit.ly/dytxs].

Replicating our previous analysis, results indicated that trait-pair correlations from ratings of faces were positively correlated with trait-pair correlations of group ratings in the abstract, ρ = .204, p < .001, 95% CI [.125, .285], a stronger relationship within the confidence interval of the previous estimate.

Together, results reveal that stereotypical associations of traits across social categories are linked with how people form impressions of those targets. For example, to the extent that 'youthful' and 'competent' are more strongly positively associated for Asian women than White men, Asian women with youthful faces are more likely to be perceived as competent (or vice versa), relative to White men.

Robustness Check. Above we restricted analyses to White participants. To test whether conclusions were robust to this specification, we repeated all analyses while making no race-based exclusions. This resulted in a total of 4,984 participants rating faces, 344 participants rating groups in the abstract, and 274 participants rating groups in the replication dataset. Results were nearly identical, suggesting that the associations between group stereotypes and the

impression formation space are robust across perceiver ethnicity. See Supplementary Materials for full description.

Supplementary Analysis

Another assumption of the above analyses is that there is variation within the trait-pair correlations across social groups in the first place. In other words, this correlation might emerge from the same relative relationship between face impressions and group-level stereotypes if trait-pair correlations for both were equivalent across all social groups. To conclude that different stereotypes about different social groups give rise to different face impressions, it is important to confirm variation in the face-trait space exists. While the initial confirmatory and exploratory factor analyses reported in the Supplementary Materials essentially reveal this is indeed the case, we sought to confirm meaningful variation within the same statistical framework used above.

To this end, using the face-impressions data only, we restructured the 546 x 1 face-impression data to a 91 x 6 matrix in which each column was a single social group. The rows continued to represent trait-pair correlations from faces. We then compared these spaces using repeated measures ANOVA, in a 2 (Target Gender: Female, Male) × 3 (Target Race: White, Black, East Asian) design. This allowed us to examine whether the face-trait space—comprised of correlations between various trait-pairs (e.g., warm–competent, warm–attractive)—differed significantly as a function of targets' race and gender.

Mauchly's test, $\chi^2(2) = 10.52$, $p = .005$, indicated a violation of sphericity for Race. This is a test of statistical assumptions, but in this case directly informs our hypothesis, because the rejection of the null for Mauchly's test indicates that the variance of the differences in trait-pair correlations were *not* homogenous across racial groups. In other words, certain groups had significantly less variance in their face-trait space, such that facial impressions were more

strongly interrelated (i.e., more homogeneous) than other groups, and vice versa. For the Race factor, we report Greenhouse-Geisser corrections below.

Consistent with our confirmatory and exploratory analyses in the Supplementary Materials, results from the 2 (Target Gender) × 3 (Target Race) repeated measures ANOVA for face ratings indicated that inter-correlations between trait-pairs were not equal across race and gender. There was a significant main effect of Target Gender, $F(1, 90) = 19.12$, $p < .001$, $\eta_p^2 = .18$, and Target Race, $F(1.80, 161.94) = 26.27$, $p < .001$, $\eta_p^2 = .23$, qualified by a marginally significant Gender × Race interaction, $F(2, 180) = 2.59$, $p = .078$, $\eta_p^2 = .03$ (Table 1, left).

Table 1

Estimated Marginal Means from a repeated measures ANOVA on the 6 trait-pair correlation matrices for face ratings (left) and abstract ratings of groups (right), in a 2 (Target Gender) × 3 (Target Race) design.

	Mean	*SE*	95% CI LL	95% CI UL	Mean	*SE*	95% CI LL	95% CI UL
Homogeneity of Facial Trait Space					Homogeneity of Group-Stereotype Space			
Gender								
Female	.305	.061	.185	.425	.300	.029	.243	.357
Male	.234	.051	.132	.336	.265	.033	.198	.331
Race								
Asian	.223	.052	.121	.326	.225	.026	.173	.277
Black	.257	.062	.134	.381	.328	.041	.247	.409
White	.328	.054	.220	.436	.294	.030	.234	.354
Gender × Race								
Asian Female	.263	.055	.153	.373	.190	.030	.130	.250
Black Female	.277	.072	.135	.420	.419	.038	.343	.495
White Female	.375	.056	.263	.486	.291	.031	.229	.354
Asian Male	.183	.049	.085	.281	.260	.029	.202	.318
Black Male	.237	.054	.130	.344	.237	.047	.143	.330
White Male	.282	.054	.174	.390	.297	.034	.229	.365

Results indicated that, on average, the associations between different pairs of trait ratings (e.g., competent, attractive) inferred from faces differ across targets' race and gender. Since the

unit of analysis is the correlation of trait-pairs, and results are the averages of these correlations, results can be interpreted as overall homogeneity of the trait space for each group. For instance, because the average trait-pair correlation is higher for women (M_r = .305) than for men (M_r = .234), we can interpret this as evidence that all traits are, on average, more interrelated for women than for men.

We performed the same restructuring and analysis for the group-stereotype data. Mauchly's test, $\chi^2(2) = 8.59$, $p = .014$, indicated violations of sphericity for Race, similar to the previous analysis, but also for the Gender × Race interaction, $\chi^2(2) = 7.30$, $p = .026$. Thus, we can infer unequal variances in trait-pair correlations across race × gender groups. Applying Greenhouse-Geiser corrections, results of the 2 (Target Gender) × 3 (Target Race) repeated measures ANOVA for trait ratings of social categories indicated that inter-correlations between trait-pairs were *not* equal across race and gender, similar to the previous analysis for trait ratings of faces. There was a significant main effect of Target Gender on the correlations of trait-pairs, $F(1,90) = 4.98$, $p = .028$, $\eta_p^2 = .05$, and a significant main effect of Target Race, $F(1.83, 164.83) = 9.72$, $p < .001$, $\eta_p^2 = .10$, qualified by a significant Gender × Race interaction, $F(1.85, 166.86) = 26.09$, $p < .001$, $\eta_p^2 = .23$ (Table 1, right).

Both these results support our underlying assumption that the face-trait space and the group-trait space are not equivalent across social groups, and lend credence to our interpretation of the relationship between the face-trait space and group-trait space. Thus, targets of different social categories evoke distinct stereotype associations, which are consistent with shifts in the trait space for facial impressions of those targets.

Study 2

Study 1 examined face-trait and group-trait impressions aggregated across perceivers, and therefore the association reflects consensual stereotypes and impressions regarding race—gender groups. However, individuals differ in their stereotype knowledge and endorsement. As a more stringent test of our hypothesis, in Study 2 we tested this association within-subjects. Specifically, we examined whether perceivers' idiosyncratic stereotypical trait associations for each group predicted their face-trait spaces (i.e., correlations among trait impressions inferred from faces) for targets belonging to those groups.

Methods

Participants

We recruited 400 participants from Amazon Mechanical Turk. Data cleaning following our pre-registered lab procedure [bit.ly/65tpb] resulted in a final sample of 181 participants aged 18 to 73 (M_{age} = 38.56, SD_{age} = 11.87, 58% male). Because the analysis was within-subjects, unlike Study 1 we included all individuals regardless of race and/or ethnicity, resulting in 114 non-Hispanic White, 18 non-Hispanic Black, 6 non-Hispanic East Asian, 22 Hispanic White, 11 Hispanic Black, and 10 selected Aboriginal/Indigenous, Pacific Islander, South Asian, Biracial, or Other.

Procedure

Participants rated faces in a 2 (*Gender*: Female, Male) × 3 (*Race*: White, Black, East Asian) × 6 (*Trait*: Aggressive, Attractive, Friendly, Healthy, Intelligent, Physically Strong) mixed methods design with repeated measures on both the Race and Trait factors. We collected a reduced number of traits due to concerns about participant fatigue in the within-subjects design.

Participants first rated White, Black, and East Asian faces that were either male or female on all 6 traits, in response to questions such as “How attractive is this person?” on 1-“Not at all” to 7-“Very much” Likert-type scales. Unlike Study 1, participants rated each target on multiple traits. Traits were presented in blocks, and order of trait presentation was randomized across participants. Facial stimuli were presented at random within each trait block (and reshuffled across trait blocks) to minimize the effects of serial dependence.

In the second part of the task, participants reported their stereotypical trait associations for each social category. Participants were asked to indicate how they thought the “average person in North America” would believe any given pair of traits were linked for each social category, expressed as a likelihood that a person with one trait would have another trait. Following previous research (Stolier et al., 2020), participants responded to questions such as “How likely is an aggressive Asian man to be attractive?” on 1-“Not at all likely” to 7-“Very likely” Likert-type scales. The order of trait presentation as well as their internal ordering within the prompt (e.g., whether aggressive or attractive appeared first in the sentence) were randomized by trial and participant.

Stimuli

Study 1 required a large amount of target stimuli, and diverse databases with minor variation in photograph standardization were included. To test generalizability and that any effects were artifacts of these different databases, in Study 2 participants rated colour frontal photographs of faces with neutral expressions from only the Chicago Face Database (Ma et al., 2015). Each participant rated 30 unique photos of one gender, 10 from each racial group. To maximize generalizability given the more limited sample, stimuli were randomly sampled from a larger pool of 120 photos (40 per racial group) on a by-participant basis. Across both female and

male targets, and across all participants, a total of 240 stimuli were used. Faces were resized to 611px (wide) x 430px (high) and presented against a plain background.

Analytic Approach

Due to the within-subject nature of our design, we analyzed data in a multilevel framework. To compare the stereotype trait space with the face-trait space within perceivers, we restructured the face rating data using a procedure similar to Study 1, with the additional step of nesting ratings within participants. For each participant, we created a 6 × 6 trait correlation matrix for the 3 groups (female *or* male White, Black, and East Asian). We estimated the trait-pair correlations (e.g., friendly–attractive) for each group (aggregating across all stimuli targets of each group), which were then Fisher-*z* transformed to allow for statistical comparison. These trait-pair correlations from face ratings were then joined with the stereotypical trait associations for each group, from the second part of the task.

This procedure resulted in a dataset in which each row contained: the target's social category (e.g., White female), a trait-pair correlation from ratings of faces (e.g., friendly–attractive), and a rating of the pairwise stereotypical association of those traits for White women (i.e., the perceiver's rated likelihood that a White woman with one of those traits would have the other trait, expressed on a 1-7 Likert-type scale). This final variable was group-centered within perceivers.

Preliminary Analysis. An assumption prompting Study 2 was that individuals would vary in their trait-pair associations. To test this directly, we built a cross-classified null model in which trait-pair correlations were nested within both participants and trait-pairs. This approach partitions the variance between and within the clusters of the model, and allowed us to calculate an intraclass correlation coefficient (ICC; (Raudenbush & Bryk, 2002), representing the

proportion of variance attributable to a portion of the model (i.e., between perceivers, between trait-pairs, or within perceiver and trait-pair). For example, perceiver-ICC is calculated as the proportion of variance attributable to between-perceiver differences. Using this approach, we determined how much variance in the trait-pair correlations from face ratings between any given pair of traits was attributable to perceiver differences versus the trait-pairs themselves (i.e., the extent to which correlations between certain trait-pairs were varying more than others).

Results produced a perceiver-ICC of 0.04 and a trait-pair-ICC of 0.26, indicating that 4% of the variance in the correlation of trait-pairs (from face ratings) was coming from between-perceiver differences, whereas 26% of this variance was coming from differences among the trait-pairs in our study (e.g., friendly–attractive, strong–intelligent).

This pre-analysis was important because it indicated that across perceivers, the correlation of trait impressions inferred from faces did not vary much (4%). Within each perceiver, this correlation may still vary as a function of each perceiver's stereotypical trait associations for each group. Thus, for the main analysis, we centered the stereotype association variable within each perceiver's mean to focus on within-perceiver variation. Furthermore, the large trait-pair ICC indicated that this cluster would need to be included in the main analysis to account for heterogeneity in the correlations across different trait-pairs.

Repeating this process, we calculated ICCs for the trait-pair correlations from stereotypes. Results indicated that 11% of the variance in stereotypical trait associations was attributable to the perceiver, 19% of this variance was attributable to the specific trait-pairs involved, and 15% of the variance was attributable to the interaction. This pre-analysis therefore provided support for including perceivers as a cluster in our primary analysis.

Relationship between Face-trait Space and Group-trait Space. Testing our primary hypothesis, we examined whether stereotypical trait associations idiosyncratically predict the face-trait space for each perceiver. Given 6 trait ratings per target, this amounts to 15 unique trait-pairs × 181 participants × 3 target racial groups, resulting in 8,145 observations nested in 181 participants and 15 trait-pairs. Perceivers' stereotypical trait associations (i.e., rating of the likelihood that a target who possesses a particular trait would also have another trait) were mean-centered within each perceiver and included as a level-1 predictor in the model (Equation 1).

$$\text{Level 1: } Y_{ijk} = \beta_{0jk} + \beta_{1jk}\left(StereotypeTrait_{ijk} - \overline{StereotypeTrait}_{cwc}\right) + R_{ijk} \quad (1)$$
$$\text{Level 2: } \beta_{0jk} = \gamma_{000} + \gamma_{010}\overline{StereotypeTrait}_{j} + U_{0j0} + U_{00k}$$
$$\beta_{1jk} = \gamma_{100} + U_{1j0}$$

At Level 1 of the model, Y_{ijk} is a correlation between face ratings on a pair of traits by perceiver *j* on trait-pair *k* (e.g., attractive–intelligent), now conditional on that perceiver's stereotypical trait association of those traits (per race × gender group). The intercept, β_{0jk}, is the expected value of this correlation across all targets, at the average level of each perceiver's stereotypical pairwise trait association (e.g., "How likely is an attractive White woman to be intelligent?") across all groups. β_{1jk} represents the correspondence between a perceiver's stereotypical pairwise trait associations *unique* to each group and the correlation of their face ratings of targets from that group (e.g., attractive–intelligent for White women). Because perceivers' stereotypical associations are mean-centered within each perceiver, values on this variable represent the unique variation in each perceiver's stereotype associations across different race × gender groups.

At Level 2, each perceiver's intercept, β_{0jk}, is an outcome modeled as the grand mean pairwise correlation for all faces, γ_{000}; the between-perceiver effect of stereotypical trait associations, γ_{010}; each perceiver's residual from the grand mean across all trait-pairs, U_{0j0}; and

the residual of each trait-pair from the grand mean across all perceivers, U_{00k}. β_{1jk} models the similarity between stereotype trait space and face-trait space within perceivers. γ_{100} is the average increase in the pairwise correlation of face ratings with every 1-unit increase in the pairwise stereotypical association of those traits, within each perceiver. The residual, U_{1j0}, represents the variation of perceiver *j* around this average slope.

We hypothesized that perceivers' stereotype trait associations for each group predict how they form impressions from faces. Thus, we expected the fixed effect, γ_{100}, to be significant. Based on the preliminary analyses and the results of Study 1, we expected this relationship to hold for targets of all social groups. This relationship may be stronger for some groups than others, for which we had no directional hypotheses.

Finally, to estimate the variance in the face-trait space *explained* by stereotypical trait associations, we used the general R^2 formula developed by (Rights & Sterba, 2019) for use in multilevel models. Because there are currently no extensions of the framework to cross-classified data structures, we adopted the formula for non-cluster-mean-centered models (see Table 5 and Appendix A2 of Rights & Sterba, 2019) and modified the matrices to reflect the cross-classified data structure. See [bit.ly/dytxs] for R code.

Results

Replicating Study 1 in a within-subjects framework, results indicated that perceivers' stereotype trait space predicted significant differences in the face-trait space (γ_{100} = .040, 95% CI [.027, .047], β = .104, p < .001). See Figure 4. Furthermore, perceivers' idiosyncratic stereotype content unique to each group explained 3.8% of the variance in structural relations within the face-trait space, whereas 24.4% of the variance was explained by other between-perceiver differences as well as differences in the correlations across trait-pairs.

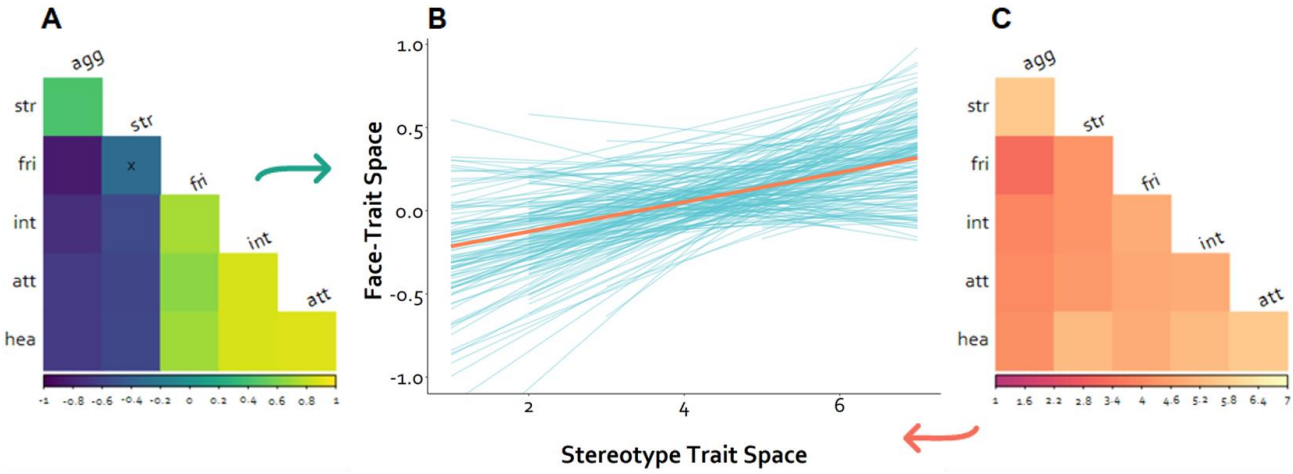


Figure 4. Comparison of stereotype- and face-trait spaces. For each perceiver evaluating each group, a correlation matrix of facial trait impressions (A) and group trait associations (C) was constructed. We tested the within-subjects relationship between these values (B). Although the analysis was carried out using Fisher-z transformed correlations from face ratings in a multilevel model, the untransformed correlations are depicted for illustrative purposes.

Though we had no directional hypotheses, we additionally tested whether the relationship between the stereotype trait space and the face-trait space was consistent across all race × gender groups. Results were consistent across all groups, with the exception of Asian women. See Supplementary Materials for full reporting.

One methodological point critical to the interpretation of these results is that the stereotypical trait-pair associations were centered within perceivers, and clustered within different trait-pairs. Thus, regardless of the trait being evaluated, within-perceiver variation in stereotypical trait associations is still associated with how perceivers form impressions from faces. The contribution of idiosyncratic stereotypes to variance explained in this sample is small. Because participants reported stereotype knowledge instead of personal endorsement of stereotypes, this may be a conservative estimate of the link between stereotypes and the trait-space generally. Nonetheless, it is an important theoretical proof of concept that when

individuals evaluate individuals from different social categories, knowledge of group stereotypes influence their impressions.

General Discussion

We present the first direct evidence suggesting that group stereotypes constrain the structure of trait impressions inferred from faces. The impression formation spaces of different race × gender groups are not the same, varying in ways consistent with stereotype associations distinct to each group. Study 1 demonstrates this pattern across perceivers, revealing how culturally consensual stereotypes are linked to the average impression-formation space of each group. Study 2 demonstrates the same phenomenon within perceivers, showing that perceivers' idiosyncratic stereotype associations predict variation in their face-trait space when evaluating targets from different groups. For example, to the extent that a perceiver believes 'attractive' and 'intelligent' to be more strongly associated for White than for East Asian women, that perceiver may be more likely to evaluate White women with attractive faces as intelligent, relative to East Asian women. Critically, this work contributes novel evidence that the structure of facial impressions overlaps with stereotypical associations, independent of the specific traits being evaluated. We empirically connect the literatures on face impressions and stereotyping, finding that the structure of trait evaluations conform to perceivers' stereotypical trait associations of the target's group.

It is important to stress that these data are cross-sectional, which limits causal inference. Yet drawing from theory, we speculate that the group stereotype space constrains social impressions drawn from faces. Our results converge with recent literature that finds the face-trait space to vary across group boundaries, such as gender (Oh et al., 2019; Sutherland et al., 2015), nationality (Jones et al., 2021; Sutherland et al., 2018), age (Oldmeadow et al., 2013), and race

(Wilson, Remedios, et al., 2017)—and supports the emerging perspective that individuals' lay beliefs about personality shape the structure of the face-trait space during impression formation (Freeman et al., 2020; Over & Cook, 2018; Stolier, Hehman, Keller, et al., 2018). Under this framework, trait impressions from faces can be understood as mappings between morphological features in 'face space' and conceptual relations in mental 'trait space', arising from learned experiences.

One limitation is that our assessment of stereotypes and face impressions could in theory be non-independent, if participants imagine a face when they provide abstract ratings of groups. However, we believe this is unlikely because participants rated what the "average person" believes about any group, potentially encouraging more belief-based semantic representations rather than one's own mental imagery of exemplars.

Given a lack of diagnostic information about a target's attributes (e.g., competence), an initial stereotypic expectation based on group membership may shape other trait inferences according to stereotypical associations in the perceiver's trait space (Nisbett & Wilson, 1977). Computational models are helpful for understanding impression formation because they illustrate that mappings in face space (e.g., symmetry, skin colouration) and trait space (e.g., attractive, trustworthy) dynamically influence one another (Freeman et al., 2020), which converges with the well-documented finding that facial impressions are both highly intercorrelated (Nisbett & Wilson, 1977; Oosterhof & Todorov, 2008) and highly variable across perceivers (Hehman et al., 2017; Hönekopp, 2006). Critically, accurate perception is not required for these associations to be influential, as perceivers observe, recall, and integrate information into existing schemas in a selective and biased manner (Kawakami et al., 2017).

Social impressions from faces have important real-world implications within the political (Todorov et al., 2005) and legal systems (Blair et al., 2004; Wilson & Rule, 2015). We find that when forming an impression, trait inferences are differently correlated across race and gender in stereotype-consistent ways. Thus, to the extent that physical strength and trustworthiness are negatively associated for Black men but unrelated for White men, sentencing decisions, which are influenced by how trustworthy a target appears, are more likely to be influenced by other attributes (e.g., physical strength) for Black vs. White male defendants. Given that defendants with faces stereotyped to be crime-congruent are more likely to be found guilty (Macrae & Shepherd, 1989), idiosyncratic stereotypes in impression formation may contribute to systematic discrepancies in conviction rates across groups.

Furthermore, while the present research demonstrates variability in the face-trait space among the social categories represented here, the theoretical implications extend beyond these groups. The impression-formation space may vary by evaluative context, mood, situational affordances, and stereotypes about other groups. Given that the associations between trait-words vary even on a perceiver-by-perceiver basis (Stolier, Hehman, Keller, et al., 2018), the utility of dimensional models of social perception that aggregate across perceivers or targets may be limited. Currently, the literature lacks a topography of how other factors systematically shift the space of social impressions.

Finally, while the present research indicates that current models of facial impressions are not fully generalizable, future research is needed to understand why the trait space shifts across racial and gender groups. Although we present evidence that stereotypes are associated with these shifts, the small percentage of variance explained by stereotypes alone indicates that other

factors are likely important. Future research can integrate these other sources of variance to better understand group differences in impression formation.

Conclusion

In summary, the present work synthesizes and advances the impression formation and intergroup literatures by examining the extent to which group stereotypes constrain first impressions from faces. We demonstrate that the impression formation space varies across female and male, White, Black, and East Asian categories, partly due to stereotypic associations with these groups. These findings inform our understanding of how and why perceivers form impressions of diverse targets differently based on social identity. Perceiver stereotypes uniquely predict the impression formation space for each group, suggesting that group differences arise early in the person perception process. These results have implications for the differential relationships that arise between facial appearance and important outcomes (e.g., hiring, sentencing) for individuals belonging to different groups.

Transparency

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Author Contributions. All the authors conceived the research and designed the methodology. Data were curated by S. Y. Xie and E. Hehman, and data were analyzed by S. Y. Xie, J. K. Flake, and E. Hehman. S. Y. Xie wrote the first draft of the manuscript. All authors reviewed and edited the manuscript, and all authors approved the final version for submission.

Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or publication of this article.

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Open Practices

All data and analysis code have been made publicly available via OSF and can be accessed at https://osf.io/dytxs/. The design and analysis plans for the direct replication performed in Study 1 were preregistered at https://osf.io/vzb48 (see Note 1 for explanation of deviation from the preregistration). This article has received the badges for Open Data and Preregistration. More information about the Open Practices badges can be found at http://www.psychologicalscience.org/publications/badges.

Notes

1. The effect-size *r* to be reproduced was erroneously reported as .818 in the preregistration. In the original study, we conducted an additional step of subtracting out the average

correlation between traits across all six race–gender categories, which produced a Spearman's ρ of .164. Thus, ρ = .164 is the effect size that we intended to replicate. This does not change the results of the replication. If we omit this additional step of subtracting out the mean correlation across race–gender groups and simply compare r = .818 with the (unsubtracted) correlation obtained in the replication, the effect is still replicated.

References

Blair, I. V. Y., Judd, C. M., & Chapleau, K. M. (2004). The influence of Afrocentric facial features in criminal sentencing. *Psychological Science*, *15*(10), 674–679.

DeBruine, L. M., & Jones, B. C. (2017). *Face Research Lab London Set. Figshare*. https://doi.org/10.6084/m9.figshare.5047666

Devine, P. G., & Elliot, A. J. (1995). Are racial stereotypes really fading? The Princeton trilogy revisited. *Personality and Social Psychology Bulletin*, *21*(11), 1139–1150.

Eckes, T. (2002). Paternalistic and envious gender stereotypes: Testing predictions from the stereotype content model. *Sex Roles*, *47*(3), 99–114.

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

Freeman, J. B., Stolier, R. M., & Brooks, J. A. (2020). Dynamic interactive theory as a domain-general account of social perception. In *Advances in Experimental Social Psychology* (Vol. 61, pp. 237–287). Elsevier.

Hehman, E., Carpinella, C. M., Johnson, K. L., Leitner, J. B., & Freeman, J. B. (2014). Early Processing of Gendered Facial Cues Predicts the Electoral Success of Female Politicians. *Social Psychological and Personality Science*, *5*(7), 815–824. https://doi.org/10.1177/1948550614534701

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*, *113*(4), 513–529.

Hester, N., & Gray, K. (2018). For Black men, being tall increases threat stereotyping and police stops. *Proceedings of the National Academy of Sciences*, *115*(11), 2711–2715. https://doi.org/10.1073/pnas.1714454115

Holbrook, C., Fessler, D. M. T., & Navarrete, C. D. (2016). Looming large in others' eyes: Racial stereotypes illuminate dual adaptations for representing threat versus prestige as physical size. *Evolution and Human Behavior*, *37*(1), 67–78. https://doi.org/10.1016/j.evolhumbehav.2015.08.004

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

Johnson, K. L., Freeman, J. B., & Pauker, K. (2012). Race is gendered: How covarying phenotypes and stereotypes bias sex categorization. *Journal of Personality and Social Psychology*, *102*(1), 116. https://doi.org/10.1037/a0025335

Jones, B. C., DeBruine, L. M., Flake, J. K., Liuzza, M. T., Antfolk, J., Arinze, N. C., Ndukaihe, I. L. G., Bloxsom, N. G., Lewis, S. C., & Foroni, F. (2021). To which world regions does

the valence–dominance model of social perception apply? *Nature Human Behaviour*, 1–9.

Kawakami, K., Amodio, D. M., & Hugenberg, K. (2017). Intergroup Perception and Cognition: An Integrative Framework for Understanding the Causes and Consequences of Social Categorization. In *Advances in Experimental Social Psychology* (1st ed., Vol. 55). Elsevier Inc. https://doi.org/10.1016/bs.aesp.2016.10.001

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*, *103*(2), 284–308.

Lay, C. H., & Jackson, D. N. (1969). Analysis of the generality of trait-inferential relationships. *Journal of Personality and Social Psychology*, *12*(1), 12.

Livingston, R. W., & Pearce, N. A. (2009). The Teddy-Bear Effect Does Having a Baby Face Benefit Black Chief Executive Officers? *Psychological Science*, *20*(10), 1229–1236. https://doi.org/10.1111/j.1467-9280.2009.02431.x

Ma, D. S., Correll, J., & Wittenbrink, B. (2015). The Chicago face database: A free stimulus set of faces and norming data. *Behavior Research Methods*. https://doi.org/10.3758/s13428-014-0532-5

Macrae, C. N., & Bodenhausen, G. V. (2000). Social cognition: Thinking categorically about others. *Annual Review of Psychology*, *51*, 93–120. https://doi.org/10.1146/annurev.psych.51.1.93

Macrae, C. N., & Shepherd, J. W. (1989). Do criminal stereotypes mediate juridic judgements? *British Journal of Social Psychology*, *28*(2), 189–191.

Nisbett, R. E., & Wilson, T. D. (1977). The halo effect: Evidence for unconscious alteration of judgments. *Journal of Personality and Social Psychology*, *35*(4), 250–256. https://doi.org/10.1037/0022-3514.35.4.250

Oh, D., Dotsch, R., Porter, J., & Todorov, A. (2019). Gender biases in impressions from faces: Empirical studies and computational models. *Journal of Experimental Psychology: General*.

Oldmeadow, J. A., Sutherland, C. A. M., & Young, A. W. (2013). Facial stereotype visualization through image averaging. *Social Psychological and Personality Science*, *4*(5), 615–623.

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

Over, H., & Cook, R. (2018). Where do spontaneous first impressions of faces come from? *Cognition*, *170*, 190–200.

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

Rights, J. D., & Sterba, S. K. (2019). Quantifying explained variance in multilevel models: An integrative framework for defining R-squared measures. *Psychological Methods*, *24*(3), 309.

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., & Freeman, J. B. (2020). Trait knowledge forms a common structure across social cognition. *Nature Human Behaviour*, *4*(4), 361–371.

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 of the United States of America*, *115*(37), 9210–9215. 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*.

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

Todorov, A., Mandisodza, A. N., Goren, A., & Hall, C. C. (2005). Inferences of Competence from Faces Predict Election Outcomes. *Science*, *308*(5728), 1623–1626. https://doi.org/10.1126/science.1110589

Willis, J., & Todorov, A. (2006). First Impressions: Making Up Your Mind After a 100-Ms Exposure to a Face. *Psychological Science*, *17*(7), 592–598. https://doi.org/10.1111/j.1467-9280.2006.01750.x

Wilson, J. P., Remedios, J. D., & Rule, N. O. (2017). Interactive effects of obvious and ambiguous social categories on perceptions of leadership: When double-minority status may be beneficial. *Personality and Social Psychology Bulletin*, *43*(6), 888–900.

Wilson, J. P., & Rule, N. O. (2015). Facial Trustworthiness Predicts Extreme Criminal-Sentencing Outcomes. *Psychological Science*, *26*(8), 1325–1331. https://doi.org/10.1177/0956797615590992

Xie, S. Y., Flake, J. K., & Hehman, E. (2019). Perceiver and target characteristics contribute to impression formation differently across race and gender. *Journal of Personality and Social Psychology*, *117*(2), 364.

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

CHAPTER 4

Cultural perceptions of faces reveal consistent race × gender associations across countries

(Xie & Hehman, 2022, to be submitted)

Preface to Chapter 4

The studies presented in Chapter 3 examine how stereotypical associations predict impressions of faces belonging to different social categories. An important preliminary finding was that the structure of the face-trait space differed significantly as a function of targets' race, gender, and race × gender category (Xie et al., 2021). This converges with recent research that found differences in the face-trait space across different participant and target samples, for example across cultures (Sutherland et al., 2018) and world regions (Jones et al., 2021). By demonstrating this variability in the face-trait space, Chapter 3 challenges current dimensional models of impression formation, which summarize the face-trait space into a small number of dimensions presumed to be invariant across perceiver and target characteristics. Further, this work makes novel theoretical and methodological contributions to the literature, demonstrating the utility of modelling and comparing facial impressions via their multidimensional relations to one another at different levels of representation (e.g., *face-trait space:* the correlational structure between any pair of trait ratings inferred from faces; *stereotype association space:* conceptual representations of how any pair of traits relate to each other for members of a social category)—and lays the groundwork for future investigation into how the face-trait space varies in other contexts.

This research advances our theoretical understanding of impression formation in two additional ways. It clarifies and tests a theoretical mechanism by which face-trait spaces might differ—namely, that perceivers' stereotypical representations about various social categories map onto the structure of their facial impressions. At both the "societal" level and the "individual" level, stereotypical associations are structured similarly to trait impressions inferred from faces, such that differences in stereotyped trait relations across groups (e.g., competence

and dominance are positively correlated for White men but negatively correlated for Black men) predict differences in how traits are inferred from individual ratings (e.g., of White male and Black male faces; Xie et al., 2021). A key implication of this work is that both cultural learning (common to members of a society) and personal experiences (unique to each perceiver) shape the conceptual "templates" that perceivers rely upon to form and organize trait impressions. Critically, this also demonstrates that social categorical information about targets (e.g., race, gender) contextualize—and constrain—the impression formation process, such that merely categorizing a face into a social group provides context for impressions.

A consequence of this is that perceivers within a culture likely have more opportunities to learn shared cultural stereotypes about social categories, and may generate more similar face-trait spaces, compared to perceivers across different cultures. This question naturally follows the findings from Chapter 3 but has yet to be empirically tested. Thus, Chapter 4 extends this work by testing whether perceivers from the same country—who have more opportunities to acquire shared cultural stereotypes—have more similar face-trait spaces when evaluating targets belonging to different social categories, compared to perceivers from another country. Stereotypical associations about social categories are shaped by cultural products (e.g., societal stereotypes, knowledge of societal inequalities) and may vary across countries. In Chapter 4, this aspect of the cultural context is operationalized using national indices of gender inequality, as a "ground truth" alternative to gender stereotypes across nations. Thus, two goals of the next chapter are to: (1) examine the extent to which racial and gender differences in the face-trait space vary across countries, and (2) identify whether gender differences in the face-trait space across countries map onto a national index of gender inequality.

Chapter 4 fits within the broader aims of this dissertation by examining how the cultural context in different countries impacts impressions of targets belonging to different social groups. By representing the structure of facial impressions across countries, which as a level of analysis allows for comparisons across different cultures, Chapter 4 builds on the findings from Chapter 3: Specifically testing whether facial impressions made within a culture overlap with cultural contexts, such as gender-related outcomes, that might produce stereotypical associations that are more likely to be shared by members of a culture.

Xie, S. Y. & Hehman, E. (in prep). Cultural perceptions of faces reveal consistent racial and gender associations across countries.

Abstract

Different cultures give rise to different psychological contexts that may influence facial first impressions. Because of cultural learning, perceivers' conceptual representations of faces may become associated with certain traits due to correlated face-trait experiences. For example, to the extent that facial features associated with 'caring' are also associated with 'strong' in a particular culture, these associations may serve as templates to guide how people form impressions of different faces. Since cultural experiences vary across countries, we examine how the face-trait space shifts (i.e., becoming more versus less 'intercorrelated') across various countries, using large-scale, international data collected by the Psychological Science Accelerator. In Analysis 1, we found that these shifts are systematically explained by targets' race and gender. In Analysis 2, gender differences in the face-trait space mapped onto a "ground-truth" measure of cultural context (i.e., national index of gender inequality) only for Latine targets. Overall, results reveal that facial impressions along racial and gender identities vary—but in a consistent manner across cultures.

Keywords: face perception, culture, cross-cultural differences, within-culture differences, individual differences, intergroup dynamics, social cognition, open data, preregistered

Introduction

Cultural products (e.g., knowledge, stereotypes, experiences) provide context for the inferences we draw about one another (Choi et al., 1999; Keating et al., 1981; Over & Cook, 2018; Sczesny et al., 2004; Sutherland et al., 2018; Varnum et al., 2010). Through exposure to cultural products, people learn culturally shared associations about social categories (e.g., "women are nurturing"; Eckes, 2002; Fiske et al., 2002), and may rely upon these associations as a "template" when inferring the characteristics of strangers who belong to these categories (Over & Cook, 2018; Stolier et al., 2020; Xie et al., 2021). Modern models of social cognition contend that simply categorizing a stranger into a social category (e.g., Asian woman) activates categorical stereotypes about that group (Kawakami et al., 2017; Kunda & Thagard, 1996). These social-categorical stereotypes dynamically interact with perceptual cues that can be observed in the target (e.g., facial morphology, hairstyle, skin colouration) to influence how perceivers form impressions of that individual (Freeman et al., 2020; Stolier, Hehman, Keller, et al., 2018).

Cultural Learning in Facial First Impressions

Children and adults spontaneously infer a rich variety of characteristics from others' facial appearance. These facial first impressions include inferences about competence (Olivola & Todorov, 2010a), aggression (Carré et al., 2010), morality (G. P. Goodwin et al., 2014), reproductive health (Rhodes, 2006), and status (Bjornsdottir & Rule, 2017). Although these inferences bear little relation to the ground truth (for review, see Jaeger et al., 2020; Todorov et al., 2015), they nonetheless exert powerful influences on behaviour, predicting who people vote into office (Ballew & Todorov, 2007; Hehman, Carpinella, et al., 2014), hire during an

interview, and sentence in a courtroom (Blair et al., 2004; Wilson & Rule, 2015). Given these downstream consequences, it is vital to understand how humans form first impressions.

Connectionist models, which integrate decades of social cognition and person perception research, model person perception as a dynamic process (Freeman et al., 2020; Freeman & Ambady, 2011; Kawakami et al., 2017; Van Overwalle & Labiouse, 2004). Specifically, "top-down" social-cognitive factors (e.g., social-categorical knowledge) interact with "bottom-up" perceptual cues (e.g., facial morphology, skin colouration) to produce an impression. Recent research has found empirical support for these models: learned stereotypical associations about social categories (e.g., race, gender) shift the structural relations among trait impressions inferred from faces (Oh et al., 2019; Xie et al., 2021), in a manner consistent with both "shared" societal stereotypes and "idiosyncratic" associations unique to different perceivers (Xie et al., 2019, 2021).

An important implication of this research is that the same social learning mechanisms can produce both shared and idiosyncratic stereotype associations. That is, cultural associations common to people within a society and personal experiences unique to each individual may jointly shape the lay theories and conceptual representations that perceivers rely upon to form and organize impressions (Eggleston et al., 2021; Over & Cook, 2018; Stolier, Hehman, Keller, et al., 2018; Varnum et al., 2010; Xie et al., 2021). On the one hand, idiosyncratic associations acquired from one's direct social interactions with others may produce individual variation in the face-trait space. On the other hand, the same learning process may also give rise to a shared social reality (Sutherland et al., 2019; Xie et al., 2019), producing consistency in the face-trait space within a culture—to the extent that people within a culture have similar experiences. Exposure to cultural products, such as media depictions of heroes, villains, and morally

ambiguous characters (Daalmans et al., 2017; Gill & Gill, 2007), may produce similar face-trait spaces for individuals living within a society.

To date, no research directly tests how cultural context shifts mappings in the face-trait space, despite a long research tradition of examining cross-cultural consensus in facial impressions (Albright et al., 1997; Keating et al., 1981; McArthur & Berry, 1987; Rule et al., 2010; Sczesny et al., 2004; Sutherland et al., 2018). Recent large-scale, international collaborations have produced large datasets of faces rated by perceivers living in different countries (Jones et al., 2021). This descriptive research finds that the structure of facial impressions varies across world regions (Jones et al., 2021; Sutherland et al., 2018), allowing for the possibility that different cultural contexts produce shared associations that drive these structural changes.

The Present Research

The present work leverages large-scale, international datasets of face ratings to examine whether the structure of trait impressions inferred from faces (i.e., *face-trait space*) varies across countries (replicating previous work; Jones et al., 2021; Sutherland et al., 2018), in a differential manner for targets belonging to different racial and gender categories (Hypothesis 1). We then test whether these differences in the face-trait space are predicted by features of the cultural context, in line with the theory that shared stereotypical associations within a culture are more similar than across cultures (Hypothesis 2). We specifically focus on the cultural context of gender representations, for both theoretical and methodological reasons: gender identity is perceptually salient in faces (Hehman, Carpinella, et al., 2014; Oh et al., 2019; Sutherland et al., 2015), cognitive representations (C. L. Martin et al., 2002; C. L. Martin & Ruble, 2004), and cultural products (Gill & Gill, 2007; Sczesny et al., 2004). Some researchers have even argued

that human cognition is fundamentally gendered, such that gender is the primary lens through which we view the social world (A. E. Martin & Slepian, 2021).

To the extent that gender representations are specific to a culture, we would expect gender differences in the face-trait space to map onto cultural norms, knowledge, and associations about gender. For example, gender norms and stereotypes may reinforce associations between gender and traits (e.g., associating femininity with warmth or masculinity with competence; Cuddy et al., 2009; Kimmel, 2000; Sczesny et al., 2004, 2006). These associations may serve as templates, guiding subsequent trait impressions of men and women (Oh et al., 2019; Sutherland et al., 2015). Thus, perceivers in this culture may judge women and men differently, and in a stereotype-constrained manner (Oh et al., 2019; Sutherland et al., 2015). In other words, the gender of the target contextualizes (and constrains) the impression formation process. This view is consistent with recent work showing that the face-trait space is more "intercorrelated" for women than for men, indicating that trait impressions for women are more strongly linked on average (Oh et al., 2019; Sutherland et al., 2019; Xie et al., 2021)—particularly when perceivers more strongly endorse gender stereotypes.

Since cultural experiences vary across nations, humans in different countries may learn, and come to rely upon, different mappings between traits and facial features that vary by gender—leading to country-level differences in the mappings between 'face space' and 'trait space' for men and women. The present study tests this hypothesis, examining to what extent gender-related outcomes (e.g., educational attainment, income inequality) in different cultures influence the way that people in those cultures form impressions of women and men. Here, gender-related outcomes were selected as a "ground-truth" alternative to gender stereotypes because of their direct impact on people's experiences. However, it is important to note that

racial and gender categories are not independent in social perceptions (i.e., race is gendered; Johnson et al., 2012). Thus, we additionally conduct analyses with target race to ensure any gender effects are not constrained to specific racial groups.

We adopt the statistical approach used in past research on face-trait representations (Stolier et al., 2020; Stolier, Hehman, Keller, et al., 2018; Xie et al., 2021), testing whether trait-pair correlations in the facial trait space vary across racial and gender categories, and whether any gender differences are moderated by a national index of gender-related outcomes. Although this index is by no means comprehensive, it is a starting point to conduct research that systematically examines the effect of cultural contexts on the way that people perceive one another. This research aims to contribute an appropriately powered descriptive analysis to that end.

Preregistered Hypotheses

We expect trait-pair correlations in countries' face-trait space to vary across targets' race and gender (Hypothesis 1), replicating previous findings cross-culturally (Oh et al., 2019; Xie et al., 2021). We also expect gender differences in the face-trait space to be moderated by a national index of gender inequality (significant interaction; Analysis 2). This would indicate a significant increase in the strength of trait-pair correlations from facial impressions between male and female targets as the country's gender inequality index increases by 1 unit.

The first null hypothesis is that there is no significant main effect of target gender on the average trait-pair correlation of the face-trait space. The second null hypothesis is that there is no significant interaction between target gender and national indices of gender inequality on the strength of trait-pair correlations in the face-trait space.

Methods

Trait Ratings

Trait ratings were sourced from a large dataset collected by the *Psychological Science Accelerator* (Chartier et al., 2018), a globally distributed lab network that collects international, multi-lab datasets. Data were collected for a multi-lab project to test models of face perception across world regions (Jones et al., 2021). The total dataset contains ratings from over 11,000 participants across 11 world regions, 48 countries, and 28 languages. Each participant rated 120 faces (of which an equal proportion were White, Black, and East Asian women and men) twice on one of 13 traits (Jones et al., 2018). See Supplementary Table 1 for the list of countries.

Data were obtained by participating in the PSA001 Secondary Analysis Challenge, during which we submitted preregistered analysis plans and R code [osf.io/3tz7x] using an exploratory segment of the dataset released by the PSA. The preregistration was approved for computational reproducibility, and confirmatory analyses were released several months after. We created a separate preregistration for analyses testing Hypothesis 2 [osf.io/g96vh] after we had already accessed both exploratory and confirmatory segments of the data, because this hypothesis was developed after the preregistration challenge had concluded.

Index of Gender Inequality

For the countries represented in the PSA dataset, a gender-related index (at the national level) was used to operationalize gendered cultural context. Specifically, this index has a value for each country, and these values were used in analyses.

We selected the gender inequality index from the United Nation's Human Development Programme.[1] This statistic is a composite measure with three dimensions: reproducible health,

[1] United Nations Human Development Reports, 2020, http://hdr.undp.org/en/content/human-development-index-hdi.

empowerment, and labour participation. For the countries in the PSA, gender inequality data were downloaded from 2019 to match the approximate year of data collection for the PSA study. If the index does not have data for a particular country, that country was omitted from analyses.

Analytic Approach

The face-trait space refers to the correlations between many of the trait impressions that people infer from faces. Here, we investigate whether this trait space becomes more tightly constrained (i.e., strongly intercorrelated on average) in some countries versus others as a function of targets' gender and race.

In a preliminary analysis, we first created eight 13 × 13 correlation matrices (13 traits) for each gender × race category, and restructured it by removing repeated trait-pairs, in a process identical to past research (Stolier, Hehman, & Freeman, 2018; Stolier, Hehman, Keller, et al., 2018; Xie et al., 2021). In the construction of each correlation matrix, we aggregated across perceivers' ratings of that particular gender × race category for targets across countries, functionally averaging across variation across perceivers and countries. In a preregistered preliminary analysis, we conducted a two-way repeated measures ANOVA, in a 2 (Target Gender: Female, Male) × 4 (Target Race: White, Black, East Asian, Latine) design in which the unit of analysis was the trait-pair correlation between any pair of traits (Fisher-*z* transformed). A main effect of Target Gender or Target Race would indicate that, averaging across countries, trait-pair correlations differ for ratings of female and male targets (or targets belonging to different racial categories). A significant Gender × Race interaction would indicate that trait-pair correlations from facial impressions differ as a function of both social categories.

For the main analysis, we additionally modelled random variability in these effects across countries, to account for country-level differences. Country-level variation contributed an

estimated ~13.6% of variance to the face-trait space (see Supplementary Analysis 1). For each country in the dataset, we constructed 13 × 13 correlation matrices for each gender × race category, aggregating across targets and perceivers. This allowed us to estimate a face-trait space for each country and gender × race group.

We then built multilevel models in which the level-1 unit of analysis was the correlation between any pair of traits, cross-classified within countries and trait-pairs. In this model, Target Gender was entered as a dummy-coded level-1 categorical predictor (0 = Male, 1 = Female), and the national index of gender inequality was entered as a level-2 continuous predictor. We additionally estimated random slopes for Target Gender, within countries and trait-pairs. See Equation 2. We built one large model testing effects averaged across target race, then built separate models for ratings of each race to examine simple effects of gender × race.

$$\begin{aligned} &\text{Level 1: } Y_{ijk} = \beta_{0jk} + \beta_{1jk} Female_{ijk} + R_{ijk} \\ &\text{Level 2: } \beta_{0jk} = \gamma_{000} + \gamma_{010} GenderIndex_k + U_{0j0} + U_{00k} \\ &\qquad\quad \beta_{1jk} = \gamma_{100} + \gamma_{110} GenderIndex_k + U_{1j0} + U_{10k} \end{aligned} \tag{2}$$

In this model, γ_{000} is the average trait-pair correlation in the face-trait space for ratings of male targets, nested within countries and trait-pairs. The random variation of country *j* across all trait-pairs (U_{0j0}) and the random variation of trait-pair *k* across all countries (U_{00k}) around this average trait-pair correlation were estimated for male targets. The fixed effect of gender, γ_{100}, is the average increase in the intercorrelation of the face-trait space from male to female targets. We hypothesized that this fixed effect of gender would be significant. Around this average gender difference, the random variation of country *j* across all trait-pairs (U_{1j0}) and trait-pair *k* across all countries (U_{10k}) were estimated.

The fixed effect of the national index of gender inequality, γ_{010}, represents the expected increase in the intercorrelation of the face-trait space (for male targets) as the country's index of

gender inequality increases by 1 unit. To test Hypothesis 2, the parameter γ_{110} represents the cross-level interaction between target gender and national gender inequality on the structure of the face-trait space. We expected this fixed effect to be significant, representing a significant increase in intercorrelations within the face-trait space *from male to female targets* as the country's gender inequality increases by 1.

Significant findings would suggest that cultural context, operationalized as gender-related outcomes, predict gender differences in how trait impressions are organized and inferred from faces. We conducted additional robustness checks to examine whether these patterns differ across target race, given the inextricable nature of racial and gender categorization. See [osf.io/3tz7x] for example R code.

Results

Preliminary Analysis

A two-way repeated measures ANOVA was conducted on 8 different trait matrices, in a 2 (Target Gender: Female, Male) × 4 (Target Race: White, Black, East Asian, Latine) design. See Figure 1. Because this analysis was conducted as part of the PSA Secondary Data Analysis challenge, results are presented separately for exploratory and confirmatory analyses.

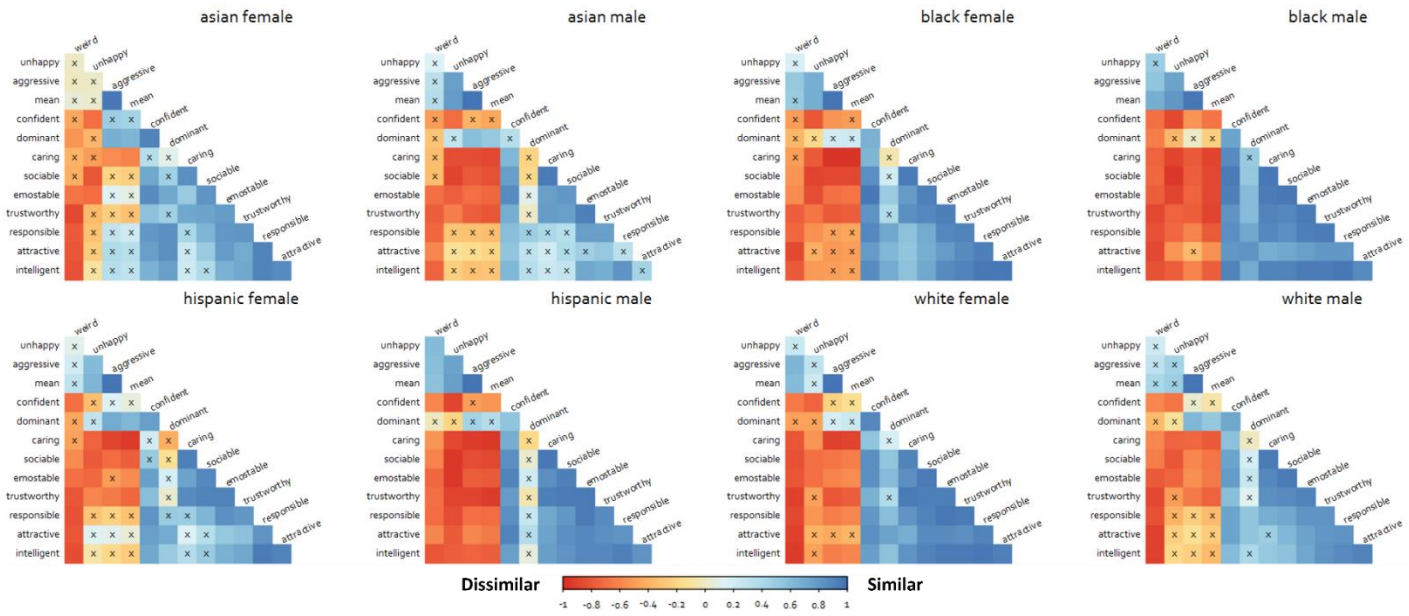

Figure 1. Pearson correlation matrices for trait impressions of faces across target race and gender (full dataset). "X" denotes a non-significant relationship at $\alpha = .0$. Matrices are sorted using hierarchical clustering order based on the "White Male" matrix.

Exploratory Results

Results from the exploratory phase of analysis indicated that the intercorrelations between trait-pairs were *not* equal across targets' race and gender. There was a main effect of gender, $F(1,77) = 7.24$, $p = .009$ but no significant main effect of race, $F(1.95, 149.98) = 1.84$, $p = .163$, qualified by a significant gender × race interaction, $F(2.52, 194.09) = 4.10$, $p = .011$.

Confirmatory Results

These findings replicated in the full dataset. There was a main effect of gender, $F(1,77) = 7.93$, $p = .006$, but no main effect of race, $F(1.94, 149.06) = 1.56$, $p = .215$, qualified by a significant gender × race interaction, $F(2.37, 182.22) = 4.14$, $p = .013$. Results indicated that, on average, the associations between different pairs of trait ratings (e.g., competent, attractive) differed across targets' gender and race.

Main Analysis

Hypothesis 1

Replicating the preliminary analysis using a model that accounts for country-level differences, results indicated that the face-trait space across countries differed, on average, for men and women. Contrary to expectations, however, the face-trait space was slightly more intercorrelated (i.e., constrained) for men than for women (γ_{100} = .021, 95% CI [.001, .040], p = .036). Because we identified a significant gender × race interaction in the preliminary analysis, and because previous work found a gender effect in the reverse direction, we probed this further by examining this gender difference for each racial category.

Partitioning the dataset into White, Black, East Asian, and Latine targets revealed differential effects of gender on the face-trait space. For White targets, gender shifted the face-trait space in the direction we expected, becoming more constrained and intercorrelated in women (γ_{100_White} = -.079, 95% CI [-.106, -.051], p < .001). For Black targets, however, this relationship reversed: the face-trait space became more constrained and intercorrelated in men (γ_{100_Black} = .070, 95% CI [.038, .103], p < .001). For East Asian targets, the effect became non-significant: the face-trait space did not differ, on average, between women and men (γ_{100_Asian} = -.021, 95% CI [-.052, .010], p = .178). Finally, for Latine targets, the effect was similar to Black targets but larger (γ_{100_Latine} = .113, 95% CI [.075, .150], p < .001). Together, these analyses reveal that gender shapes the face-trait space differently across racial targets. See Supplementary Materials for exploratory analyses probing these nuanced interactions.

Hypothesis 2

Next, we examined whether gender differences in each country's face-trait space was moderated by a national index of gender inequality. In the main analysis (averaging across target race), we found tentative evidence for a significant cross-level interaction between target gender,

and gender inequality index, on the structure of facial impressions for each country (γ_{110} = -.070, 95% CI [-.128, -.013], p = .019). This effect was negative, indicating that as national gender inequality increased by 1 unit, the face-trait space become *more intercorrelated* (i.e., constrained) for women than for men. In other words, the structure of facial impressions becomes more tightly interrelated when perceivers from less egalitarian countries evaluate women (versus men).

To test whether this pattern was specific to certain racial groups, we conducted a three-way mixed anova. The three-way cross-level interaction between target gender, target race, and national gender inequality index was significant, $F(3,23755.2) = 6.73$, $p < .001$. This indicated that the effect of national gender inequality on gender differences in the face-trait space was moderated by race. We therefore conducted simple effects analyses to examine this pattern for each racial category, again partitioning the data into White, Black, East Asian, and Latine targets. For evaluations of White targets, the cross-level interaction between target gender and gender inequality index was non-significant (γ_{110_White} = -.069, 95% CI [-.154, .016], p = .109). For Black targets, this interaction was non-significant (γ_{110_Black} = -.061, 95% CI [-.179, .057], p = .307). For East Asian targets, this interaction was also non-significant (γ_{110_Asian} = -.002, 95% CI [-.087, .082], p = .96). Only for Latine targets was this interaction significant (γ_{110_Latine} = -.149, 95% CI [-.263, -.036], p = .012), suggesting that the effect observed in the "race-blind" analysis was driven primarily by evaluations of Latino and Latina faces.

General Discussion

Analysis of ~1.4 million trait ratings suggests that the structure of trait impressions inferred from faces (i.e., face-trait space) varies across countries, but nonetheless shifts in systematic ways across racial and gender categories. Cross-culturally replicating the results from

previous research (Xie et al., 2021), our findings indicate that targets' racial and gender identity provides context during impression formation, shaping the conceptual relations between trait impressions (e.g., how "attractiveness" correlates with "competence") in a manner that is consistent for perceivers across different cultures. However, there was mixed evidence that gendered shifts in the face-trait space in each country could be linked to a national index of gender inequality, which captures gender-related outcomes (e.g., educational attainment, income inequality) in different countries. Thus, although we found consistent gender × race differences in the face-trait spaces of 41 countries, our operationalization of gender-related cultural context did not consistently explain these differences across all racial groups. The face-trait space of women and men differ in a similar way across countries—and, for Latina women and Latino men only, differ as a function of countries' gender inequality.

Nuanced interactions between targets' race and gender are important for interpreting these results. Previous research recruiting North American participants found that the face-trait space is more strongly interrelated for women than for men (Oh et al., 2019; Xie et al., 2021), suggesting that impressions of women are more tightly constrained or "homogeneous" (Oh et al., 2019; Xie et al., 2021). Although we replicated this main effect of target gender using a cross-cultural dataset, we observed differences in the direction of gendered differences in the face-trait space, as a function of target race. That is, for perceivers across multiple countries, trait impressions of White faces were more strongly interrelated for women than for men, consistent with previous work. However, this effect reversed for Black and Latine faces (i.e., the face-trait space became more interrelated for men than for women), and disappeared for East Asian faces (i.e., no differences between men and women).

To shed light on these gender × race interactions, we considered several explanations as to why the structure of facial impressions might become more constrained for White women (versus White men), but less constrained for Black/Latine women (versus Black/Latin men)—and undifferentiated for East Asian women and men. First, we compared face-trait representations in North America with other world regions. We did not find a significant difference, ruling out the possibility that gender representations in North America manifest differently compared to other world regions. Another possibility was that the specific trait-pairs collected in this dataset differed from those in previous research, which impacted how the face-trait space shifts across gender. We descriptively examined how specific trait-pair correlations differ across groups, to identify which trait-pairs were driving these effects.[2] Several specific traits were largely responsible for the gender × race differences we observed. For example, the correlation between sociable and intelligent was much higher for White women than White men, but much lower for Black women than Black men (and Latina women than Latino men). One possibility is that stereotypes of White women are more constrained than stereotypes of White men, but stereotypes of Black and Latino men are more constrained than stereotypes of Black and Latina women—partly due to these groups' representations in international media (Cuddy et al., 2009; Hester & Gray, 2018b; Xie et al., 2021). As we did not test this hypothesis directly, future research is needed to confirm this speculation.

An alternative explanation, consistent with contemporary theories of intersectional stereotyping, is that perceivers attend to just *one* particularly salient social identity (or one salient

[2] The trait-pair correlations with the biggest gender differences (averaging across race and country) were between: sociable & intelligent, responsible & attractive, intelligent & caring, intelligent & trustworthy.

The trait-pair correlations with the smallest gender differences (averaging across race and country) were between: trustworthiness & dominant, confident & aggressive, weird & confident, mean & confident.

intersectional identity) when evaluating members who belong to multiple social categories (Ghavami & Peplau, 2013; Petsko et al., 2022; Petsko & Bodenhausen, 2020; Purdie-Vaughns & Eibach, 2008). According to this view, perceivers may attend to whichever identity (or intersectional identity) they find more diagnostic at the moment of evaluation, as a function of the social context (Petsko & Bodenhausen, 2020; Purdie-Vaughns & Eibach, 2008). For example, when evaluating White targets, gender may be more salient than race because "Whiteness" is relatively neutral (Frankenberg et al., 1997), and because White women are a salient intersectional identity (Frankenburg, 1993). Alternatively, when evaluating Black and Latine targets, race may be more salient than gender because perceivers attend to specific perceptual cues (e.g., skin tone), and have stronger stereotypical associations related to skin tone (Norwood, 2014). For example, people across the world exhibit some degree of skin tone bias (Hunter, 2007; Norwood, 2014; Uzogara et al., 2014; Uzogara & Jackson, 2016). Participants may also hold stronger stereotypes about Black and Latine men because of androcentric bias. For instance, previous research as found that stereotypes of ethnic groups were more similar to stereotypes of the men than of the women in those groups (Ghavami & Peplau, 2013). Taken together, the gender × race interactions observed in the present research are consistent with current accounts of intersectional stereotyping in social perception.

Another key finding of this work was that gender differences in the face-trait space of each country were predicted by a national index of gender inequality. However, this effect was small. When we additionally partitioned the dataset into different target racial groups (White, Black, East Asian, Latine), we found that this effect was significant only for trait impressions of Latine faces. Because the WHO index of gender inequality is "race-blind" in that it provides a

composite score of gender inequality without considering interactions with race, it is possible that it obscured inequalities at the intersection of gender and race.

The data in the present work are cross-sectional, which limits causal inference. Yet drawing from theory, we speculate that cross-culturally, stereotypes specific to racial and gender groups are shifting social impressions drawn from faces. Although our findings converge with recent literature that finds the face-trait space to vary across group boundaries, such as gender (Oh et al., 2019; Sutherland et al., 2015; Xie et al., 2021), nationality (Jones et al., 2021; Sutherland et al., 2018), age (Oldmeadow et al., 2013), and race (Wilson, Remedios, et al., 2017; Xie et al., 2021)—we do observe some more nuanced differences at the intersection of gender and race that are consistent across different countries. This suggests that future work investigating the representation of first impressions ought to take these intersecting identities into account. Further, we provide tentative evidence to support the emerging perspective that social learning—for instance, of lay beliefs common to a culture—shape the structure of the face-trait space during impression formation (Freeman et al., 2020; Over & Cook, 2018; Stolier, Hehman, Keller, et al., 2018). Under this framework, trait impressions from faces arise from similar mappings between morphological features in 'face space' and conceptual relations in mental 'trait space', arising from learned experiences.

The gender × race interactions we observed are relatively consistent across cultures. An interesting implication of this is that across different cultures, stereotypical associations may have some degree of consensus, possibly due to the digitization of mass media and its effects on cross-cultural communication (Lifintsev & Wellbrock, 2019; Lyons & Kashima, 2001). Before the internet, there may have been far greater variability in the structure of facial impressions—at least cross-culturally—than we observe in this contemporary dataset. However, we caution

against over-interpreting this finding. The data, while cross-cultural, were sourced from undergraduate students, and might not be representative of the broader population of individuals within each culture.

The cultural context can be regarded as a system of meaning that dynamically shapes, and is shaped by, the social activities of individuals. To the extent that people rely on stereotypical associations for social perception, cultural differences in these stereotypes should shift people's first impressions in a manner consistent with these cultural differences. Here, our operationalization of the cultural context was limited to a single, widely used index of countries' gender inequality, which does not comprehensively capture cultural differences in how women and men are perceived and represented. Further, the index of national gender inequality that we used does not take race into consideration, despite the evidence that race and gender interact to shape social impressions. Future work that examines cross-cultural differences in first impressions should carefully consider the intersection

Conclusion

The present work investigates how the structure of facial first impressions shifts across cultures, as a function of the target's race and gender and each country's national index of gender inequality. Although the face-trait space varies across cultures to some extent, we found systematic racial and gender differences in this space that were consistent across the countries included in a large, international dataset. Across countries, the face-trait space was more interrelated (i.e., tightly constrained) for White women than for White men, more interrelated for Black and Latino men than for Black and Latina women, and similar for East Asian women and men. These gender differences in the face-trait space mapped onto a "ground truth" measure of cultural context (i.e., national index of gender inequality) only for evaluations of Latine targets.

Overall, results reveal that facial impressions along racial and gender identities vary—but in a consistent manner across cultures.

Supplementary Materials

Supplementary Table 1

List of countries from the Psychological Science Accelerator (PSA) Study 001 Dataset

country	region	country	region
ARG	South America	NED	Western Europe
AUS	Australia & New Zealand	NGA	Africa
AUT	Western Europe	NOR	Scandinavia
BEL	Western Europe	NZL	Australia & New Zealand
BRA	South America	PER	South America
CAN	USA & Canada	POL	Eastern Europe
CHI	South America	POR	Western Europe
CHN	Asia	PSA	USA & Canada
COL	South America	ROU	Eastern Europe
DNK	Scandinavia	RSA	Africa
ECU	Central America & Mexico	RUS	Eastern Europe
ESA	Central America & Mexico	SRB	Eastern Europe
ESP	Western Europe	SUI	Western Europe
FIN	Scandinavia	SVK	Eastern Europe
FRA	Western Europe	SWE	Scandinavia
GER	Western Europe	TAI	Asia
GRE	Western Europe	THA	Asia
HUN	Eastern Europe	TUK	Middle East
IND	Asia	TUR	Middle East
IRI	Middle East	UAE	Middle East
ITA	Western Europe	UK	UK
KEN	Africa	USA	USA & Canada
MAS	Asia	SLV	Central America & Mexico
MEX	Central America & Mexico		

Supplementary Analysis 1

Probing race and gender interaction effects.

Analyses restricted to North American participants found a small but significant main effect of Target Gender, $F(1,155) = 11.70$, $p < .001$, $\eta_p^2 = .07$, a large significant main effect of Target Race $F(3, 436.88) = 132.48$, $p < .001$, $\eta_p^2 = .46$, qualified by a moderate and significant Gender × Race interaction, $F(3, 442.05) = 64.07$, $p < .001$, $\eta_p^2 = .29$.

Analyses restricted to participants outside of North America found a miniscule but significant main effect of Target Gender, $F(1,3197) = 12.03$, $p < .001$, $\eta_p^2 = .003$, a moderate significant main effect of Target Race $F(3, 9429.01) = 1171.516$, $p < .001$, $\eta_p^2 = .27$, qualified by a small and significant Gender × Race interaction, $F(3, 9480.80) = 663.72$, $p < .001$, $\eta_p^2 = .13$.

Supplementary Table 2

Gender differences in trait-pair correlations (absolute values) in descending order, averaging across target race and country

Trait-pair	Avg Gender Δ	Trait-pair	Avg Gender Δ
sociable~~intelligent	0.417033	mean~~emostable	0.303164
responsible~~attractive	0.407197	unhappy~~aggressive	0.302784
intelligent~~caring	0.403543	weird~~aggressive	0.30099
trustworthy~~intelligent	0.38497	emostable~~confident	0.300854
intelligent~~attractive	0.37866	unhappy~~mean	0.300654
sociable~~attractive	0.378291	unhappy~~emostable	0.300209
dominant~~confident	0.375828	emostable~~aggressive	0.297824
unhappy~~confident	0.373295	sociable~~emostable	0.297195
dominant~~attractive	0.372252	weird~~responsible	0.296509
intelligent~~emostable	0.359158	weird~~caring	0.295436
responsible~~intelligent	0.344658	trustworthy~~emostable	0.292832
trustworthy~~caring	0.341921	responsible~~dominant	0.291114
responsible~~caring	0.340553	responsible~~aggressive	0.290965
intelligent~~aggressive	0.338486	responsible~~mean	0.289797
emostable~~attractive	0.33745	responsible~~confident	0.28958
unhappy~~intelligent	0.333837	weird~~trustworthy	0.289355
weird~~attractive	0.333587	dominant~~aggressive	0.287824
sociable~~confident	0.332329	unhappy~~trustworthy	0.286329
caring~~attractive	0.332256	intelligent~~dominant	0.285822
trustworthy~~attractive	0.330397	weird~~intelligent	0.285294
caring~~aggressive	0.33008	mean~~attractive	0.281645
sociable~~responsible	0.330018	intelligent~~confident	0.281526
trustworthy~~aggressive	0.32717	sociable~~dominant	0.265493
responsible~~emostable	0.324317	weird~~emostable	0.265406
trustworthy~~mean	0.323051	trustworthy~~confident	0.263814
sociable~~caring	0.320914	weird~~sociable	0.263444
confident~~caring	0.319848	mean~~aggressive	0.263133
emostable~~caring	0.317162	attractive~~aggressive	0.261988
mean~~caring	0.315208	mean~~dominant	0.258526
trustworthy~~responsible	0.315207	weird~~dominant	0.25753
confident~~attractive	0.314614	emostable~~dominant	0.254914
mean~~intelligent	0.310662	weird~~mean	0.254309
sociable~~aggressive	0.309507	weird~~unhappy	0.252508
unhappy~~sociable	0.309369	unhappy~~dominant	0.246627
trustworthy~~sociable	0.307615	dominant~~caring	0.241613
unhappy~~responsible	0.305774	mean~~confident	0.235799
sociable~~mean	0.305488	weird~~confident	0.228241
unhappy~~attractive	0.304874	confident~~aggressive	0.212927
unhappy~~caring	0.304186	trustworthy~~dominant	0.195242

References

Albright, L., Malloy, T. E., Dong, Q., Kenny, D. A., Fang, X., Winquist, L., & Yu, D. (1997). Cross-cultural consensus in personality judgments. *Journal of Personality and Social Psychology*, *72*(3), 558.

Ballew, C. C., & Todorov, A. (2007). Predicting political elections from rapid and unreflective face judgments. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(46), 17948–17953. https://doi.org/10.1073/pnas.0705435104

Bjornsdottir, R. T., & Rule, N. O. (2017). The visibility of social class from facial cues. *Journal of Personality and Social Psychology*, *113*(4), 530.

Blair, I. V. Y., Judd, C. M., & Chapleau, K. M. (2004). The influence of Afrocentric facial features in criminal sentencing. *Psychological Science*, *15*(10), 674–679.

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

Chartier, C., McCarthy, R., & Urry, H. (2018). The psychological science accelerator. *APS Observer*, *31*(3).

Choi, I., Nisbett, R. E., & Norenzayan, A. (1999). Causal attribution across cultures: Variation and universality. *Psychological Bulletin*, *125*(1), 47.

Cuddy, A. J. C., Fiske, S. T., Kwan, V. S. Y., Glick, P., Demoulin, S., Leyens, J.-P., Bond, M. H., Croizet, J.-C., Ellemers, N., Sleebos, E., Htun, T. T., Kim, H.-J., Maio, G., Perry, J., Petkova, K., Todorov, V., Rodríguez-Bailón, R., Morales, E., Moya, M., … Ziegler, R. (2009). Stereotype content model across cultures: Towards universal similarities and some differences. *British Journal of Social Psychology*, *48*(1), 1–33. https://doi.org/10.1348/014466608X314935

Daalmans, S., Hijmans, E., & Wester, F. (2017). From good to bad and everything in between: An analysis of genre differences in the representation of moral nature. *Journal of Media Ethics*, *32*(1), 28–44.

Eckes, T. (2002). Paternalistic and envious gender stereotypes: Testing predictions from the stereotype content model. *Sex Roles*, *47*(3), 99–114.

Eggleston, A., Flavell, J. C., Tipper, S. P., Cook, R., & Over, H. (2021). Culturally learned first impressions occur rapidly and automatically and emerge early in development. *Developmental Science*, *24*(2), e13021.

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

Frankenberg, R., Aanerud, R., Muraleedharan, T., Chabram-Dernersesian, A., & others. (1997). *Displacing whiteness: Essays in social and cultural criticism*. Duke University Press.

Frankenburg, R. (1993). *White women, race matters: The social construction of whiteness*. Routledge.

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

Freeman, J. B., Stolier, R. M., & Brooks, J. A. (2020). Dynamic interactive theory as a domain-general account of social perception. In *Advances in Experimental Social Psychology* (Vol. 61, pp. 237–287). Elsevier.

Ghavami, N., & Peplau, L. A. (2013). An intersectional analysis of gender and ethnic stereotypes: Testing three hypotheses. *Psychology of Women Quarterly*, *37*(1), 113–127.

Gill, R., & Gill, R. M. (2007). *Gender and the Media*. Polity.

Goodwin, G. P., Piazza, J., & Rozin, P. (2014). Moral character predominates in person perception and evaluation. *Journal of Personality and Social Psychology*, *106*(1), 148.

Hehman, E., Carpinella, C. M., Johnson, K. L., Leitner, J. B., & Freeman, J. B. (2014). Early Processing of Gendered Facial Cues Predicts the Electoral Success of Female Politicians. *Social Psychological and Personality Science*, *5*(7), 815–824. https://doi.org/10.1177/1948550614534701

Hester, N., & Gray, K. (2018). For Black men, being tall increases threat stereotyping and police stops. *Proceedings of the National Academy of Sciences*, *115*(11), 2711–2715. https://doi.org/10.1073/pnas.1714454115

Hunter, M. (2007). The persistent problem of colorism: Skin tone, status, and inequality. *Sociology Compass*, *1*(1), 237–254.

Jaeger, B., Sleegers, W., Stern, J., Penke, L., & Jones, A. L. (2020). *The accuracy and meta-accuracy of personality impressions from faces*.

Johnson, K. L., Freeman, J. B., & Pauker, K. (2012). Race is gendered: How covarying phenotypes and stereotypes bias sex categorization. *Journal of Personality and Social Psychology*, *102*(1), 116. https://doi.org/10.1037/a0025335

Jones, B. C., DeBruine, L. M., Flake, J. K., Aczel, B., Adamkovic, M., Alaei, R., Alper, S., Solas, S. Á., Andreychik, M. R., Ansari, D., Arnal, J. D., Babinčák, P., Balas, B., Baník, G., Krystian, Barzykowski, Baskin, E., Batres, C., Beaudry, J. L., … Chartier, C. R. (2018). Social perception of faces around the world: How well does the valence-dominance model generalize across world regions? (Registered Report Stage 1). *Nature Human Behaviour*, 1–36. https://doi.org/10.31234/osf.io/n26dy

Jones, B. C., DeBruine, L. M., Flake, J. K., Liuzza, M. T., Antfolk, J., Arinze, N. C., Ndukaihe, I. L. G., Bloxsom, N. G., Lewis, S. C., & Foroni, F. (2021). To which world regions does the valence–dominance model of social perception apply? *Nature Human Behaviour*, 1–9.

Kawakami, K., Amodio, D. M., & Hugenberg, K. (2017). Intergroup Perception and Cognition: An Integrative Framework for Understanding the Causes and Consequences of Social Categorization. In *Advances in Experimental Social Psychology* (1st ed., Vol. 55). Elsevier Inc. https://doi.org/10.1016/bs.aesp.2016.10.001

Keating, C. F., Mazur, A., & Segall, M. H. (1981). A cross-cultural exploration of physiognomic traits of dominance and happiness. *Ethology and Sociobiology*, *2*(1), 41–48.

Kimmel, M. S. (2000). *The gendered society*. Oxford University Press, USA.

Kunda, Z., & Thagard, P. (1996). Forming Impressions From Stereotypes, Traits, and Behaviors: A Parallel-Constraint-Satisfaction Theory. *Psychological Review*, *103*(2), 284–308.

Lifintsev, D., & Wellbrock, W. (2019). Cross-cultural communication in the digital age. *Estudos Em Comunicação*, *1*(28), 93–104.

Lyons, A., & Kashima, Y. (2001). The reproduction of culture: Communication processes tend to maintain cultural stereotypes. *Social Cognition*, *19*(3: Special issue), 372–394.

Martin, A. E., & Slepian, M. L. (2021). The primacy of gender: Gendered cognition underlies the Big Two dimensions of social cognition. *Perspectives on Psychological Science*, *16*(6), 1143–1158.

Martin, C. L., & Ruble, D. (2004). Children's search for gender cues: Cognitive perspectives on gender development. *Current Directions in Psychological Science*, *13*(2), 67–70.

Martin, C. L., Ruble, D. N., & Szkrybalo, J. (2002). Cognitive theories of early gender development. *Psychological Bulletin*, *128*(6), 903.

McArthur, L. Z., & Berry, D. S. (1987). Cross-cultural agreement in perceptions of babyfaced adults. *Journal of Cross-Cultural Psychology*, *18*(2), 165–192.

Norwood, K. J. E. (2014). *Color matters: Skin tone bias and the myth of a postracial America.* Routledge/Taylor & Francis Group.

Oh, D., Dotsch, R., Porter, J., & Todorov, A. (2019). Gender biases in impressions from faces: Empirical studies and computational models. *Journal of Experimental Psychology: General*.

Oldmeadow, J. A., Sutherland, C. A. M., & Young, A. W. (2013). Facial stereotype visualization through image averaging. *Social Psychological and Personality Science*, *4*(5), 615–623.

Olivola, C. Y., & Todorov, A. (2010). Elected in 100 milliseconds: Appearance-Based Trait Inferences and Voting. *Journal of Nonverbal Behavior*, *34*(2), 83–110. https://doi.org/10.1007/s10919-009-0082-1

Over, H., & Cook, R. (2018). Where do spontaneous first impressions of faces come from? *Cognition*, *170*, 190–200.

Petsko, C. D., & Bodenhausen, G. V. (2020). Multifarious person perception: How social perceivers manage the complexity of intersectional targets. *Social and Personality Psychology Compass*, *14*(2), e12518.

Petsko, C. D., Rosette, A. S., & Bodenhausen, G. V. (2022). Through the looking glass: A lens-based account of intersectional stereotyping. *Journal of Personality and Social Psychology*.

Purdie-Vaughns, V., & Eibach, R. P. (2008). Intersectional invisibility: The distinctive advantages and disadvantages of multiple subordinate-group identities. *Sex Roles*, *59*(5–6), 377–391. https://doi.org/10.1007/s11199-008-9424-4

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

Rule, N. O., Ambady, N., Adams Jr, R. B., Ozono, H., Nakashima, S., Yoshikawa, S., & Watabe, M. (2010). Polling the face: Prediction and consensus across cultures. *Journal of Personality and Social Psychology*, *98*(1), 1.

Sczesny, S., Bosak, J., Neff, D., & Schyns, B. (2004). Gender stereotypes and the attribution of leadership traits: A cross-cultural comparison. *Sex Roles*, *51*(11–12), 631–645.

Sczesny, S., Spreemann, S., & Stahlberg, D. (2006). Masculine = competent? Physical appearance and sex as sources of gender-stereotypic attributions. *Swiss Journal of Psychology*, *65*(1), 15–23. https://doi.org/10.1024/1421-0185.65.1.15

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., & Freeman, J. B. (2020). Trait knowledge forms a common structure across social cognition. *Nature Human Behaviour*, *4*(4), 361–371.

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 of the United States of America*, *115*(37), 9210–9215. 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*.

Sutherland, C. A. M., Rhodes, G., Burton, N. S., & Young, A. W. (2019). Do facial first impressions reflect a shared social reality? *British Journal of Psychology*, *0*(0). https://doi.org/10.1111/bjop.12390

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

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*(15), 1–27. https://doi.org/10.1146/annurev-psych-113011-143831

Uzogara, E. E., & Jackson, J. S. (2016). Perceived skin tone discrimination across contexts: African American women's reports. *Race and Social Problems*, *8*(2), 147–159.

Uzogara, E. E., Lee, H., Abdou, C. M., & Jackson, J. S. (2014). A comparison of skin tone discrimination among African American men: 1995 and 2003. *Psychology of Men & Masculinity*, *15*(2), 201.

Van Overwalle, F., & Labiouse, C. (2004). A recurrent connectionist model of person impression formation. *Personality and Social Psychology Review*, *8*(1), 28–61.

Varnum, M. E., Grossmann, I., Kitayama, S., & Nisbett, R. E. (2010). The origin of cultural differences in cognition: The social orientation hypothesis. *Current Directions in Psychological Science*, *19*(1), 9–13.

Wilson, J. P., Remedios, J. D., & Rule, N. O. (2017). Interactive effects of obvious and ambiguous social categories on perceptions of leadership: When double-minority status may be beneficial. *Personality and Social Psychology Bulletin*, *43*(6), 888–900.

Wilson, J. P., & Rule, N. O. (2015). Facial Trustworthiness Predicts Extreme Criminal-Sentencing Outcomes. *Psychological Science*, *26*(8), 1325–1331. https://doi.org/10.1177/0956797615590992

Xie, S. Y., Flake, J. K., & Hehman, E. (2019). Perceiver and target characteristics contribute to impression formation differently across race and gender. *Journal of Personality and Social Psychology*, *117*(2), 364.

Xie, S. Y., Flake, J. K., Stolier, R. M., Freeman, J. B., & Hehman, E. (2021). Facial impressions are predicted by the structure of group stereotypes. *Psychological Science*, *32*(12), 1979–1993. https://doi.org/10.1177/09567976211024259

CHAPTER 5

Everyday perceiver-context influences on impression formation: No evidence of consistent effects

(Xie, Thai, & Hehman, 2022, *Personality and Social Psychology Bulletin*)

Preface to Chapter 5

The study presented in Chapter 4 investigated the extent to which impressions of faces belonging to different racial and gender categories varied across countries (Hypothesis 1), as a function of the gendered cultural context in each country (operationalized as a national index of gender inequality; Hypothesis 2). First, replicating the findings from Chapter 3 with a large cross-cultural dataset, the structure of facial impressions (i.e., face-trait space) shifted across targets' race and gender. However, the direction of this shift was more nuanced than previously observed, and depended upon the intersection of the target's racial and gender identity. Specifically, the face-trait space became more intercorrelated or tightly constrained for White women compared to White men—consistent with previous work (Oh et al., 2019; Xie et al., 2021)—but this pattern reversed for Black and Latine targets, becoming more intercorrelated for Black and Latino men versus Black and Latina women, and disappeared for East Asian targets (i.e., no gender difference). Critically, although the relations among trait impressions inferred from faces vary to some extent across different countries (contributing ~13% of the variance in the face-trait space), there is cross-cultural consensus in how first impressions are formed across these racial and gender categories. Extending the theoretical explanation from Chapter 3—that targets' social identity contextualizes and constrains the impression formation process—Chapter 4 provides preliminary evidence that this occurs in a manner consistent with contemporary theories of intersectional stereotyping, such that *one* social category (i.e., either race or gender) may be especially salient, such that stereotypes associated with this category serve as a more influential "template" in facial first impressions.

The second analysis in Chapter 5 found that gender differences in the face-trait space of each country were significantly predicted by the country's cultural context, operationalized as

gender-related outcomes captured by a national index of gender inequality. As countries increased in gender inequality, the face-trait space became significantly more intercorrelated (i.e., tightly constrained) for women than for men. This indicates that for countries with greater gender inequality, trait inferences from women's faces are more strongly interrelated on average. However, examining this interaction effect at the level of target race revealed that it was significant only for impressions of Latina women versus Latino men, suggesting that gender differences in evaluations of Latine targets was primarily driving this effect. The nuanced interactions between gender and race observed in the previous analysis suggests that operationalizing cultural context using a "race-blind" measure of gender inequality may partially obscure the impact of cultural context on facial first impressions. Much like Chapter 3, this chapter demonstrates that learned associations shape the conceptual associations that perceivers rely upon to form impressions of targets.

The study in Chapter 4 demonstrates that the face-trait space shifts as a function of social category and cultural context. However, participants are undergraduate students (across the world) evaluating targets in the context of a social psychology experiment, which may be an important constraint on how findings can be interpreted. Critically, almost all existing research on impression formation comes from participants rating faces on a computer screen, in highly controlled environments. There are limits to what we can learn about person perception from research conducted in such environments. To address this gap, Chapter 5 explores how real-world contexts experienced by perceivers influence impression formation in daily life, using recent experience sampling methods (Thai & Page-Gould, 2018) to track daily changes in people's experienced contexts at the moment that they are forming impressions of faces. This

study collects a rich, longitudinal dataset to investigate how impression formation varies “in the wild” across a variety of real-world contexts experienced by perceivers.

This next study is the first of its kind and captures a range of perceiver-contexts that might be psychologically meaningful, encompassing intra-individual variability in moods, physiological states, local environmental factors, and psychological situations. Thus, the next chapter describes research that aims to quantify the impact of naturally varying, real-world contexts on impression formation, by incorporating a sufficiently diverse number of contexts without manually recruiting participants into specific contexts in the lab. This approach has the potential to reveal day-to-day (or even intra-day) intra-individual fluctuations in the impression formation process that have so far remained elusive in impression formation research. Chapter 5 therefore fits within the broader aims of this dissertation by examining how impression formation operates in more ecologically valid contexts, while taking within-perceiver variability into account.

Xie, S. Y., Thai, S., & Hehman, E. (in press). Everyday perceiver-context influences on impression formation: No evidence of consistent effects. ***Personality and Social Psychology Bulletin*****.**

Abstract

Facial impressions (e.g., trustworthy, intelligent) vary considerably across different perceivers and targets. However, nearly all existing research comes from participants evaluating faces on a computer screen in a lab or office environment. We explored whether social perceptions could additionally be influenced by perceivers' experiential factors that vary in daily life: mood, environment, physiological state, and psychological situations. To that end, we tracked daily changes in participants' experienced contexts during impression formation using experience sampling. We found limited evidence that perceivers' contexts are an important factor in impressions. Perceiver context alone does not systematically influence trait impressions in a consistent manner—suggesting that perceiver and target idiosyncrasies are the most powerful drivers of social impressions. Overall, results suggest that perceivers' experienced contexts may play only a small role in impressions formed from faces.

Keywords: person perception, impression formation, social cognition, attitudes

Introduction

People form impressions of one another at a glance, such as whether a person looks high-status or intelligent (Bjornsdottir & Rule, 2017; Zebrowitz et al., 2003). Regardless of accuracy, these impressions are pervasive and consequential, predicting election outcomes (Ballew & Todorov, 2007; Olivola & Todorov, 2010a), sentencing decisions (Blair et al., 2004; Wilson & Rule, 2015), and financial lending rates (Duarte et al., 2012) in the real world. Yet our understanding of the way that facial impressions are formed depend overwhelmingly on face ratings made by people situated in social psychology studies. In most of these studies, people rate faces while sitting in front of a computer, in a highly controlled laboratory environment. Whether impression formation differs when participants experience other contexts is unknown—even though this question is critical to how we should interpret such lab-based results. To what extent are facial impressions influenced by situational and contextual factors that participants experience in daily life? We adopted an experience-sampling paradigm (Thai & Page-Gould, 2018), collecting ratings from participants as they went about their day, to address this question.

Variability in Facial First Impressions

Social impressions from faces are jointly influenced by perceiver characteristics, target characteristics, and perceiver-by-target interactions (Hehman et al., 2018; Kenny, 2019; Kunda & Thagard, 1996). Among these components, the contributions of target characteristics (e.g., morphological cues, social identity) have been studied extensively in isolation, with hundreds of studies demonstrating how different targets elicit judgments of attractiveness, trustworthiness, among many other traits (Todorov et al., 2015). This literature is situated in ecological theories that highlight the functional significance of face perception, offering a partial explanation for the human tendency to readily overgeneralize facial cues (e.g., an upturned mouth) to stable trait

inferences (e.g., friendly; Zebrowitz et al., 2003). More recent work has also examined how targets in different contexts are perceived, by varying the visual context of target stimuli. For example, people integrate facial cues (e.g., untrustworthy face) and contextual cues (e.g., threatening or neutral scene) when evaluating the trustworthiness of a face (Brambilla et al., 2018; Mattavelli et al., 2021), and faces appear more attractive when they appear in a group (Carragher et al., 2021)

Yet perceivers also play an active role in impression formation, differing in their impressions of the same face. For instance, perceivers who vary in their social identity (Kawakami et al., 2017) or stereotype knowledge (Oh et al., 2019; Wilson, Hugenberg, et al., 2017) may evaluate the same target very differently. These perceiver contributions are central to modern theories of social cognition (Brewer, 1988; Macrae & Bodenhausen, 2000), and current perspectives conceptualize impression formation as a dynamic process, during which the bottom-up processing of facial features interacts with multiple top-down cognitive factors (Freeman et al., 2020). For example, people's intuitions about trait correlations (e.g., "how intelligent is someone who is attractive?") explain considerable variability in how facial impressions are formed (Stolier et al., 2020; Stolier, Hehman, Keller, et al., 2018), suggesting that conceptual knowledge unique to each perceiver shapes impression formation.

Recently, researchers have examined the relative importance of these components in face impressions (Hehman et al., 2017; Hönekopp, 2006; Judd et al., 2012; Xie et al., 2019). By using cross-classified multilevel models to estimate variance components from different clusters in the data, this research decomposes the total variance in face impressions to those uniquely attributable to perceivers, targets, or perceiver-by-target interactions (Hehman et al., 2017; Judd et al., 2012; Kenny, 2019; Xie et al., 2019). Results indicate perceiver idiosyncrasies contribute a

greater proportion (~20-25%) of variance than target characteristics (~10-15%), though perceiver-by-target interactions contribute the most overall (~32-39%; Hehman et al., 2017; Hönekopp, 2006; Xie et al., 2019).

Although perceiver characteristics appear to contribute a large share of known variance in face impressions, it is unclear what this 'perceiver-level variance' captures. It may reflect stable, trait-level idiosyncrasies such as personality, stereotype knowledge, response style, or state-like influences such as affective state, evaluative context, external environment, or psychological situations. Recent work suggests that perceivers' stereotype knowledge and lay theories of personality play a role (Stolier et al., 2020; Stolier, Hehman, Keller, et al., 2018; Xie et al., 2021), as well as their degree of acquiescence and positivity bias (Heynicke et al., 2021). However, these factors do not explain all perceiver variance, and other sources of perceiver-level variance are likely important. Critically, between 20-40% of the variance in facial impressions remains unexplained. This unexplained variance may reflect measurement error, or a meaningful source of intraindividual variability that has yet to be explored. To that end, the present research examines to what extent situational, day-to-day contextual factors experienced by perceivers contribute to variability in social impressions.

Do Perceiver Contexts Influence Impression Formation?

Impression formation does not occur in a vacuum. In everyday life, people are embedded in various contexts when forming impressions of others. A perceiver's context can encompass one's broader culture (Jaeger et al., 2019), personal environment (Barrett & Kensinger, 2010), or experienced situation (Rauthmann & Sherman, 2018). Although research on the influence of perceiver contextual factors on impression formation is scarce, a recent twin study found that genes explain little variability in facial impressions compared to one's personal environment

(Sutherland et al., 2020), encompassing local factors related to one's upbringing and community. Consistent with this finding, research with a large, international sample found that the broader cultural context also explains minimal variability, relative to individual differences (Hester et al., 2021). These findings allow for the possibility that any meaningful perceiver-level contextual variability in face impressions may exist at the locus of situational, day-to-day variation in one's recent experiences, rather than in one's broader culture or genetic makeup.

To the extent that these everyday experiential factors are psychologically meaningful, they may impact the impression formation process. For example, in contexts associated with harm (e.g., weapons are present), people readily evaluate others as angrier (Holbrook et al., 2014; Maner et al., 2005), larger (Fessler et al., 2012), and more physically threatening (Wilson, Hugenberg, et al., 2017), compared to neutral contexts. Further, perceivers' mood states may interact with features of the environment to impact situation construal. For example, people form impressions that are mood-congruent (A. Abele & Petzold, 1994; Forgas, 1992; Forgas & Bower, 1987), and properties of the environment can both shape and be shaped by mood (Chartrand, Baaren, & Bargh, 2006). The psychological experience of perceivers may therefore impact the way that they process and interpret novel targets.

To experimentally assess how impression formation varies across a sufficiently diverse number of perceiver contexts would require there to be an improbably large number of fixed situations, in which we manipulate participants' moods, perceived situations, and environment. Instead of experimentally inducing these different contexts, we used an experience-sampling paradigm (Thai & Page-Gould, 2018) to explore how perceivers—going about their daily lives and experiencing different contexts in a naturalistic manner—form impressions of targets.

To our knowledge, no studies have examined the influence of daily experiences on perceivers forming impressions, and there are no theoretical frameworks from which to derive specific hypotheses. With notable exceptions, most of the existing research on impression formation comes from participants embedded in the context of a social psychology experiment, sitting in a lab and rating faces. Furthermore, participants typically only evaluate each target once, which limits the amount of intraindividual variability that can be observed. Some research has examined context in impression formation, but focusing on target contexts, with targets embedded in diverse visual contexts as impressions are formed (e.g., Brambilla et al., 2018; Carragher et al., 2021; Fessler et al., 2012). Accordingly, here we present the first exploratory study to examine the perceiver context factors that might influence how they form impressions.

As participants went about their daily lives, we sent them a photo of a face, and measured their impressions as well as aspects of their physical and psychological context. We aimed to answer two research questions: First, to what extent do perceivers' everyday contexts matter for impression formation? Second, which perceiver contexts are important for driving impressions in a systematic manner across different participants? By collecting evaluations from participants over time, we allowed natural sources of intraindividual variability to emerge, and examined whether perceivers' contexts meaningfully contributed to variability in social impressions.

Methods

Experience Sampling

We explored the impact of people's naturally varying, day-to-day contexts on the way that they form impressions from faces, using experience sampling (Thai & Page-Gould, 2018) to track daily changes in participants' contexts at the moment that they form impressions of facial stimuli. We used 'perceiver context' broadly to encompass perceivers' environmental and

psychological states that might contribute to intraindividual variability in facial impressions. Accordingly, we focused on state-like variables that were likely to fluctuate within individuals. Data, code, and study materials available at [osf.io/xdmjr]. This research was approved by the McGill University Research Ethics Board.

Participants

330 U.S. participants were recruited from Amazon Mechanical Turk to complete an intake questionnaire and participate in the experience-sampling study. We overrecruited to ensure we would be able to attain a final sample similar to previous research that used this experience-sampling method (Thai & Page-Gould, 2018). 218 participants (52% female, M_{age} = 36.0, SD_{age} = 10.3) continued with the study: 168 White, 18 East Asian, 17 Black, 8 Latine, 3 Aboriginal/Indigenous, 2 multiracial, 1 South Asian, 1 undisclosed. The average income of participants was $61,148 (*SD* = $35,269), and the highest level of education attained included: 1 high school or less, 19 high school graduate, 52 some college, 33 associate's degree, 77 bachelor's degree, 31 master's degrees, 1 professional degree, 3 doctoral degree, 1 undisclosed.

Procedure

Participants completed an intake questionnaire, which included a brief measure of personality (Rammstedt & John, 2007) and demographic questions. They were then directed to a webpage explaining how to install and use the *ExperienceSampler* smartphone app (Thai & Page-Gould, 2018) that would record their responses throughout the day for up to 15 consecutive days. Figure 1 reveals that participants completed measures across a wide variety of geographic locations, ensuring variability in some of the factors that we measured, such as weather or other characteristics of the environment.

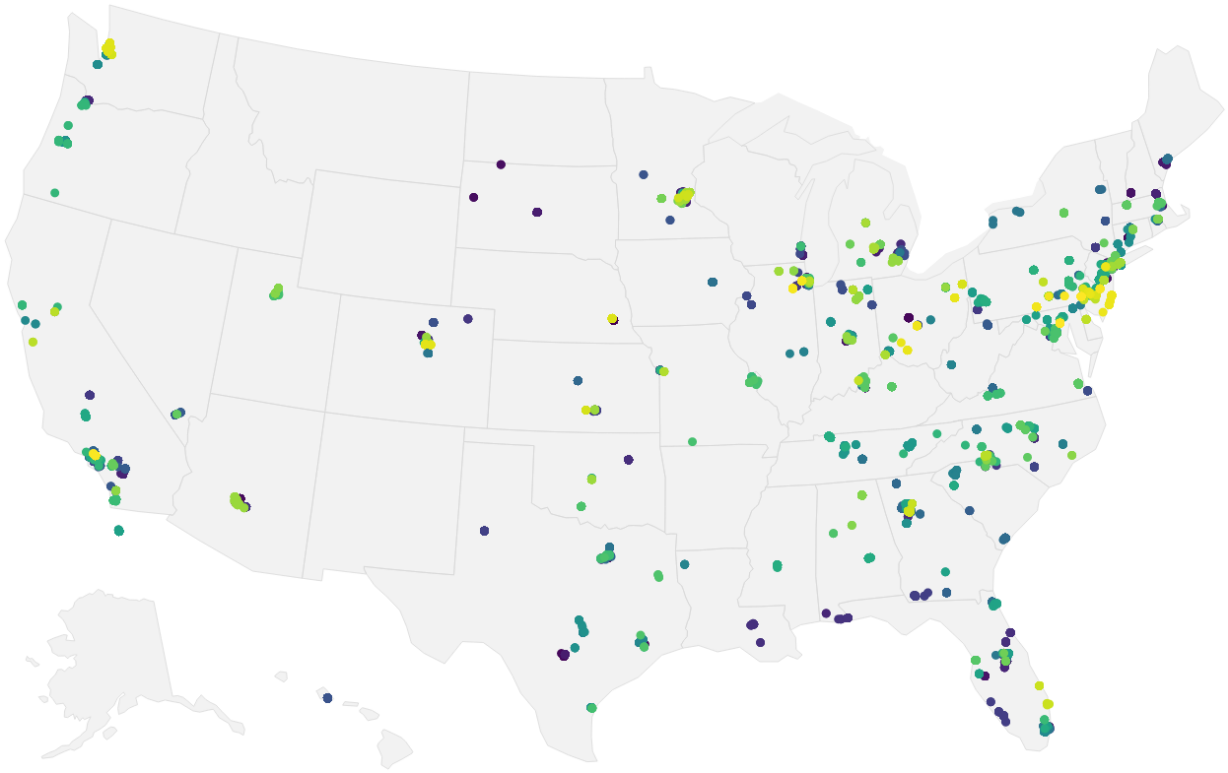

Figure 1. Participants' location (longitude/latitude) at the time of each response (constrained to the U.S. for visualization). Unique colors represent unique participants (*n*=218).

Data collection proceeded in multiple waves between August 29 to December 16 in 2019. Participants were notified twice a day for up to 15 consecutive days at quasi-random times via the app. Participants indicated the hours that they would be available to use their phone on weekdays and weekends, and notification times were randomized within these periods. When responding to a notification, participants were asked to report their impression of one randomly-selected human face, on 6 traits commonly assessed in impression formation research: friendliness, trustworthiness, attractiveness, intelligence, physical strength, and dominance (Hehman et al., 2017; Todorov et al., 2015). Participants rated each trait impression on 1-"Not at all" to 7-"Very much" Likert-type scales. Traits were presented in randomized order across surveys and across participants. After ratings, participants then completed brief measures of their

current situation, environment, mood, and physiological state. The order of questionnaires and items within questionnaires were also randomized per survey. Measures were brief to minimize participant fatigue and attrition. See Supplementary Materials for the complete questionnaire.

Our theoretical and statistical focus was on within-subject variability, and a limited set of stimuli was ideal for focusing on the potential influence of perceiver contexts. See Figure 2 for an illustration of within-subject variability in target ratings over time. Stimuli comprised photographs of White, emotionally-neutral faces (8 male, 7 female) randomly selected from the Chicago Face Database (Ma et al., 2015). If participants responded to all notifications, then a total of 180 trait ratings would be obtained per participant: 30 responses × 6 trait ratings of 15 stimuli, each rated twice. Participants could miss 5 notifications total, after which they would no longer receive notifications.

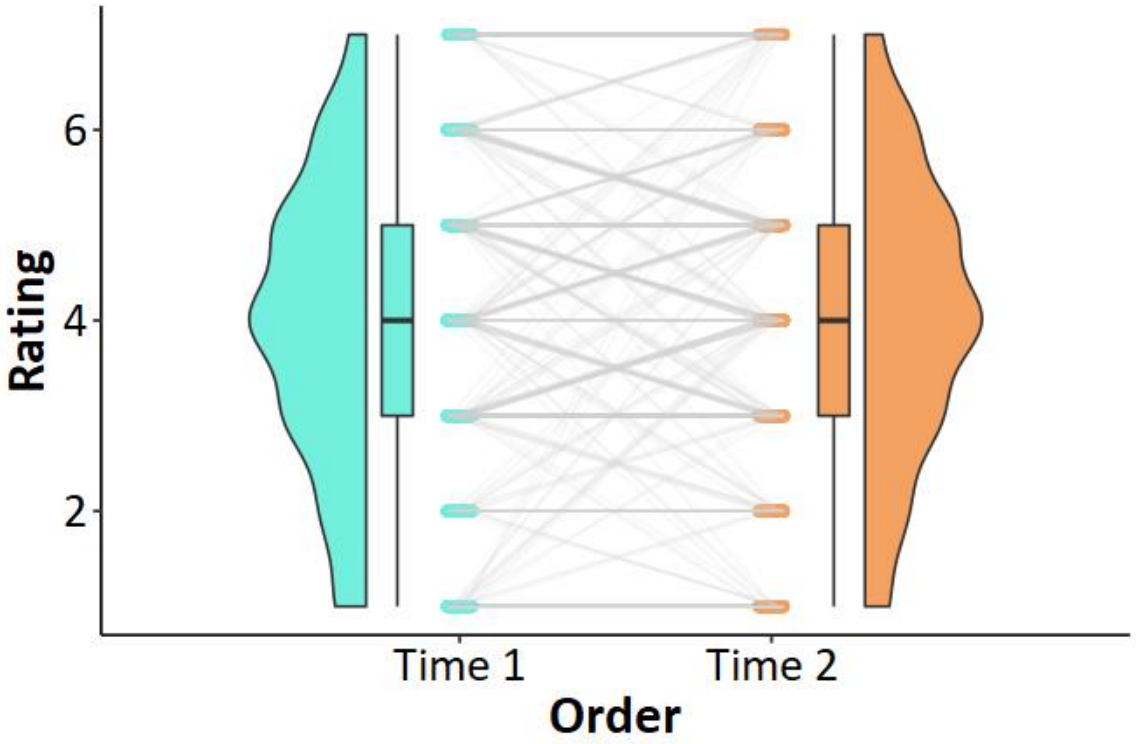

Figure 2. Ratings of the same target at Time 1 and Time 2, across all participants and traits. Grey lines connect ratings from the same participants. That many are diagonal reveals that participants

did not always provide identical ratings to the same target across different time points, allowing for the possibility that perceivers' experienced contexts might explain such variation.

Measures

We measured several ways in which physical environment and psychological states may vary within individuals across 15 days. However, there are countless factors that might influence one's immediate psychological context. Because it was not possible to comprehensively explore all contexts, items were selected based on salience and subjective intuitions by the research team, with the goal of casting a wide net. In total, measures of perceivers' experienced contexts included 22 items, administered at each survey. No variables other than those reported in the manuscript have been measured. See Supplementary Materials for the full questionnaire.

Measuring Situations. Modern approaches to situation measurement focus on how situations are subjectively perceived (Brown et al., 2015; Parrigon et al., 2017; Rauthmann & Sherman, 2018). Since 2014, various situation taxonomies have been developed around this principle. Given the large content overlap across different measures (Horstmann et al., 2017), we decided to use the shortest validated measure available for the systematic assessment of situations that focuses specifically on the description of everyday situations: the ultra-brief (8-item) form of the Situational 8 DIAMONDS (Rauthmann et al., 2014; Rauthmann & Sherman, 2015), a taxonomy of situation characteristics comprising (D)uty, (I)ntellect, (A)dversity, (M)ating, p(O)sitivty, (N)egativity, (D)eception, and (S)ociality. The ultra-brief form of the DIAMONDS (Rauthmann & Sherman, 2015) has one item tapping each dimension (e.g., "Are you in a situation where work has to be done?"), on 1-"Not at all" to 7-"Totally" Likert scales.

Measuring Environment. Environment variables included weather (i.e., sunny, rainy) measured on 1-"Not at all" to 7-"Very much" Likert-type scales, temperature (in Fahrenheit, on a

sliding scale from Very Cold: -20 to Very Hot: 120), and checkboxes indicating whether the respondent was indoors or outdoors, alone, with strangers, or with familiar others.

Measuring Mood. We included six items capturing mood: happy, calm, energetic, fearful/anxious, angry, and sad. These were derived from adjectives loading strongly on the mood factors identified in the UWIST Mood Adjective Checklist (Matthews et al., 1990). Participants responded to the prompt, "Thinking about yourself and how you feel in the past 30 minutes, to what extent do you feel: […]", on a Likert-type scale from 1-"Not at all" to 7-"Very much".

Measuring Physiological State. We included two items capturing basic physiological states: Tired and Hungry. Participants responded to the prompt, "How [tired / hungry] are you right now?" on a 1-"Not at all" to 7-"Very much" Likert-type scale.

Demographics. In the intake questionnaire, participants completed a variety of demographic items (i.e., gender, age, ethnicity, income, and education). In addition, they completed a brief measure of personality: the 11-item version of the Big Five Inventory (Rammstedt & John, 2007). Given our interest in within-subject effects, these variables were not of primary interest, but served as robustness checks to ensure that any contextual effects were not explained by trait-like perceiver characteristics.

Analysis 1

Quantifying Perceiver-Context Variability in Face Impressions

We quantified the variance in facial impressions attributable to different contexts experienced by perceivers. Because we had no a priori hypotheses about which perceiver contexts would influence facial impressions, nor to what extent they could influence impressions, we randomly (by participant) partitioned the data into exploratory (N = 109, n ratings = 2236)

and confirmatory hold-out (*N* = 109, *n* ratings = 2190) datasets to reduce the possibility that any models developed on the exploratory data were overfitted. There were no preregistrations for this study.

Analytic Approach

We built a cross-classified multilevel model with no predictors (i.e., null model) to partition the data into variance attributable to context, perceiver, targets, and their higher order interactions. Similar cross-classified models have been used in social psychology research (Judd et al., 2012) to decompose and quantify the variance in impressions originating at the target and perceiver levels (Hehman et al., 2017; Hönekopp, 2006; Kenny, 2019; Xie et al., 2019). Here, the level-1 unit of analysis is a trait rating made at the time that participants are responding to each survey, which is cross-classified by targets, perceivers, and contexts. Models were estimated using the *lme4* (Bates et al., 2015) package in R[3]. See Supplementary Materials for further elaboration of this model.

Modeling Heterogeneity in Real-World Contexts. To estimate this model, each rating in Level 1 of the model must be nested within a categorical context cluster, just as it is nested within a participant and target cluster. Given that there are 22 predictors, it is impractical to model all higher-order interactions by entering them as predictors in a multilevel model. For example, including all higher-order interactions requires estimating an additional 4,194,281 parameters. Thus, an important first step was to identify distinct perceiver contexts, and assign each response to a distinct context in a class of contexts. For example, one perceiver context (e.g., outdoors, warm, sunny, social environment, hungry) may be differentiated from another

[3] R code:

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lmer(TraitRating ~ 1 + (1|PerceiverID) + (1|TargetID) + (1|ContextID) +
(1|PerceiverID:TargetID) + (1|ContextID:PerceiverID) + (1|ContextID:TargetID), data)
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perceiver context (e.g., alone, indoors, in an environment that requires work to be done, tired) based on participants' responses to multiple contextual variables. As we did not have any a priori hypotheses about which combinations of perceiver-level contextual variables might be psychologically meaningful, we adopted a data-driven approach.

Our strategy was to identify qualitatively distinct perceiver contexts that emerge from combinations of contextual features. Specifically, we used latent profile analysis (LPA) to examine how participants' responses to these contextual variables cluster together and constructed distinct classes of contexts in a data-driven manner, using quantitative data to express qualitatively distinct contexts. This was possible given a longitudinal dataset, with observations that are repeated within (and between) participants who differ in trait characteristics (e.g., personality, worldview) but who may nonetheless experience similar psychological states as they experience similar contexts. This strategy allowed us to estimate the variance in social impressions arising from perceiver contexts. We implemented latent profile analysis using the *tidyLPA* package in R (Rosenberg et al., 2019).

Latent Profile Analysis of Real-World Contexts

Latent profile analysis (LPA) estimates an underlying categorical latent variable from continuous indicators (Hox & Roberts, 2011; Pastor et al., 2007). Often used in person-centered analyses, its practical advantage is that it mimics higher-order interaction terms and catalogues complicated interaction effects in a simple way, as subgroups or 'classes'. This approach is suited for data in which distinct subgroups—that is, qualitative differences—are expected (Hox & Roberts, 2011; Pastor et al., 2007). Here, the 22 contextual indicators intend to describe qualitatively distinct real-world contexts experienced by participants when they respond to each

survey. LPA has previously been used to examine distinct subtypes in personality (Merz & Roesch, 2011) and goal orientation (Pastor et al., 2007).

Some common concerns about these class of models include the sensitivity of the class separation and the number of latent profiles correctly identified (Bauer & Curran, 2003; Peugh & Fan, 2013). To maximize the correct identification of latent profiles, we used a class-invariant unrestricted parametrization, which offers some improvement in model recovery over the default of assuming local independence (Pastor et al., 2007; Peugh & Fan, 2013). In determining sample size, we ensured that the number of observations would greatly exceed $n = 500$ even after partitioning into an exploratory ($n = 3132$) and confirmatory segment ($n = 3071$), given the within-subjects design. Next, we searched between 2 to 51 classes to cover a broad range of possible classes (51 is a computational ceiling). Model selection was based on two indices: the Bootstrap Likelihood Ratio Test (BLRT) and the Bayesian Information Criterion (BIC), determined in a recent simulation study to outperform other indices in terms of correctly and reliably recovering the true number of classes across different sample sizes (Nylund et al., 2007). The BIC balances goodness-of-fit with parsimony (Raftery, 1995); reductions of 10 points or more between two models indicates improved fit. The BLRT compares the fit between two models, where *p*-values below .05 indicate superior fit of class k versus $k - 1$. Finally, we made decisions on number of latent profiles based on both the exploratory and confirmatory dataset.

LPA assigns each survey response to a certain class based on the highest probability of belonging to each class. We used the exploratory data to search for the optimal number of classes based on the lowest BIC and significance on the BLRT. Because LPA was designed to model heterogeneity in observed data, it was unlikely that the optimal number of classes should replicate exactly across data with different inputs. However, we expected the optimal number of

classes to be similar across exploratory and confirmatory segments of our data. By identifying the best-performing model in the exploratory dataset and validating its performance in the confirmatory dataset, we could be more confident that LPA had retrieved the correct number of latent profiles (i.e., perceivers' experienced contexts in which impressions are formed) from the observed variables.

In the main analysis, we entered this perceiver-contextual class variable into the cross-classified model as a random cluster, along with perceivers and targets. Estimates from these models were used to calculate intraclass correlation coefficients (ICCs). These ICCs represent the percentage of variance in a trait rating explained by different clusters of the multilevel model.

Results

We implemented LPA to identify the number of qualitatively distinct perceiver-contexts observed in our data. LPA conducted on the exploratory dataset (*n* ratings = 2236, *N* participants = 109) found the optimal number of contexts to be 44. We assessed the robustness of this solution with the confirmatory dataset (*n* ratings = 2190, *N* participants = 109), which found the optimal number of contexts to be 50, followed by 42 and 44. See Supplementary Table 1 for the top 10 solutions ranked by lowest BIC across both datasets.

Of the solutions that had a significant BLRT *p*-value across both datasets and the lowest BIC values, the model with 44 classes was the most parsimonious. We therefore selected the 44-class model for our primary analyses. We do not interpret these 44 classes as a representative, generalizable taxonomy of real-world contexts experienced by perceivers, but rather the number of distinct perceiver contexts present in our dataset. This allowed us to include the contextual cluster (i.e., with 44 distinct contexts) as a random cluster in a multilevel model. We conducted

supplementary analyses with other class solutions which had significant *p*-values on the BLRT to confirm that results weren't contingent on a particular solution (Supplementary Analysis 1).

In our main analysis, each survey response was assigned to a 'context' class based on the LPA solution with 44 classes. On average, participants in the exploratory dataset experienced 8.83 total contexts (*SD* = 4.01, *range* = 1-18), whereas participants in the confirmatory dataset experienced 8.59 total contexts (*SD* = 3.44, *range* = 1-17). See Supplementary Table 3 for an example of one distinct 'context' that was identified according to this classification.

Quantifying Contextual Variability in Face Impressions

Overview. The variance in trait impressions across all 6 traits was decomposed into between-perceiver, between-target, between-context, perceiver × target, perceiver × context, target × context, and residual variance. We first present a bird's-eye view of all ICC estimates and 95% CIs (Table 1) from the exploratory (Figure 3) and confirmatory (Figure 4) datasets.

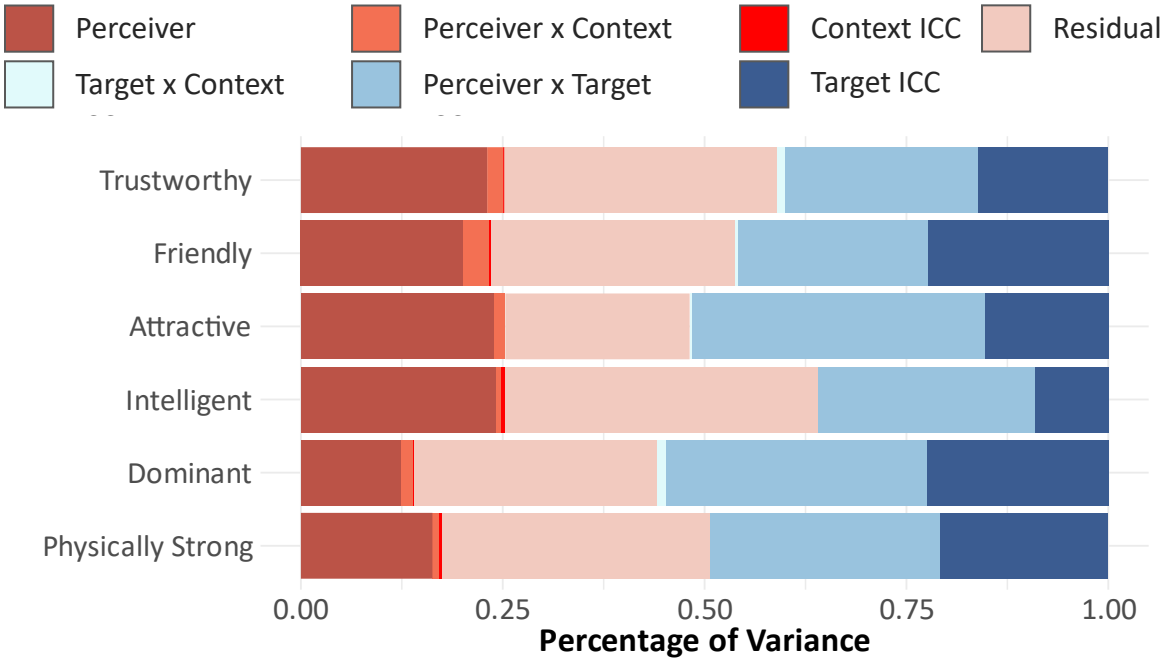


Figure 3. Relative contributions of perceiver-level, target-level, context-level, perceiver × target, perceiver × context, target × context, and residual variance to trait impressions: trustworthy, friendly, attractive, intelligent, dominant, and physically strong. Results from exploratory dataset.

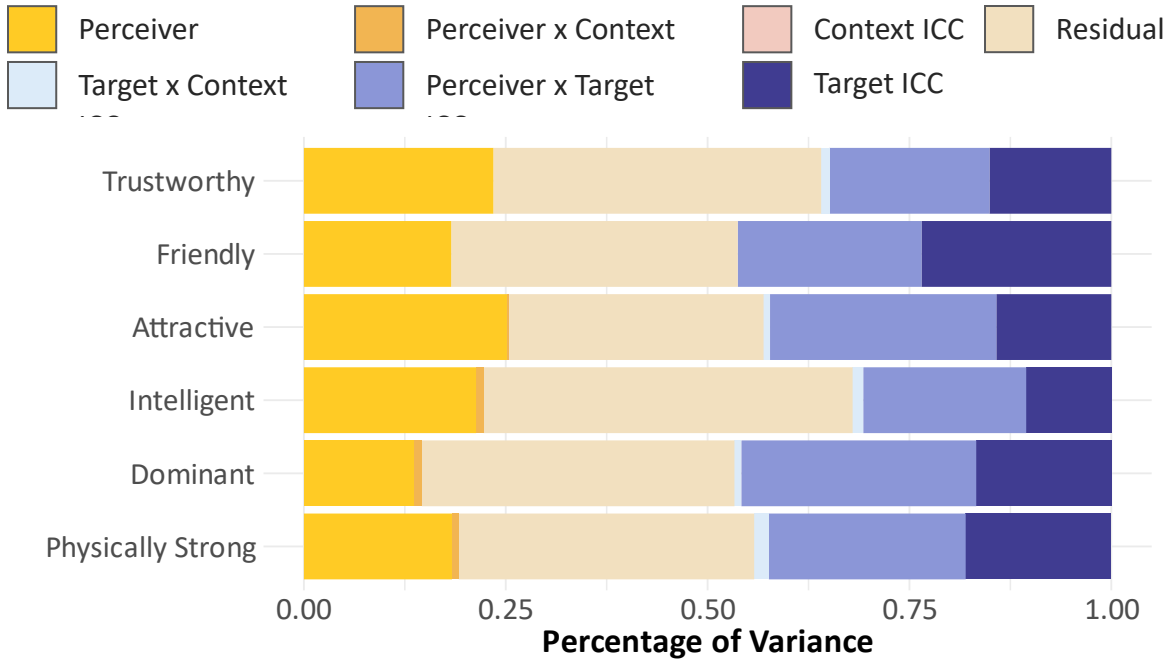


Figure 4. Relative contributions of perceiver-level, target-level, context-level, perceiver × target, perceiver × context, target × context, and residual variance to trait impressions: trustworthy, friendly, attractive, intelligent, dominant, and physically strong. Results from confirmatory dataset.

Table 1

Intra-class correlation coefficients and 95% confidence intervals by trait

	Exploratory Dataset (n = 109)				Confirmatory Dataset (n = 109)			
	Perceiver ICC	95% CI	Target ICC	95% CI	Perceiver ICC	95% CI	Target ICC	95% CI
Trait								
Trustworthy	.231	[.163, .293]	.162	[.052, .255]	.235	[.169, .297]	.151	[.051, .238]
Friendly	.201	[.133, .262]	.223	[.096, .349]	.182	[.120, .236]	.235	[.105, .360]
Attractive	.238	[.169, .305]	.153	[.047, .243]	.252	[.183, .319]	.142	[.040, .224]
Intelligent	.241	[.177, .304]	.091	[.018, .147]	.213	[.155, .271]	.105	[.026, .170]
Dominant	.124	[.075, .168]	.224	[.094, .347]	.136	[.085, .179]	.167	[.056, .265]
Physically Strong	.163	[.106, .215]	.209	[.084, .327]	.183	[.124, .238]	.180	[.063, .283]
	Exploratory Dataset (n = 109)				Confirmatory Dataset (n = 109)			
	Perceiver × Target ICC	95% CI	Context ICC	95% CI	Perceiver × Target ICC	95% CI	Context ICC	95% CI
Trustworthy	.238	[.188, .287]	.001	[.000, .003]	.198	[.148, .244]	.000	[.000, .000]
Friendly	.236	[.178, .287]	.002	[.000, .004]	.228	[.169, .280]	.000	[.000, .000]
Attractive	.363	[.301, .423]	.000	[.000, .000]	.280	[.225, .330]	.000	[.000, .000]
Intelligent	.269	[.218, .316]	.005	[.000, .010]	.202	[.152, .250]	.000	[.000, .000]
Dominant	.324	[.256, .388]	.001	[.000, .003]	.291	[.231, .348]	.000	[.000, .000]
Physically Strong	.285	[.221, .345]	.003	[.000, .005]	.244	[.188, .293]	.000	[.000, .000]
	Exploratory Dataset (n = 109)				Confirmatory Dataset (n = 109)			
	Perceiver × Context ICC	95% CI	Target × Context ICC	95% CI	Perceiver × Context ICC	95% CI	Target × Context ICC	95% CI
Trustworthy	.020	[.000, .040]	.011	[.000, .021]	.000	[.000, .000]	.010	[.000, .020]
Friendly	.032	[.007, .056]	.003	[.000, .005]	.000	[.000, .000]	.000	[.000, .000]

Attractive	.015	[.000, .030]	.002	[.000, .005]	.002	[.000, .004]	.008	[.000, .016]
Intelligent	.007	[.000, .013]	.000	[.000, .000]	.009	[.000, .018]	.013	[.000, .027]
Dominant	.015	[.000, .030]	.012	[.000, .024]	.011	[.000, .021]	.009	[.000, .017]
Physically Strong	.008	[.000, .016]	.000	[.000, .000]	.008	[.000, .017]	.018	[.000, .036]

Contributions of Perceivers' Experienced Contexts. Central to our research question, the novel aspect of this analysis relates to the unique contribution of day-to-day perceiver contexts to face impressions. We found that the contextual factors examined here do not, on their own, contribute any unique variance to face impressions (~0%). This indicates that the average rating made in one context class (across all perceivers rating all targets) does not differ from the average rating made in another context class (across all perceivers rating all targets). For example, in a simplified scenario in which being in a sunny setting or not was a distinct context experienced by perceivers, if ratings were consistently different when perceivers were in a sunny vs. less sunny setting, then we would observe a higher context-ICC.

Importantly, perceivers' experienced contexts do not meaningfully contribute variance to trait impressions regardless of the perceiver or target being rated. Summarizing across all traits, the perceiver × context interaction ICC contributed only ~1.6% (exploratory: 0.7% - 3.2%) and ~0.5% (confirmatory: 0.0% - 1.1%) of the variance in face impressions. This suggests that different participants experiencing different contexts did *not* vary in their trait ratings—regardless of which stimuli they were evaluating. As a hypothetical example, if happy people evaluated others as friendlier on a sunny day, whereas unhappy people evaluated others as less friendly on such a day, then we would observe a higher perceiver-by-context ICC. In this scenario, differences between perceivers (how happy they are on average) interact with their experienced contexts (how sunny it is when they respond to the survey) to shape their impressions of any target's face. However, these perceiver × context interactions contributed very little variation in trait impressions, indicating that different participants were not

differentially affected by their day-to-day contexts when forming impressions of strangers. Similarly, the target × context ICC contributed only ~0.5% (exploratory: 0.0% - 1.2%) and ~1.0% (confirmatory: 0.0% - 1.8%) of variance, suggesting that different targets being rated in different perceiver-contexts did *not* elicit different trait ratings (regardless of rater). As a hypothetical example, if targets with downturned eyebrows were evaluated as more intelligent when raters were in a work situation, whereas targets with upturned eyebrows were rated as less intelligent in such a situation, then we would observe a higher target-by-context ICC. However, differences between targets (e.g., eyebrow shape) do not appear to interact with any perceiver's experienced context (being in a work situation) to shape impressions of the target. We discuss the implications of these findings in more detail in the General Discussion.

Perceiver versus Target Contributions. Other contributions were generally consistent with previous research (Hehman et al., 2017; Hönekopp, 2006; Xie et al., 2019). Summarizing across 6 traits, results indicated that between-perceiver differences uniquely contributed ~20% of the variance in face impressions in the exploratory dataset (12.4% - 23.8%) and ~20% in the confirmatory dataset (13.6% - 25.2%). These contributions varied across traits in a manner consistent with previous literature. Between-target differences (e.g., facial appearance) uniquely contributed, on average, ~17.7% (exploratory: 9.1% - 22.4%) and ~16.4% (confirmatory: 10.5% - 23.5%) of the variance in each dataset. Both the perceiver-ICC and target-ICC estimates generally replicated previous work partitioning variance in face impressions (Hehman et al., 2017; Xie et al., 2019).

Across all sources of variance, the perceiver × target ICC was the largest in both exploratory and confirmatory segments. Summarizing across 6 traits, this interaction contributed ~29.0% (exploratory: 23.6 - 36.3%) and ~24.0% (confirmatory: 19.8 - 29.1%) of the variance in

face impressions. This estimate was similar but slightly smaller than the estimates observed in previous work examining the perceiver × target interaction component (Hehman et al., 2017; Hönekopp, 2006). This perceiver × target interaction can be interpreted as 'personal taste', or differential criteria that perceivers use when judging different stimuli.

Robustness Checks. Given our design, one additional concern was that rating faces twice over the 15-day period might have influenced results. Exploring this possibility, estimates did not change when we additionally included a variance component for participation-over-time, using participants' chronological trial count (see Supplementary Analysis 1C). This suggests that participation in the study over time did *not* introduce any variability in responding (e.g., as a result of fatigue or boredom). We also checked whether repeated presentations of a target (i.e., the exact same photo) influenced subsequent ratings of that same target. Overall, naïve ratings do not differ significantly from subsequent ratings in a systematic manner when averaging across perceivers, targets, and contexts (Supplementary Analysis 1D). This indicates that the mere act of seeing the same face again did not systematically shift trait ratings. Finally, we added to the model the number of unique contexts that each participant experienced according to the 44-class solution. Adding participants' context count did not shift the estimates for these variance components, and this variable was not consistently significant. This indicates that diversity in contexts experienced did not systematically shift trait ratings.

Analysis 2

Which Contexts are Important for Predicting Face Impressions?

Analytic Approach

Next, we turned to a predictive modeling approach to assess which specific perceiver-level contextual variables might drive face impressions. We built a separate model for each of

the 6 traits, where ratings on a trait (e.g., trustworthiness) served as the outcome variable in a cross-classified multilevel model, with each questionnaire item (e.g., “How sunny is it?”) entered as a separate predictor. Models were cross-classified at the perceiver and target levels.

We had anticipated some multicollinearity among our numerous contextual variables and performed LASSO variable selection (Tibshirani, 1996) by incorporating L1-penalized estimation into generalized linear mixed-effects models to identify a more parsimonious model. However, results suggested we retain all variables in all models.

Accordingly, we built 6 models to predict ratings on each trait. We entered all 22 participant-mean centered contextual variables into the model (at Level 1) along with each participant’s mean for each variable (at Level 2) to estimate both between- and within-perceiver effects. Models included random slopes for all level-1 predictors. Given the already complex model and no theoretically derived predictions, we did not include higher-order interactions (i.e., given 22 predictors, to estimate all three-way and two-way interactions would require estimating an additional 1,771 parameters). Models were estimated using the *lme4* (Bates et al., 2015) and *brms* (Bürkner, 2017) packages in R. See Supplementary Materials for code and further elaboration of this model.

Results

We investigated which specific perceiver-context predictors influenced impressions. Due to the large number of predictors and hypothesis tests, we interpreted effects as meaningful only if they were significant ($\alpha = .05$) across both exploratory and confirmatory datasets. See Supplementary Table 2 for comprehensive reporting of all within-perceiver and between-perceiver effects of contextual variables on each of the 6 traits.

Trustworthy and Friendly. For impressions of both trustworthiness and friendliness (*r* = .70; typically highly correlated in impressions), only the between-perceiver effect of energetic mood was significant across both datasets. On average, people who felt energetic more often than others judged faces as friendlier (exploratory: $\gamma_{010}\overline{X}_{energetic}$ = .38, 95% CI [.16, .60], confirmatory: $\gamma_{010}\overline{X}_{energetic}$ = .26, 95% CI [.05, .47]) and more trustworthy (exploratory: $\gamma_{010}\overline{X}_{energetic}$ = .32, 95% CI [.10, .54], confirmatory: $\gamma_{010}\overline{X}_{energetic}$ = .22, 95% CI [.01, .43]). No other effects were consistent across both exploratory and confirmatory sets.

Attractive and Intelligent. Across exploratory and confirmatory datasets, none of the 22 contextual variables examined here had a consistent impact on ratings of attractiveness nor intelligence (*r* = .51).

Dominant and Physically Strong. For impressions of dominance and physical strength (*r* = .59; typically highly correlated in impressions), the between-perceiver effects of angry mood and hunger were significant across both datasets. On average, people who felt angry more often than others judged faces as less dominant (exploratory: $\gamma_{020}\overline{X}_{angry}$ = -.89, 95% CI [-1.41, -.37], confirmatory: $\gamma_{020}\overline{X}_{angry}$ = -.47, 95% CI [-.93, -.02]) and less physically strong (exploratory: $\gamma_{020}\overline{X}_{angry}$ = -.59, 95% CI [-1.04, -.15], confirmatory: $\gamma_{020}\overline{X}_{angry}$ = -.43, 95% CI [-.86, -.01]).

People who felt hungrier on average judged faces as more dominant (exploratory: $\gamma_{030}\overline{X}_{hungry}$ = .18, 95% CI [.02, .34], confirmatory: $\gamma_{030}\overline{X}_{hungry}$ = .28, 95% CI [.10, .46]) and physically stronger (exploratory: $\gamma_{030}\overline{X}_{hungry}$ = .16, 95% CI [.03, .29], confirmatory: $\gamma_{030}\overline{X}_{hungry}$ = .22, 95% CI [.05, .38]). Thus, participants who often felt angry judged faces as less dominant and physically weaker, whereas those who often felt hungry judged faces as more dominant and physically stronger.

Additional Analyses. Though our theoretical interest centered on within-subject effects, to better characterize these between-participant effects, we explored whether participant gender or Big-Five personality scores were responsible for energetic mood, anger, and hunger effects. Specifically, we wanted to make sure these effects were robust even with other participant characteristics in the model.

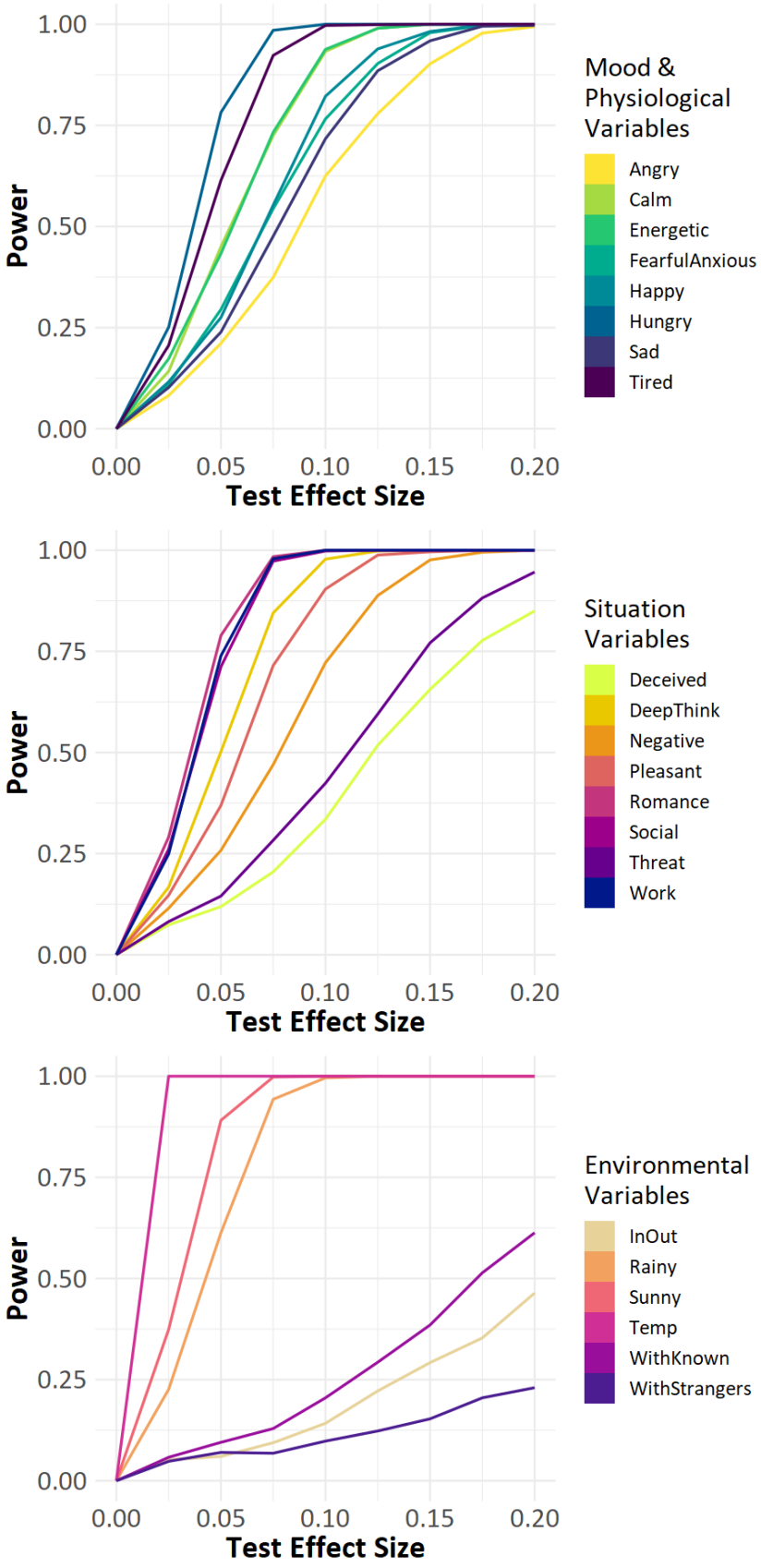
The effect of energetic mood on ratings of trustworthiness and friendliness was *not* moderated by gender. Energetic mood remained significant even after controlling for Big-Five personality scores, indicating that participants who felt more energetic on average judged targets to be friendlier and more trustworthy—even after controlling for traits such as extraversion.

In addition, the effect of hunger on ratings of dominance and physical strength was *not* moderated by gender. Hunger remained significant even after controlling for Big-Five personality scores, indicating that participants who felt hungrier on average judged targets to be stronger and more dominant—even after controlling for traits such as agreeableness.

However, the effect of angry mood on ratings of dominance and physical strength—while not moderated by gender—was significant only in the exploratory dataset, when controlling for Big-Five personality scores. Descriptively, we found that participant-level angry mood was moderately correlated with Big-Five agreeableness (r = -.33) in the confirmatory dataset. This suggests that our measure of participants' average level of angry mood is related to participants' trait-level agreeableness, and may not explain enough variance in dominance and physical strength on its own.

Finally, none of the Big-Five personality dimensions examined here had a consistent significant effect on ratings along any of these 6 traits, across both exploratory and confirmatory datasets.

Sensitivity Analysis. Throughout, we found no consistent effects of within-subject variation. One concern was that our power was too low to detect such effects, should they exist. Accordingly, we conducted a sensitivity analysis to determine at what power we would be able to detect any effects, given the variation observed in each variable. The power curve is available in Figure 5. Starting with a small effect at $\beta = \pm .20$, we found that we had >99% power to detect this effect for 17 of our 22 variables, and >85% power to detect this effect for all 19 continuous variables of our 22 variables. For three variables (Are you with strangers? Are you with known others? Are you inside or outside?), we had much lower power. All three of the variables were dichotomous, and closer inspection revealed this result was likely due to low variance. For these three variables, our results should be viewed with caution. However, for the remainder, our within-subjects longitudinal design enabled high statistical power to detect within-subject contextual effects. Only for variables with a quite small true effect size of smaller than $\beta = \pm .10$ would our tests be underpowered.


Power
1.00
0.75
0.50
0.25
0.00
0.00
0.05
0.10
0.15
0.20
Test Effect Size
Mood &
Physiological
Variables
Angry
Calm
Energetic
FearfulAnxious
Happy
Hungry
Sad
Tired
Power
1.00
0.75
0.50
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0.00
0.00
0.05
0.10
0.15
0.20
Test Effect Size
Situation
Variables
Deceived
DeepThink
Negative
Pleasant
Romance
Social
Threat
Work
Power
1.00
0.75
0.50
0.25
0.00
0.00
0.05
0.10
0.15
0.20
Test Effect Size
Environmental
Variables
InOut
Rainy
Sunny
Temp
WithKnown
WithStrangers

Figure 5. Sensitivity analysis demonstrating our power to detect various desired effect sizes, at $N_{participants}$ = 109 (matched to the participant sample size of our exploratory/confirmatory datasets separately), $N_{stimuli}$ = 15 (matched to the target sample size of our datasets), and n = 2,236 (to approximate our observed $n_{observations}$ at 2,236 and 2,190 across exploratory and confirmatory datasets).

General Discussion

When scientists study impression formation in the lab, they typically want their findings to generalize to other contexts in which people form facial impressions. Yet research with greater external validity is difficult, limiting our ability to answer basic questions about social perception. Researchers studying impression formation have long considered that perceivers' contexts may be an important source of variance in impressions. Here, we present the first direct investigation into how people's day-to-day experiences shape their impressions. Using experience-sampling, we examined to what extent perceivers' daily experiences influenced the way that they form impressions from faces. Importantly, we found that perceivers' experienced contexts did not meaningfully impact their trait impressions. The average trait impression formed in one perceiver context did not differ from the average impression formed in another perceiver context. This suggests that certain perceiver-related factors (e.g., mood, environment, physiological state, psychological situation) are unlikely to shift their trait impressions of faces.

Moreover, this conclusion did *not* vary across different perceivers experiencing different contexts. As a hypothetical example, if happy people judged others as friendlier on a sunny day whereas unhappy people did not, then the differences between perceivers (e.g., how happy they are) would interact with their experienced context (e.g., how sunny it is) to shape their impressions of targets. Yet we found that the interaction between perceivers and their experienced contexts contributed a negligible amount (~1%) of the overall variance in face impressions. To put this into perspective, recent work found that ~50% of between-perceiver

variance can be attributed to positivity bias and an acquiescing response style (Heynicke et al., 2021; Rau et al., 2021). Our findings suggest that less than ~1% of this between-perceiver variance may additionally be accounted for by individuals' varying responsivity to their experienced contexts. Any differences in how individuals form trait impressions are unlikely to be driven by their experienced contexts, such as features of their local environment or psychological situation.

Our results converge with recent work that examines individual variance in how social impressions are formed from faces. For example, broader country-based cultural differences contribute negligible variance to face impressions relative to individual differences (Hester et al., 2021). Similarly, genetics seem to have little impact on impressions relative to one's personal upbringing and environment (Sutherland et al., 2020). Here, we investigated which of these individual differences matter more (i.e., by disentangling the contributions of stable individual differences from perceivers' situational, experienced contexts). We found that perceivers' day-to-day experienced contexts are unlikely to impact how they form impressions of others—and highlight the importance of other perceiver characteristics (e.g., personality or development) in shaping social perception.

Consistent with this interpretation, Analysis 2 found stable differences across perceivers in how they form impressions. Across multiple timepoints, participants who reported feeling more energetic than others judged targets as friendlier and more trustworthy. Those who reported feeling hungrier and less angry than others judged targets as more dominant and physically strong. These effects were independently produced four total times, across exploratory and confirmatory sets of two highly-correlated traits (Xie et al., 2019; Zebrowitz et al., 2003). Since these mood and physiological perceptions were significant between-perceiver but not within-

perceiver predictors, they represent individual differences and not within-person change over time. We discuss these between-person differences in a later section. Overall, the real-world contexts examined here do not meaningfully affect face impressions.

Consistent with previous work, we found that the perceiver-by-target interaction was by far the largest contributor to variance in facial impressions. Across multiple traits, estimates of perceiver-by-target contributions were similar but slightly smaller (20-36%) than those in previous studies (32-40%; Hehman et al., 2017; Hönekopp, 2006). The use of fewer stimuli compared to previous studies may have limited the variance in "personal taste" that could be captured by the perceiver-by-target interaction. However, 95% confidence intervals around ICCs for attractiveness, dominance, and physical strength contained the estimates obtained in previous work, providing evidence that these estimates generalize across multiple evaluative contexts (e.g., rating faces in-lab or more naturalistically on a phone app) and study characteristics (e.g., rating one face vs. many faces per session, one trait vs. multiple traits at a time).

The variance uniquely attributable to perceiver characteristics alone was ~20% across traits, similar to previous work (20-25%; Hehman et al., 2017; Xie et al., 2019). Thus, the inclusion of perceivers' experienced context did not partition out any meaningful variance in 'idiosyncratic' or perceiver-level variability. This affects the interpretation of these clusters in cross-classified multilevel models, which are increasingly used in research on interpersonal judgments. Specifically, by partitioning the perceiver-by-context interaction, we can be more confident that what remains of 'perceiver-level variance' in most lab-based studies of impression formation is specific to individual differences across people.

Finally, target characteristics uniquely contributed ~17% to the variance in facial impressions. This percentage can be interpreted as consensus (across perceivers) in trait

impressions that are driven by differences in target stimuli. Given the focus of the present research on within-participant variability and the large number of questions, we purposely limited the number of target stimuli. Yet results from this smaller target set are consistent with estimates of target variance from previous research with much larger sets (10-15%; Hehman et al., 2017; Xie et al., 2019), providing evidence that any results we obtained here were not a function of a smaller target set.

Overall, the residual unexplained variance was as large as 20-40% of the variance in previous research (Hehman et al., 2017; Xie et al., 2019). Our attempts here to incorporate perceiver context did not significantly reduce this unexplained percentage, as perceivers' experienced contexts do not seem to exert a strong influence on impressions. Critically, there are two practical implications of this work for future research on face perception. Researchers interested in examining sources of variance in trait impressions might be better served by investigating more stable individual differences, versus momentary situational factors experienced by the participant. Further, our results suggest that conclusions from face impression research conducted in lab or office settings may be likely to generalize to other perceivers' experienced contexts, though further research is required.

Participant Trait-Level Predictors

Though our theoretical focus was on within-person variation, we did find three between-person predictors of various trait impressions: anger, hunger, and energetic mood. While to our knowledge, these relationships have not been previously documented, they are consistent with some findings in related domains. For example, participants with higher average levels of anger rated targets lower on strength and dominance, consistent with functional accounts finding that anger was associated with lower perceptions of risk (Lerner & Keltner, 2000).

Similarly, participants with greater average hunger rated targets as stronger and more dominant. Previous work has found that people who are physically incapacitated perceive targets as larger and more muscular (Fessler & Holbrook, 2013). This conclusion is consistent with the present work to the extent that hunger correlates with feelings of weakness. Participants who feel hungrier on average may feel physically disadvantaged, and overestimate risk by perceiving targets as more dominant and formidable.

Finally, in novel social situations or when interacting with a stranger, energetic mood is characterized by a heightened tendency to approach positive stimuli (Elliot, 2006). Individuals who, on average, experienced higher energetic mood rated targets as friendlier and more trustworthy, with no impact on other traits—suggesting it was associated not with overall positivity, but with impressions relevant to approach appraisals.

Limitations

The present research was more externally valid than previous lab-based studies. Because participants were going about their day, any impressions formed of targets would better approximate the psychological contexts that scientists are hoping to capture in their research. Yet despite some advantages, the present design is still divorced from reality in some ways. Targets to be evaluated were still static and presented on a screen, and were not encountered naturally in the wild. Stimuli were contextually and emotionally neutral. We adopted this design intentionally to incrementally isolate one novel component of the day-to-day impression formation process (i.e., perceivers' experienced contexts), yet future research can continue to expand the external validity of impression formation research. Further, while dynamic in-person evaluations are not captured here, people do regularly evaluate others from static photographs (e.g., dating apps, social media) in which targets are embedded in different contexts. For instance, target contexts

such as visual scenery and the presence of other people can influence judgments of trustworthiness (Brambilla et al., 2018; Mattavelli et al., 2021), emotion (Barrett & Kensinger, 2010), and attractiveness (Carragher et al., 2021). While the present work explores perceiver contexts, more work is necessary to understand how perceiver and target contexts interact to shape impressions.

Second, the present work operationalizes perceivers' "day-to-day contexts" as a limited combination of environmental features, mood, physiological states, and psychological situations that were somewhat subjectively chosen by the researchers. To the extent that other perceiver contexts meaningfully impact impression formation, our estimates of contextual influence will be underestimates. Our conclusions are limited to perceiver contexts in which participants are able to complete a study on their phone. Responding to a survey on their phone may have momentarily removed perceivers from their experienced context. Moreover, this design may limit the identification of specific contexts in which participants are unable or unwilling to respond to their phone. This may have contributed to low variance in the three categorical variables that had low power in our study (Are you with strangers? Are you with known others? Are you inside or outside?). Results for these three variables should therefore be viewed with caution. Although these contexts do not capture the range of all possible perceiver contexts, we have sampled regularly-experienced, day-to-day contexts. Future work could explore whether other (e.g., extreme, unusual) perceiver contexts reveal meaningful variation in impressions not captured here.

Finally, the longitudinal design necessitated a trade-off between comprehensiveness in our measures and minimizing participant fatigue to maximize response rate as they went about their day. The limited stimulus set used does not represent the diverse population of individuals

who evaluated them, and future research might explore whether these contextual influences hold for different, more diverse, and less controlled stimuli. Although we used fewer stimuli than is typically reported in previous research, the present work focuses on perceiver context effects—and we do not expect our estimates of these effects to be biased by the limited number of stimuli. For example, across all 6 traits, our estimates of the perceiver-by-target ICCs, perceiver-ICCs, and target-ICCs replicate those reported in other studies with much larger (and more diverse) stimuli sets (e.g., ~800; Hehman et al., 2017; Xie et al., 2019). The correlation of trait ratings across timepoints (r = .66 in exploratory dataset, r = .61 in confirmatory dataset) was similar to those observed in datasets with more stimuli (r = .72; Hehman et al., 2017). We did not include any target-level predictors (e.g., target race, target gender) in our model, given low power to detect target-level effects. Finally, the use of a small, controlled set of context-neutral stimuli may have helped isolate any observed intraindividual variance to perceiver factors.

Conclusion

Impression formation researchers have long considered that perceivers' experienced context might be a meaningful source of variation in impressions. The present work contributes by testing this possibility, finding limited evidence that perceivers' contexts are an important factor in impressions. Perceiver context alone does not systematically influence trait impressions in a consistent manner—suggesting that perceiver and target idiosyncrasies are the most powerful drivers of social impressions. Importantly, we found no evidence to suggest that perceivers' experienced contexts could shape face impressions in a systematic way. This result tentatively suggests that the conclusions drawn from most social psychology research on impression formation, in which participants are seated in front of a computer, may be robust to

fluctuations in day-to-day perceiver experiences of mood, environment, and perceived psychological situation.

References

Abele, A., & Petzold, P. (1994). How does mood operate in an impression formation task? An information integration approach. *European Journal of Social Psychology*, *24*(1), 173–187.

Ballew, C. C., & Todorov, A. (2007). Predicting political elections from rapid and unreflective face judgments. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(46), 17948–17953. https://doi.org/10.1073/pnas.0705435104

Barrett, L. F., & Kensinger, E. A. (2010). Context is routinely encoded during emotion perception. *Psychological Science*, *21*(4), 595–599.

Bates, D., Mächler, M., Bolker, B. M., & Walker, S. C. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1). https://doi.org/10.18637/jss.v067.i01

Bauer, D. J., & Curran, P. J. (2003). Distributional assumptions of growth mixture models: Implications for overextraction of latent trajectory classes. *Psychological Methods*, *8*(3), 338.

Bjornsdottir, R. T., & Rule, N. O. (2017). The visibility of social class from facial cues. *Journal of Personality and Social Psychology*, *113*(4), 530.

Blair, I. V. Y., Judd, C. M., & Chapleau, K. M. (2004). The influence of Afrocentric facial features in criminal sentencing. *Psychological Science*, *15*(10), 674–679.

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*, 34–42.

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

Brown, N. A., Neel, R., & Sherman, R. A. (2015). Measuring the evolutionarily important goals of situations: Situational affordances for adaptive problems. *Evolutionary Psychology*, *13*(3), 1474704915593662.

Bürkner, P.-C. (2017). brms: An R Package for Bayesian Multilevel Models Using Stan. *Journal of Statistical Software*, *80*(1), 1–28. https://doi.org/10.18637/jss.v080.i01

Carragher, D. J., Thomas, N. A., & Nicholls, M. E. (2021). The dissociable influence of social context on judgements of facial attractiveness and trustworthiness. *British Journal of Psychology*.

Duarte, J., Siegel, S., & Young, L. (2012). Trust and credit: The role of appearance in peer-to-peer lending. *The Review of Financial Studies*, *25*(8), 2455–2484.

Elliot, A. J. (2006). The hierarchical model of approach-avoidance motivation. *Motivation and Emotion*, *30*(2), 111–116.

Fessler, D. M. T., & Holbrook, C. (2013). 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., & Snyder, J. K. (2012). Weapons make the man (larger): Formidability is represented as size and strength in humans. *PloS One*, *7*(4).

Forgas, J. P. (1992). On mood and peculiar people: Affect and person typicality in impression formation. *Journal of Personality and Social Psychology*, *62*(5), 863.

Forgas, J. P., & Bower, G. H. (1987). Mood effects on person-perception judgments. *Journal of Personality and Social Psychology*, *53*(1), 53.

Freeman, J. B., Stolier, R. M., & Brooks, J. A. (2020). Dynamic interactive theory as a domain-general account of social perception. In *Advances in Experimental Social Psychology* (Vol. 61, pp. 237–287). Elsevier.

Hehman, E., Stolier, R. M., Freeman, J. B., Flake, J. K., & Xie, S. Y. (2018). Toward a comprehensive model of face impressions: What we know, what we do not, and paths forward. *Social and Personality Psychology Compass*, *13*(2), e12431. https://doi.org/10.1111/spc3.12431

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*, *113*(4), 513–529.

Hester, N., Xie, S. Y., & Hehman, E. (2021). Little Between-Region and Between-Country Variance When Forming Impressions of Others. *Psychological Science*.

Heynicke, M., Rau, R., Leising, D., Wessels, N., & Wiedenroth, A. (2021). Perceiver Effects in Person Perception Reflect Acquiescence, Positivity, and Trait-Specific Content: Evidence From a Large-Scale Replication Study. *Social Psychological and Personality Science*. https://doi.org/10.1177/19485506211039101

Holbrook, C., Galperin, A., Fessler, D. M. T., Johnson, K. L., Bryant, G. A., & Haselton, M. G. (2014). If looks could kill: Anger attributions are intensified by affordances for doing harm. *Emotion*, *14*(3), 455.

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

Horstmann, K. T., Rauthmann, J. F., & Sherman, R. A. (2017). Measurement of situational influences. *The SAGE Handbook of Personality and Individual Differences*, 465–484.

Hox, J. J., & Roberts, J. K. (2011). *Handbook of advanced multilevel analysis*. Psychology Press.

Jaeger, B., Evans, A., & van Beest, I. (2019). *Facial appearances and electoral success: Does regional corruption moderate preferences for trustworthy-looking politicians?*

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

Kawakami, K., Amodio, D. M., & Hugenberg, K. (2017). Intergroup Perception and Cognition: An Integrative Framework for Understanding the Causes and Consequences of Social

Categorization. In *Advances in Experimental Social Psychology* (1st ed., Vol. 55). Elsevier Inc. https://doi.org/10.1016/bs.aesp.2016.10.001

Kenny, D. A. (2019). *Interpersonal perception: The foundation of social relationships*. Guilford Publications.

Kunda, Z., & Thagard, P. (1996). Forming Impressions From Stereotypes, Traits, and Behaviors: A Parallel-Constraint-Satisfaction Theory. *Psychological Review, 103*(2), 284–308.

Lerner, J. S., & Keltner, D. (2000). Beyond valence: Toward a model of emotion-specific influences on judgement and choice. *Cognition & Emotion*, *14*(4), 473–493.

Ma, D. S., Correll, J., & Wittenbrink, B. (2015). The Chicago face database: A free stimulus set of faces and norming data. *Behavior Research Methods*. https://doi.org/10.3758/s13428-014-0532-5

Macrae, C. N., & Bodenhausen, G. V. (2000). Social cognition: Thinking categorically about others. *Annual Review of Psychology*, *51*, 93–120. https://doi.org/10.1146/annurev.psych.51.1.93

Maner, J. K., Kenrick, D. T., Becker, D. V., Robertson, T. E., Hofer, B., Neuberg, S. L., Delton, A. W., Butner, J., & Schaller, M. (2005). Functional projection: How fundamental social motives can bias interpersonal perception. *Journal of Personality and Social Psychology*, *88*(1), 63.

Mattavelli, S., Masi, M., & Brambilla, M. (2021). Not Just About Faces in Context: Face–Context Relation Moderates the Impact of Contextual Threat on Facial Trustworthiness. *Personality and Social Psychology Bulletin*, 01461672211065933.

Matthews, G., Jones, D. M., & Chamberlain, A. G. (1990). Refining the measurement of mood: The UWIST mood adjective checklist. *British Journal of Psychology*, *81*(1), 17–42.

Merz, E. L., & Roesch, S. C. (2011). A latent profile analysis of the Five Factor Model of personality: Modeling trait interactions. *Personality and Individual Differences*, *51*(8), 915–919.

Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural Equation Modeling: A Multidisciplinary Journal*, *14*(4), 535–569.

Oh, D., Dotsch, R., Porter, J., & Todorov, A. (2019). Gender biases in impressions from faces: Empirical studies and computational models. *Journal of Experimental Psychology: General*.

Olivola, C. Y., & Todorov, A. (2010). Elected in 100 milliseconds: Appearance-Based Trait Inferences and Voting. *Journal of Nonverbal Behavior*, *34*(2), 83–110. https://doi.org/10.1007/s10919-009-0082-1

Parrigon, S., Woo, S. E., Tay, L., & Wang, T. (2017). CAPTION-ing the situation: A lexically-derived taxonomy of psychological situation characteristics. *Journal of Personality and Social Psychology*, *112*(4), 642.

Pastor, D. A., Barron, K. E., Miller, B. J., & Davis, S. L. (2007). A latent profile analysis of college students' achievement goal orientation. *Contemporary Educational Psychology*, *32*(1), 8–47.

Peugh, J., & Fan, X. (2013). Modeling unobserved heterogeneity using latent profile analysis: A Monte Carlo simulation. *Structural Equation Modeling: A Multidisciplinary Journal*, *20*(4), 616–639.

Raftery, A. E. (1995). Bayesian model selection in social research. *Sociological Methodology*, 111–163.

Rammstedt, B., & John, O. P. (2007). Measuring personality in one minute or less: A 10-item short version of the Big Five Inventory in English and German. *Journal of Research in Personality*, *41*(1), 203–212.

Rau, R., Carlson, E. N., Back, M. D., Barranti, M., Gebauer, J. E., Human, L. J., Leising, D., & Nestler, S. (2021). What is the structure of perceiver effects? On the importance of global positivity and trait-specificity across personality domains and judgment contexts. *Journal of Personality and Social Psychology*, *3*(120), 745–764.

Rauthmann, J. F., Gallardo-Pujol, D., Guillaume, E. M., Todd, E., Nav, C. S., Sherman, R. A., Ziegler, M., Jones, A. B., & Funder, D. C. (2014). The situational Eight DIAMONDS: A taxonomy of major dimensions of situation characteristics. *Journal of Personality and Social Psychology*, *107*(4), 677–718. https://doi.org/10.1037/a0037250

Rauthmann, J. F., & Sherman, R. A. (2015). Ultra-brief measures for the situational eight DIAMONDS domains. *European Journal of Psychological Assessment*.

Rauthmann, J. F., & Sherman, R. A. (2018). The Description of Situations: Towards replicable domains of psychological situation characteristics. *Journal of Personality and Social Psychology*, *114*(3), 482–488. https://doi.org/10.1037/pspp0000162

Rosenberg, J., Beymer, P., Anderson, D., van Lissa, C. J., & Schmidt, J. (2019). TidyLPA: An R package to easily carry out Latent Profile Analysis (LPA) using open-source or commercial software. *Journal of Open Source Software*, *4*(44), 978.

Stolier, R. M., Hehman, E., & Freeman, J. B. (2020). Trait knowledge forms a common structure across social cognition. *Nature Human Behaviour*, *4*(4), 361–371.

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 of the United States of America*, *115*(37), 9210–9215. https://doi.org/10.1073/pnas.1807222115

Sutherland, C. A. M., Burton, N. S., Wilmer, J. B., Blokland, G. A. M., Germine, L., Palermo, R., Collova, J. R., & Rhodes, G. (2020). Individual differences in trust evaluations are shaped mostly by environments, not genes. *Proceedings of the National Academy of Sciences*, *117*(19), 10218–10224.

Thai, S., & Page-Gould, E. (2018). ExperienceSampler: An open-source scaffold for building smartphone apps for experience sampling. *Psychological Methods*, *23*(4), 729.

Tibshirani, R. (1996). Regression shrinkage and selection via the lasso. *Journal of the Royal Statistical Society: Series B (Methodological)*, *58*(1), 267–288.

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*(15), 1–27. https://doi.org/10.1146/annurev-psych-113011-143831

Wilson, J. P., Hugenberg, K., & Rule, N. O. (2017). Racial Bias in Judgments of Physical Size and Formidability: From Size to Threat 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

Wilson, J. P., & Rule, N. O. (2015). Facial Trustworthiness Predicts Extreme Criminal-Sentencing Outcomes. *Psychological Science*, *26*(8), 1325–1331. https://doi.org/10.1177/0956797615590992

Xie, S. Y., Flake, J. K., & Hehman, E. (2019). Perceiver and target characteristics contribute to impression formation differently across race and gender. *Journal of Personality and Social Psychology*, *117*(2), 364.

Xie, S. Y., Flake, J. K., Stolier, R. M., Freeman, J. B., & Hehman, E. (2021). Facial impressions are predicted by the structure of group stereotypes. *Psychological Science*, *32*(12), 1979–1993. https://doi.org/10.1177/09567976211024259

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 : An Official Journal of the Society for Personality and Social Psychology, Inc*, *7*(3), 194–215.

Transparency

Author Contributions

Conceived research: All authors. Methodology: All authors. Data Curation: SYX. Analysis: SYX, EH. Writing—Original Draft: SYX. Writing—Review and Editing: All authors.

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Supplemental Material

Supplemental material is available online with this article.

Note

1. R code:

   lmer(TraitRating ~ 1 + (1|PerceiverID) + (1|TargetID) + (1|ContextID) + (1|PerceiverID: TargetID) + (1|ContextID: PerceiverID) + (1|ContextID: TargetID), data)

CHAPTER 6

Situational affordances constrain first impressions from faces

(Xie & Hehman, to be submitted)

Preface to Chapter 6

Chapter 5 explores the extent to which facial impressions vary across naturalistic contexts experienced by people going about their daily lives. This research adopted a novel experience-sampling paradigm to track daily changes in participants' experienced contexts (e.g., mood, environment, physiology, psychological situation) as they formed impressions of faces, and used a rigorous statistical framework to decompose the variance in facial impressions. Overall, there was minimal evidence that everyday perceiver-contexts contributed meaningful variance in facial impressions. Contexts experienced by perceivers did not systematically shift facial impressions, and this conclusion did not vary across different perceivers experiencing different contexts—indicating that any differences in how individuals form facial impressions are unlikely to be driven by day-to-day experienced contexts, at least within the span of two weeks. In contrast, target characteristics (e.g., facial cues, social identity), more stable perceiver characteristics (e.g., personality, long-term development), and their interactions are more important for driving facial impressions. Consistent with this interpretation, a secondary analysis revealed stable differences across perceivers in how they form impressions. Over a two-week period, participants who reported feeling more energetic than others judged targets as friendlier and more trustworthy, and those who reported feeling hungrier and less angry than others judged targets as more dominant and physically strong (Xie et al., in press).

Chapter 5 makes several original methodological and theoretical contributions to the literature. Previously, basic descriptive research on how impression formation might be shaped by real-world contexts—and the extent to which these contexts matter for impression formation, compared to perceiver or target characteristics—did not exist. This was the first study to examine how perceiver-contexts outside of controlled laboratory settings impact impressions, and it

demonstrates how impression formation can be studied in a more ecologically valid way. Moreover, this work illustrates the use of a novel strategy to identify qualitatively distinct contexts from combinations of quantitative contextual variables, combined with a rigorous multilevel modelling framework to quantitatively describe the extent to which different naturalistic contexts contribute variance in facial impressions. Thus, Chapter 5 fulfills the overarching aims of this dissertation by quantitatively characterizing the impact of real-world contexts on impression formation, and comparing its impact to known determinants of facial impressions.

However, one limitation of this research is that targets are still being evaluated in the context of an impression formation task. The study in Chapter 5, and the vast majority of studies in the impression formation literature, ask perceivers to form impressions of individuals who bear no relevance (real or manipulated) to the perceiver: the impression formation activity is "goal-neutral", in that perceivers are forming impressions of targets for the sake of forming impressions. How might the process of impression formation change when perceivers are situated in contexts that are *not* goal-neutral? Some past work has found that being in a threatening context changes the way that people perceive objective attributes of the target (e.g., physical size, height; Fessler et al., 2012; Holbrook et al., 2016). This suggests that perceptions of targets are influenced by contextual cues (e.g., presence of weapons) which make certain motives more salient and relevant (e.g., self-protection), compared to a context absent these relevant cues (Brown et al., 2015; Neel et al., 2017). Critically, empirical work testing this theoretical explanation in the domain of impression formation is conspicuously absent, and how facial impressions generally vary as a function of situational goals remains unclear.

To that end, the final study of this dissertation (Chapter 6) experimentally tests how salient contextual goals impact the general structure of trait impressions inferred from faces. This research empirically evaluates the theoretical mechanism proposed in the previous paragraph. Specifically, situational affordances (i.e., opportunities or obstacles to fulfill one's goals) may exert strong constraints on the face-trait space (Hypothesis 1), causing perceivers to attend to situationally relevant cues and form an impression on traits relevant to those cues—which then influence impressions on other, less situationally relevant traits (Hypothesis 2). The main aim of this next chapter is to test whether the structure of facial impressions becomes more intercorrelated (i.e., tightly constrained) in contexts where fundamental motives are made salient (e.g., mate-seeking, self-protection, disease avoidance), compared to a goal-neutral context. This research focuses on fundamental motives shared by most humans (Kenrick et al., 2010; Schaller et al., 2017) instead of artificial goals generated by the research context, to ensure that the goals in the experimental conditions are sufficiently relevant to the perceiver. Further, a second objective of this research is to identify the situationally relevant trait in each context, and test whether impressions on this "central" trait predicts impressions on other, less central traits.

Chapter 6 fulfills the overarching aims of this dissertation by experimentally manipulating perceivers' situational goals during impression formation, and then comparing the face-trait space across neutral and goal-relevant contexts. This research tests the causal claim that perceivers form impressions differently when they experience situations that are *goal-relevant*, which affords opportunities or obstacles relevant to fundamental social motives. Specifically, facial impressions should become more strongly interrelated, and centered on goal-relevant traits, during these situations. Building on the analytic approach introduced in Chapter 3 and extended in Chapter 4, this research models the representational structure of facial impressions

(i.e., face-trait space) by using correlations between any pair of trait ratings inferred from faces (e.g., correlation between ratings of competence and ratings of trustworthiness), and statistically compares the structure of this face-trait space across neutral versus goal-relevant contexts within a rigorous, cross-classified multilevel framework. Critically, whereas Chapter 5 examined how facial impressions vary in real-world contexts absent any specific situational goals, this next chapter directly manipulates the goal relevance of situations in which perceivers are situated when they form impressions. Thus, this study was designed to provide causal evidence in support of—or contrary to—the hypothesis that psychologically meaningful situations impact the way people form impressions of others.

Xie, S. Y., & Hehman, E. (in prep). Situational affordances constrain first impressions from faces.

Abstract

Humans spontaneously attribute a rich variety of traits (e.g., trustworthy, competent) to strangers based on facial appearance. Despite decades of research on these facial first impressions, few studies have investigated how situational affordances relevant to human perceivers impact impression formation. Nearly all existing research comes from participants forming impressions of targets who bear no relevance (real or manipulated) to the participant. Here, we tested whether situational affordances (i.e., opportunities or obstacles to fulfilling one's goals) related to three fundamental social motives—mate-seeking, self-protection, and disease avoidance—constrain the way that perceivers form impressions from faces. Across 167,951 ratings from 400 Canadian undergraduates, situational affordances caused the structure of facial impressions to change, generally becoming more constrained when targets were rated in goal-relevant contexts versus a goal-neutral context absent any affordances. These changes may arise from participants forming impressions on one central, goal-relevant trait, which influences ratings on other less-relevant traits.

Keywords: face perception, impression formation, social cognition, attitudes, context effects, affordances

Introduction

People readily judge others by their facial appearance. Within milliseconds of seeing a face, we attribute stable characteristics to that individual (Willis & Todorov, 2006), such as whether they are competent (Todorov et al., 2005), approachable (Oldmeadow et al., 2013), or high or low status (Bjornsdottir & Rule, 2017). Regardless of accuracy (see Jaeger et al., 2020; Todorov et al., 2015), facial impressions influence our cognition and behavior, with downstream consequences for society—predicting who we vote into office (Ballew & Todorov, 2007; Hehman, Carpinella, et al., 2014), convict in court (Blair et al., 2004; Wilson & Rule, 2015), and deem worthy of a loan (Duarte et al., 2012). For better or worse, these initial judgments are the bedrock of human interactions. As such, understanding how such impressions are formed is vital.

Contextualized Impression Formation

Naturally, impression formation does not occur in a vacuum. Every impression requires a perceiver and a target, and both are embedded within the broader context of one's culture, circumstances, and current situation (Over & Cook, 2018; Smith & Collins, 2009; Turner et al., 1994). Yet despite decades of impression formation research, the role that situational factors play in shaping impressions has received little empirical attention. Most of the extant literature is situated in ecological theories that highlight the functional significance of face perception, emphasizing how characteristics of the *target* being perceived (e.g., facial morphology, affect, social identity) elicit trait judgments in a relatively consistent manner across different observers (Adams et al., 2012; Cloutier et al., 2005; Ekman & Friesen, 1971; Oosterhof & Todorov, 2008; Zebrowitz & Montepare, 2008). Yet perceivers also participate in the impression formation process, dynamically interpreting and representing targets by negotiating "bottom-up" perceptual information with pre-existing "top-down" associations in the mind (Freeman et al., 2020;

Freeman & Ambady, 2011; Kenny, 2019; Macrae & Bodenhausen, 2000; Van Overwalle & Labiouse, 2004; Zebrowitz et al., 2003). For instance, even perceivers in the same culture show considerable variability in their trait judgments of the same targets (Hehman et al., 2017; Hester et al., 2021; Hönekopp, 2006; Xie et al., 2019), suggesting that idiosyncrasies in how perceivers process, interpret, and represent information influence how they form impressions.

To the extent that contextual factors are psychologically meaningful, these factors may shape the impression formation process. For example, consider the contrast between seeing a stranger during a speed-dating event versus a nighttime walk. A target with a certain set of characteristics (e.g., confident, assertive, physically strong) may appear attractive at a speed-dating event that affords romantic opportunities—but may appear to the perceiver as threatening in a dark street at night which affords obstacles to one's goal of self-protection. Intuitively, it is easy to imagine the psychological impact that these situations may have on first impressions. Yet empirical research on how situations (and the goals that they afford) systematically impact impression formation does not exist. The current research addresses this conspicuous gap in the literature. In the next section, we summarize the literature on situational affordances, and describe the theorized mechanism by which these affordances might impact facial impressions.

Situational Affordances

People experience situations that vary in psychologically meaningful ways. These situations may provide various opportunities and obstacles (i.e., *affordances*; Gibson, 1979; McArthur & Baron, 1983) relevant to one's fundamental social motives (Brown et al., 2015; Kenrick et al., 2010; Neel et al., 2017). For instance, attending a speed-dating event affords opportunities to meet and socialize with potential romantic partners, whereas walking along a dark street at night creates obstacles to one's self-protection motive (Schaller et al., 2017). These

affordances are intuitive: humans reflexively and efficiently process the psychological properties of situations (Rauthmann et al., 2015; Rauthmann & Sherman, 2019; Schellenberg, 2008; Sherman et al., 2015; Yang et al., 2009), which shapes their construal of their current circumstances and provides context for subsequent behaviour (Mischel, 1968; Neel et al., 2017; Rauthmann, 2016; Rauthmann & Sherman, 2019; Ross & Nisbett, 1991). Thus, situations vary in how they are perceived as a function of the adaptive opportunities and challenges that they afford.

People are embedded within situations when they form impressions of others (Ittelson & Cantril, 1954). Perceivers who recognize the affordances of any given situation may form impressions differently (to the extent that these affordances are relevant). For example, in contexts that afford harm (e.g., weapons are present), and when evaluating racialized targets that are stereotypically associated with aggression, perceivers readily evaluate targets as angrier (Holbrook et al., 2014; Maner et al., 2005), physically larger (Fessler et al., 2012), and more threatening (Wilson, Hugenberg, et al., 2017) compared to "neutral" contexts (or targets who are not stereotypically associated with threat). This suggests that participants may process targets in a different manner as a function of the threat context, due to shifts in multiple levels of representation. Specifically, mental relations between physical features (e.g., height, size) and trait inferences (e.g., threat) may become more strongly correlated when threat is contextually salient, versus a neutral context. However, it is unclear whether this theoretical explanation extends to other trait judgments beyond physical formidability—and to other contexts beyond threat. Understanding how other trait impressions are impacted by different contextual affordances is vital, because people develop rich concepts about others beyond judgments of threat (Jones et al., 2018; Lin et al., 2021; Sutherland et al., 2016).

The Structuring Role of Situational Affordances

Spontaneous trait inferences from faces can be modelled as mappings between positions in "morphological feature space" and positions in "conceptual trait space", arising from perceivers' learned face–trait experiences (Conway et al., 2019; Over & Cook, 2018; Stolier, Hehman, Keller, et al., 2018). For example, people who learn through experience that two traits are conceptually related (e.g., aggressiveness and physical strength) should infer a trait from a face (e.g., aggressive) to the extent that they infer the other trait simultaneously from that face (e.g., physically strong). These "top-down" conceptual relations are then integrated into the processing and interpretation of "bottom-up" perceptual cues in faces (Freeman et al., 2020). Specifically, a perceiver may associate aggression with a specific facial cue (e.g., downturned eyebrows), and upon perceiving this cue, integrate their conceptual associations between aggressiveness and physical strength into their impression of the target—perceiving the target as both aggressive and physically strong (Stolier, Hehman, Keller, et al., 2018; Xie et al., 2021).

The Present Research

Building on this theoretical framework, mappings in the "conceptual trait space" which guide first impressions may shift dynamically as a function of situational affordances. For example, a perceiver holds prior beliefs about the relationship between attractiveness and trustworthiness, and leverage theses associations to form an impression when they have limited information about a target (Monroe et al., 2017; Over & Cook, 2018; Stolier, Hehman, Keller, et al., 2018). These conceptual associations, which the perceiver relies upon as a "template" during impression formation, may change when there are perceived opportunities in the current situation to find a mate, given the potential for social interaction. Thus, the mental relationship between trustworthiness and attractiveness may be context-bound as a function of goal relevance. We

theorize that situational affordances constrain the conceptual associations that guide facial impressions: when people are seeking a mate, attractiveness may scale with trustworthiness (and many other social attributions), whereas when people go about their daily lives (i.e., neutral context), attractiveness and trustworthiness may be less correlated.

Following this logic, prior expectations for the associations among traits may shift when goal affordances become salient, such as when a situation becomes psychologically relevant to the perceiver. Impression formation in these situations hinges on rapidly and efficiently processing many features of the self, target, and situation, to produce a timely action response—and may therefore leverage a more heuristic style of information processing to quickly negotiate a large number of features, streamlining the impression formation process (Becker et al., 2010; Bohner et al., 1995; Chaiken et al., 1996; Markman & Otto, 2011).

Further, situations are more likely to be perceived as relevant if they afford opportunities or obstacles to achieve fundamental human motives (Brown et al., 2015), such as mate-seeking, self-protection, or disease avoidance. Thus, when certain fundamental motives (e.g., mate-seeking) are made salient due to the affordances of a situation (e.g., being at a speed-dating event), then the style of cognitive processing may shift to favour rapid, actionable judgments over accuracy (Tversky & Kahneman, 1974; Willis & Todorov, 2006). Formally, we theorize that the impression formation process becomes more constrained when situational affordances are salient, producing impressions that are (1) more strongly intercorrelated and (2) centered on a small number of goal-relevant traits. This allows perceivers to trade nuance and cognitive complexity (e.g., the stranger is attractive but may not be trustworthy) for speed and interpretability (e.g., the stranger is attractive and probably trustworthy) to produce an appropriate action.

To date, no research has tested whether (and to what extent) situational affordances constrain the space of trait impressions. The present research aims to fill that gap. Study 1 explores how perceivers form impressions of people across goal-relevant versus goal-neutral contexts when certain fundamental motives (e.g., mate seeking, self-protection, disease avoidance) are made relevant. We predict that compared to the neutral context, facial impressions in contexts with goal affordances will be more strongly intercorrelated on average, and centered on a small number of goal-relevant traits.

Methods

Procedure

Participants rated faces in one of four Context conditions (Mate-Seeking, Self-Protection, Disease Avoidance, Control), in a between-subjects design. Ratings of faces were obtained from participants randomly assigned to a Context. Specific goal affordances (e.g., mate-seeking) were made relevant by presenting participants with a mock smartphone app with a specific goal (e.g., dating app). These apps are available and used to similar ends in the real world. As part of the cover story, participants were informed that our lab collaborated with Montreal-based technology companies to assist in the development of apps locally situated in Montreal. Participants were asked to imagine that they are using the app as they realistically would in everyday life, and to evaluate the people presented in the app. Participants randomly assigned to the neutral context condition were presented with a mock smartphone app to simply evaluate faces.

Participants rated faces in response to questions such as “How attractive is this person?” on 1-“Not at all” to 7-“Very much” Likert-type scales, on 7 traits that commonly spontaneously arise when individuals observe others: Friendly, Trustworthy, Strong, Aggressive, Intelligent, Attractive, and Healthy (Oosterhof & Todorov, 2008; Sutherland et al., 2013, 2015, 2018; Willis

& Todorov, 2006; Zebrowitz et al., 2003). Each participant rated each target on multiple traits. The order of trait presentation was randomized across participants. Additionally, to minimize the effects of serial dependence (e.g., attractiveness ratings of one face depend on the preceding face's attractiveness; Kok et al., 2017), stimuli were presented in random order across participants. After rating each target, participants in any of the three experimental conditions made a binary choice relevant to the goal of the app (e.g., in the dating condition, "Are you interested in matching with this person?"). Finally, at the end of the study, participants were presented with data-quality checks (e.g., "Should we use your data? […]") and optional demographic questions (e.g., gender, ethnicity, age, sexual orientation, and relationship status). We also included an open-ended question asking participants to describe the criteria they used to form their evaluations, to allow for qualitative analysis of participants' thought process as they completed the tasks.

We investigated several goal-relevant contexts with affordances related to fundamental social motives (Kenrick et al., 2010; Schaller et al., 2017): (1) dating/mate seeking, (2) self-protection, (3) disease avoidance, and (4) a control condition with no context. These motives were selected due to the anticipated ease of experimentally inducing goal affordances related to these motives. In the dating condition, participants were presented with a mock dating app (see Supplementary Materials), rated each face on various traits, and made a binary Yes/No choice in response to the prompt, "Are you interested in matching with this person?" The self-protection condition depicted the app as a crime detection app that uses algorithms to detect criminal offenders based on facial appearance. In addition to rating faces, participants made a binary Yes/No choice in response to the prompt, "Do you think this person has committed a crime?" The disease avoidance condition depicted the app as a health-screening app to detect whether a

person has an infectious disease from their facial appearance. In addition to rating faces, participants made a binary Yes/No choice in response to the prompt, “Do you think this person is ill?” These binary-choice variables were included so that we could assess which traits were central or most relevant to each condition. Finally, in the control condition, participants were presented with faces in the context of a face-rating app, and asked to rate each face with no additional context.

Participants

An in-lab sample of 400 participants (100 per condition × 4 conditions) was planned [osf.io/shdy6]. A power analysis confirmed that we would be able to detect significant differences between the experimental conditions and the control condition at an effect size of 0.20. Participants were recruited from the McGill Psychology Human Participant Pool (SONA), and consisted of undergraduate students 18 years of age or older enrolled in Psychology courses at McGill. During recruitment, we oversampled by 10% to ensure we could reach our planned sample size after exclusions. Data cleaning followed pre-registered procedures. In total, 447 participants completed the study. We removed 13 participants who indicated in their end-of-study data quality survey that we should not use their data, removed 11 participants who were manually flagged by research assistants as having completed the study in a rush or as having their data “contaminated” (i.e., by other participants discussing their experimental conditions in the same room), and removed 23 participants for whom at least 50% of their ratings of the same trait were repeated across trials.

Overall, 400 participants were retained in analyses. Of these 400 participants, 90 were randomly assigned to the dating condition, 106 were assigned to the threat/self-protection condition, 100 were assigned to the disease-avoidance condition, and 104 were assigned to the

neural control condition. The participant sample was 88.3% female, 11.7% male, and 0.02% other, ranged in age from 18 to 44 (M = 20.42, SD = 2.16), and included: 225 White, 72 East Asian, 25 South Asian, 11 Black, 1 Aboriginal/Indigenous, 40 Other, 20 Biracial/Mixed, and 6 Decline to respond.

Stimuli

In-lab participants rated photos of naturalistic-looking, "deepfake" faces generated by *StyleGAN2* (Karras et al., 2019), consisting of 60 faces randomly drawn from a pool of 204 (102 female, 102 male) high-quality, naturalistic images of White faces. We limited data collection to White faces to ensure that any contextual effects were being driven by the experimental manipulation, instead of interactions with the target's race. In the dating condition, participants decided whether they would be evaluating male or female faces by indicating whether they were more attracted to men or women. In the threat/self-protection condition, all participants were shown male faces under the assumption that female faces would not be deemed sufficiently physically threatening to participants, and would fail to induce relevance of the self-protection motive. In the disease avoidance and control conditions, participants were randomly assigned to evaluate *either* male or female faces, to match the single-gender task design of the other conditions. This ensured that all participants, regardless of condition, rated either men or women.

Hypotheses

Hypothesis 1: More Constrained Face-Trait Space. We predicted that the average trait-pair correlation would be higher in contexts where goal affordances were made salient (mate-seeking, self-protection, disease avoidance), compared to a neutral control condition (Figure 1A) absent any situational affordances. This result would be evidence that the structure of facial impressions shifts across contexts, becoming more constrained (i.e., intercorrelated) in situations

with strong goal affordances (Figure 1B). This analysis was preregistered prior to analysis but during data collection [osf.io/shdy6].

Null Hypothesis. The null hypothesis is that there are no significant differences in the average trait-pair correlations in the experimental versus the control condition.

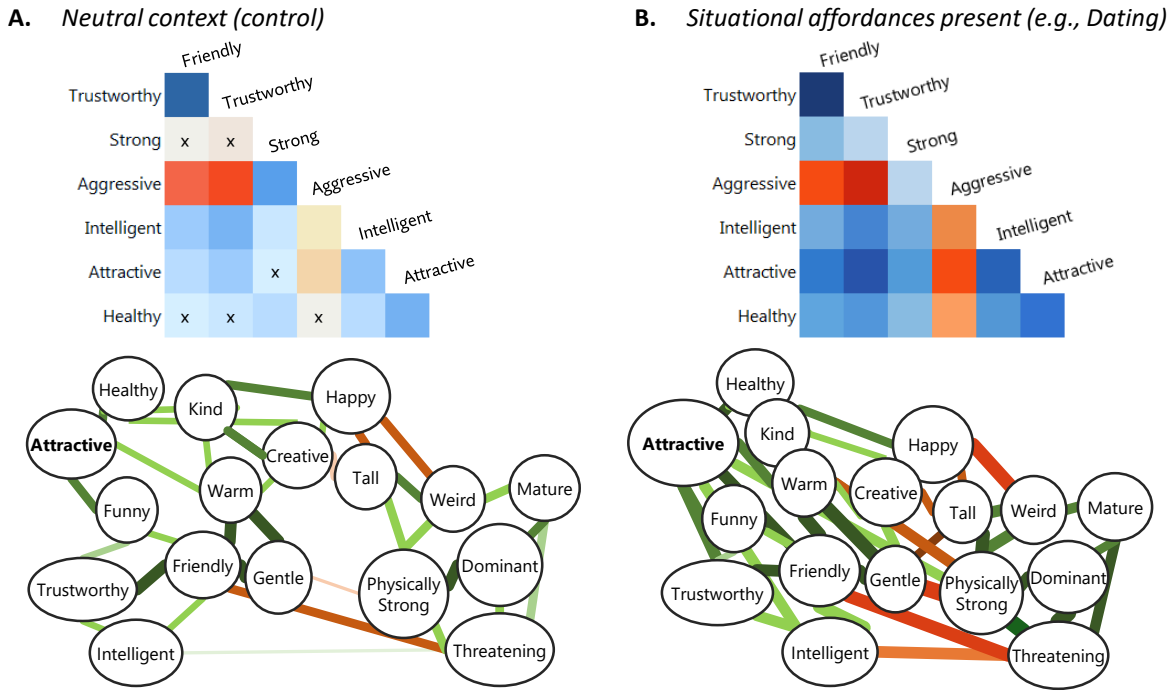


Figure 1. Hypothetical correlation structures of trait impressions inferred from faces (top). Their underlying conceptual representations are also depicted (bottom). The structure of facial impressions is expected to become more intercorrelated (i.e., tightly constrained) when (B) situational affordances are present, versus in (A) neutral contexts absent any relevant goals.

Hypothesis 2: Centrality of Traits. This exploratory analysis concerns the mechanism underlying any observed changes in the face-trait space. Goal-relevant traits were expected to have a stronger correlation on average (i.e., be more central) with all other traits, in the conditions where they were theorized to be goal-relevant (i.e., *attractive*: mate-seeking, *trustworthy*: self-protection, *healthy*: disease-avoidance), relative to the control condition.

For example, trait impressions of attractive and trustworthy might be correlated at $r = .4$ in a neutral context, but increase to $r = .7$ in a mate-seeking context (where 'attractive' is central), thereby increasing the average trait-pair correlation in the goal-relevant context. Here, a face-valid prediction was that the traits 'attractive', 'aggressive', and 'healthy' would be central to situations related to dating, self-protection, and disease avoidance respectively. However, which trait is central to each context is an empirical question. Therefore, we identified which traits were central to the face-trait space in each context by regressing participants' binary Yes/No responses in each experimental condition (e.g., Dating: "Are you interested in matching with this person?") on each of the 7 trait ratings, and testing which traits significantly increased the probability of responding "Yes" to the binary question in each experimental condition. We predicted that the traits 'attractive', 'trustworthy' (which is strongly negatively correlated with 'aggressive' at $r = -.80$; Xie et al., 2019), and 'healthy' would be central in the dating, threat, and disease-avoidance conditions respectively, and be significant predictors of this binary response in each condition.

Analytic Approach

To test whether situational affordances cause the structure of facial impressions to differ (i.e., becoming more constrained in goal-relevant contexts), we statistically compared the trait space of facial impressions across conditions. Extending previous work in this area, we represented the face-trait space as a correlation matrix of the weighted relationships (i.e., correlations) between different trait ratings inferred from faces (Stolier, Hehman, & Freeman, 2018; Stolier, Hehman, Keller, et al., 2018; Xie et al., 2021). We created a 7 × 7 trait correlation matrix for each target in each of the four conditions, producing four matrices per target. Correlations were Fisher-*z* transformed to allow statistical comparisons, and converted to

absolute values to allow us to test the hypothesis that the face-trait space becomes more strongly intercorrelated when situational affordances are present. See Figure 2 for a visualization of this analytic approach.

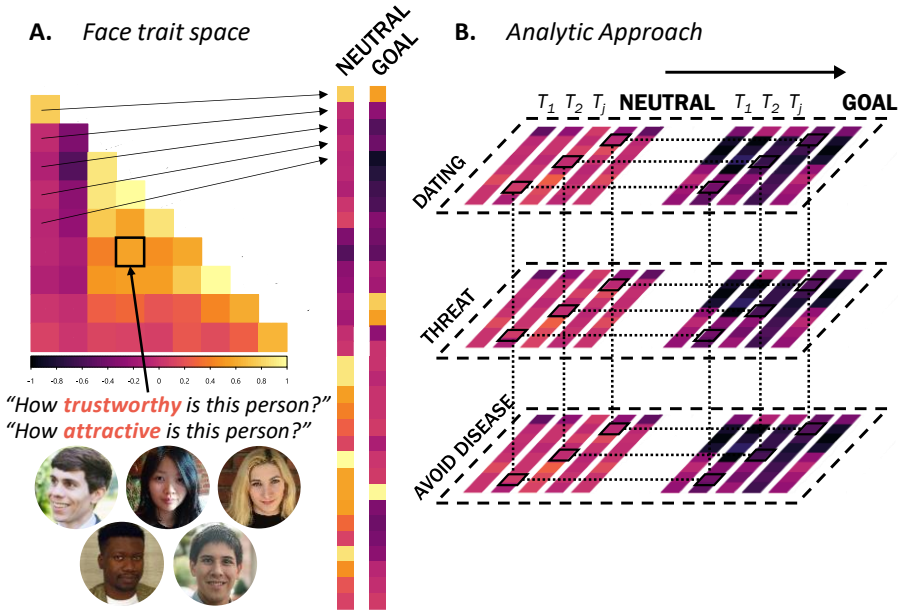


Figure 2. Example comparisons of perceivers' (A) correlation matrices from trait ratings of faces between (B) three different "goal-relevant" conditions versus the neutral control condition. For each trait-pair *k*, we test changes between target *j*'s face-trait space across goal-relevant versus neutral contexts.

Hypothesis 1: More Constrained Face-Trait Space. We built cross-classified multilevel models using the *lme4* package in R (Bates et al., 2015) to examine whether the face-trait space (i.e., a correlation matrix representing all trait-pair correlations) differed significantly between goal-relevant (dating, threat, disease avoidance) and the goal-neutral (control) conditions (Figure 2). The level-1 unit of analysis was the correlation between a pair of traits (e.g., healthy-friendly) aggregated across perceivers and nested within targets. Given 7 trait ratings per target, this amounted to 21 unique trait-pairs × 204 targets, resulting in 4,284 level-1 observations cross-classified within targets (*j*) and trait-pairs (*k*). Contexts (Dating, Threat, Disease Avoidance, and

Control) were represented as three dummy-coded level-1 categorical predictors in the model, where the Control (neutral context) condition served as the reference group (see Equation 3).

$$\begin{aligned}
&\text{Level 1: } Y_{ij} = \beta_{0jk} + \beta_{1j}Dating_{ijk} + \beta_{2j}Threat_{ijk} + \beta_{3j}Disease_{ijk} + R_{ijk} \quad (3)\\
&\text{Level 2: } \beta_{0jk} = \gamma_{000} + U_{0j0} + U_{00k}\\
&\qquad\quad \beta_{1jk} = \gamma_{100} + U_{1j0}\\
&\qquad\quad \beta_{2jk} = \gamma_{200} + U_{2j0}\\
&\qquad\quad \beta_{3jk} = \gamma_{300} + U_{3j0}
\end{aligned}$$

In this model, γ_{000} is the average trait-pair correlation (between any two traits) in the Neutral Context (control) condition. These correlations are aggregated across perceivers and nested within targets and trait-pairs, are Fisher-z transformed, and converted to absolute values in order to test our hypothesis. U_{0j0} is the random variation of target *j* around this average trait-pair correlation, averaging across all trait-pairs. U_{00k} is the random variation of trait-pair *k* around this average trait-pair correlation, averaging across all targets. The parameters $\gamma_{100}, \gamma_{200}, \gamma_{300}$ are the fixed effects of the categorical predictors. We expected these fixed effects to be significant and positive, indicating that the average trait-pair correlation is stronger (i.e., more interrelated in magnitude) in contexts with situational affordances versus the control condition.

However, one limitation of this analysis was that trait-pair correlations were aggregated across perceivers. In order to obtain trait-pair correlations, some aggregation is unavoidable. This approach functionally assumes that perceivers are "interchangeable" for each target, allowing us to obtain trait-pair correlations from the face-trait space of each target. Yet perceivers may disagree on the association between a pair of traits (e.g., for one perceiver, trustworthiness and attractiveness may be strongly related; but for another, uncorrelated; Stolier, Hehman, Keller, et al., 2018; Xie et al., 2021). To account for this perceiver variability, and test the robustness of any significant findings, we additionally examined perceiver variability in how much the face-

trait space shifted across different contexts. Similar to the above analysis, a multilevel model was built for all trait-pair correlations, except the level-1 unit would now be aggregated across targets and nested within perceivers. Functionally, this assumes that the face-trait space (aggregated across targets) may vary between perceivers. See Equation 4.

$$\text{Level 1: } TraitpairCorrelation_{ijk} = \beta_{0jk} + R_{ijk} \quad (4)$$
$$\text{Level 2: } \beta_{0jk} = \gamma_{000} + \gamma_{010}Dating + \gamma_{020}Threat + \gamma_{030}Disease + U_{0j0} + U_{00k}$$

In this model, γ_{000} is the average trait-pair correlation between any two traits in the Neutral Context condition. U_{0j0} is the random variation of perceiver *j* around this average trait-pair correlation, U_{00k} is the random variation of trait-pair *k* around this average, and $\gamma_{010}, \gamma_{020}, \gamma_{030}$ are the fixed effects of the contextual variables. These are now level-2 predictors because each participant can only be in one condition. If these fixed effects are significant, it would indicate that the average trait-pair correlation differs across conditions, even after accounting for random variability between perceivers. That is, even though two perceivers in the same condition may disagree on the relationship between any two traits (e.g., trustworthy and attractive), the average relationship between any two traits still differs across contexts. This result would support significant findings from the previous model (Equation 3).

Hypothesis 2: Trait Centrality. Situational affordances may constrain the face-trait space to become more intercorrelated because a few goal-relevant traits are driving inferences of other traits (Asch, 1946; Goldman et al., 1983; Hughes et al., 2017; Kelley, 1950; Neuberg & Fiske, 1987; Nisbett & Wilson, 1977; Orehek et al., 2010; Reynolds & Oakes, 2000). Here, we explored which traits were relevant or 'central' to the face-trait space across conditions.

Identifying Central Traits. We identified central traits by examining the predictive utility of each trait on social judgments relevant to the goals of a particular situation. Specifically, ratings on each of the 7 traits were entered as predictors into a multilevel logistic regression

model, where the outcome variable was the probability of making a positive response to the behavioural question in that experimental condition (e.g., in the Dating condition, "Are you interested in matching with this person?"), cross-classified within targets and perceivers. A separate model was built for each of the three conditions in which situational affordances were present (conditions 1-3). See Equation 5 for this model.

$$\begin{aligned}
&\text{Level 1: } \text{Logit}\left(P_{ijk}\middle|Y_{ijk}=1\right) = \beta_{0jk} + \\
&\qquad \beta_1 Friendly_{ijk} + \beta_2 Strong_{ijk} + \cdots + \beta_7 Trait_{ijk} + R_{ijk} \\
&\text{Level 2: } \beta_{0jk} = \gamma_{000} + U_{0j0} + U_{00k} \\
&\qquad \beta_{1jk} = \gamma_{100} \\
&\qquad \beta_{2jk} = \gamma_{200} \\
&\qquad \ldots \\
&\qquad \beta_{7jk} = \gamma_{700}
\end{aligned} \tag{5}$$

In this model, γ_{000} represents the conditional odds of responding "Yes" to the question in the contextual condition, averaged across all perceivers and targets at the average value of all 7 traits. Odds are cross-classified within targets and perceivers, where U_{0j0} is the random variation of perceiver *j* around this average, and U_{00k} is the random variation of target *k* around this average. The trait ratings are entered as level-1 continuous predictors, where there are 7 traits. The parameters $\gamma_{100}, \gamma_{200}, \ldots \gamma_{700}$ are the fixed effects of each trait rating on the odds of responding "Yes", conditional on other fixed and random effects. Significant fixed effects indicate that ratings on that trait significantly change the odds of responding "Yes" to the behavioural question in that condition, conditional on all other effects. Thus, the central trait in each context should be significant, and should have the largest effect on the odds of any perceiver responding "Yes" to any target.

Results

Hypothesis 1: Face-Trait Space

Figure 4 provides a descriptive bird's-eye view of trait-pair correlations across contexts.

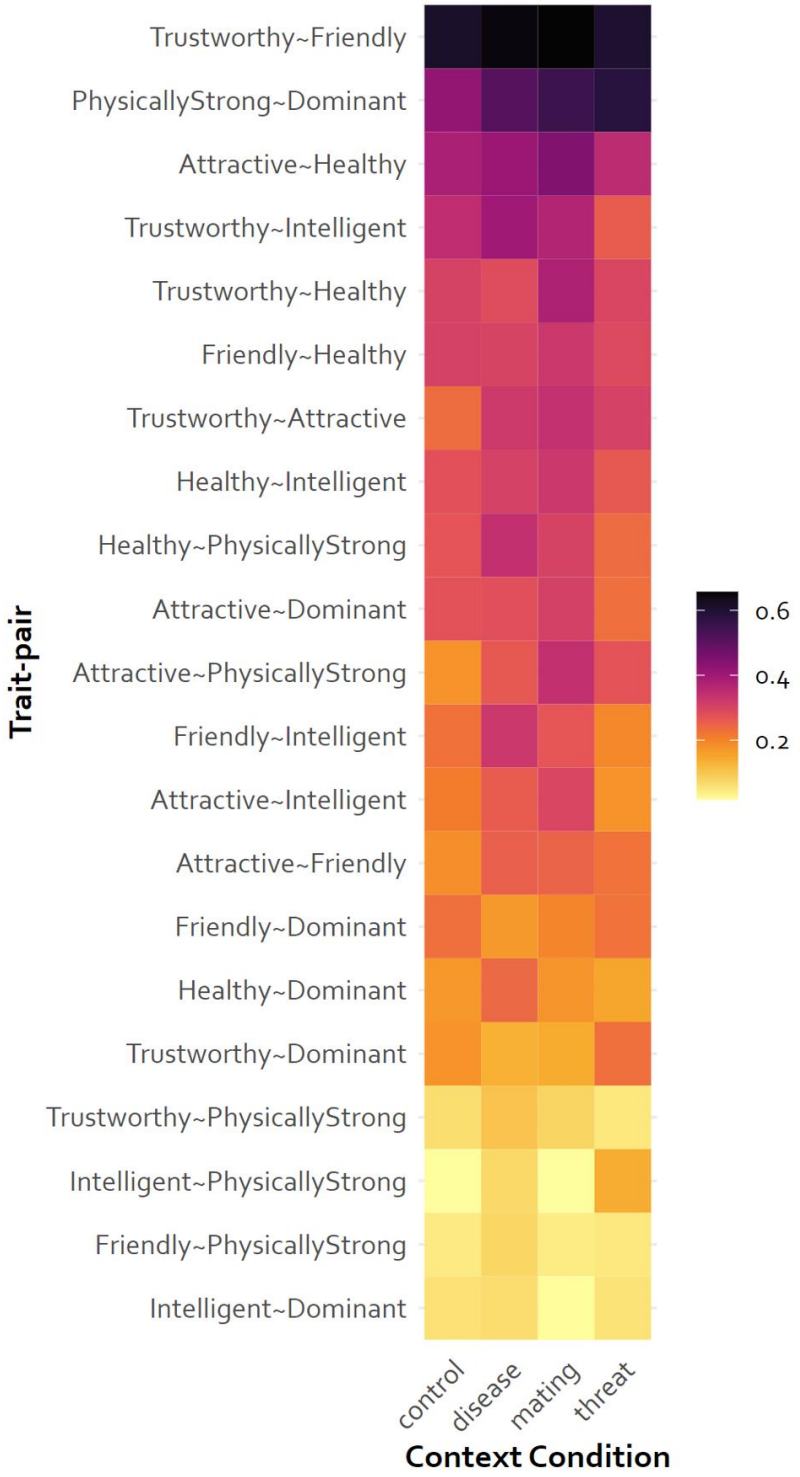


Figure 4. Trait-pair correlations from ratings of faces across three experimental contexts and one control context. Pearson correlation coefficients were Fisher-z transformed and converted into absolute values. Darker colours represent stronger magnitude of correlation (regardless of direction) between any pair of traits.

Results indicated that the structure of trait impressions inferred from faces (i.e., face-trait space) differed significantly across goal-relevant versus neutral contexts, partially supporting our hypothesis. As predicted, the face-trait space became more strongly intercorrelated (i.e., constrained) when targets were rated in a Dating context compared to a neutral context (γ_{100} = .07, 95% CI [.056, .085], β = .14, p < .001), and when targets were rated in a Disease-Avoidance context compared to a neutral context (γ_{200} = .04, 95% CI [.023, .050], β = .08, p < .001). However, contrary to expectations, the face-trait space became less strongly intercorrelated (i.e., differentiated) when targets were rated in a Threat/Self-Protection context compared to a neutral context (γ_{300} = -.03, 95% CI [-.040, -.014], β = -.04, p < .001). See Figure 5.

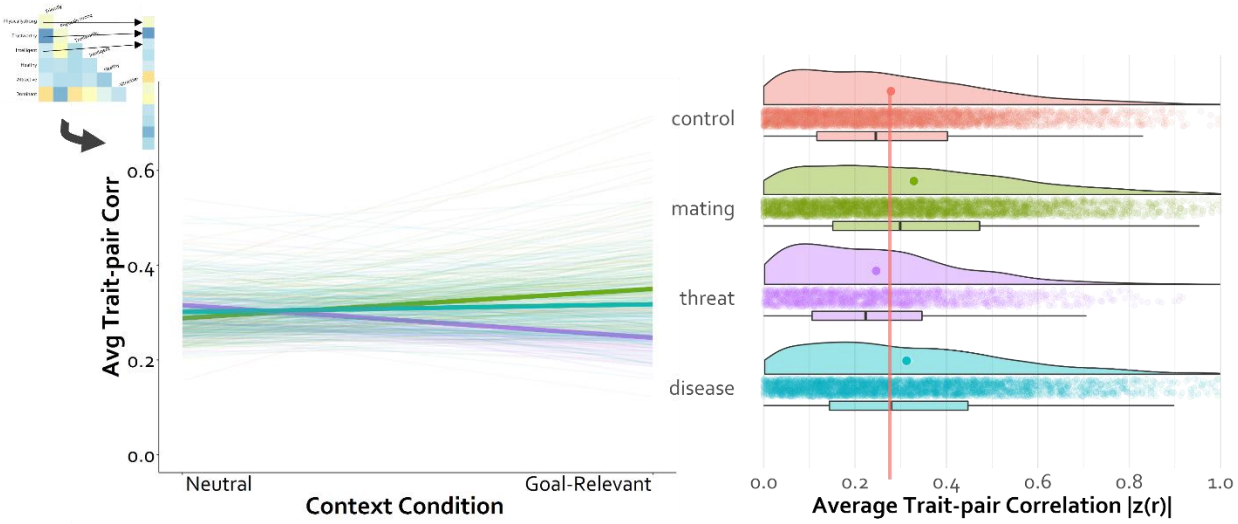


Figure 5. Left: Spaghetti plot of fixed effects that illustrate the expected change in the average intercorrelation of trait-pairs going from a neutral context to three goal-relevant contexts: dating/mate-seeking (green), disease-avoidance (teal), and threat/self-protection (purple). Individual lines represent the slope for a single target, and bold lines represent the average relationship across all targets. *Right:* Raincloud plots visualizing the means, boxplots, and distributions of these trait-pair correlations in each condition. All correlations are Fisher *z*-transformed and converted to absolute values, capturing magnitude regardless of direction.

As a robustness check, we repeated this analysis now aggregating across targets and nesting within perceivers, to ensure that variability in perceivers' trait-pair correlations would

not change results. As predicted, the face-trait space became more strongly intercorrelated (i.e., constrained) when perceivers were situated in a Dating context compared to a neutral context (γ_{010} = .03, 95% CI [.001, .054], β = .05, p = .049), and in a Disease-Avoidance context compared to a neutral context (γ_{020} = .03, 95% CI [.004, .056], β = .08, p = .03). However, contrary to expectations—and failing to replicate the pattern in the above analysis—the face-trait space did not significantly change when perceivers were situated in a Threat/Self-Protection context compared to a neutral context (γ_{030} = .017, 95% CI [-.001, .042], β = -.03, p = .20).

Overall, results supported our hypothesis for 2 of 3 goal-relevant contexts (mate-seeking, disease avoidance), but were inconsistent in the self-protection context. Qualitative analysis of participants' responses to the question, "What criteria did you use to make your decisions?" suggests that the manipulation failed in this condition. Threats to one's self-protection motive may not have been salient enough, as some participants reported feeling uncertain that any of the targets had committed a crime. Half of the participants struggled to explain their decision criteria. Across the 56 participants who reported focusing on specific traits to inform their final judgment, there was lack of consensus on which traits were important—particularly compared to the other goal-relevant contexts (see Table 1).

Table 1

Frequency of a trait being mentioned in an open-ended question about decision criteria

	attractive	trustworthy	friendly	phys. strong	dominant	intelligent	healthy
Control	9	16	22	6	9	7	9
Mating	**35**	15	17	3	6	11	3
Disease	4	2	4	2	1	0	**19**
Threat	2	**14**	12	12	10	3	3

Note: Bolded values indicate the trait that was hypothesized to be central in each context.

Hypothesis 2: Trait Centrality

Similarly, results from multilevel logistic regression were consistent with our hypotheses for 2 of 3 goal-relevant contexts (mate-seeking, disease avoidance), but not the self-protection context. See Table 2 for a summary of fixed effects across all three models.

Table 2

Fixed effects of trait ratings on the odds of making a goal-relevant behaviour

	Mate-Seeking			Disease Avoidance			Self-Protection		
	b	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*
Trait									
Attractive	**2.40**	.09	<.001	.01	.06	.876	**-.23**	.04	<.001
Trustworthy	**.65**	.07	<.001	.00	.05	.946	**-.94**	.04	<.001
Friendly	**.29**	.06	<.001	.01	.05	.791	**-.41**	.04	<.001
Phys. Strong	.07	.06	.246	-.08	.05	.065	**.20**	.04	<.001
Dominant	.09	.05	.078	.06	.04	.156	**.37**	.03	<.001
Intelligent	**.29**	.06	<.001	-.02	.05	.63	**.08**	.04	.019
Healthy	.06	.07	.366	**-1.79**	.06	<.001	**-.11**	.04	.005

Note. Bolded values are significant at $\alpha = .05$

In the Dating/Mate-seeking context, attractiveness was the largest significant predictor of the odds of responding "Yes" to the question, "Would you be interested in matching with this person?" A 1-unit increase in attractiveness ratings increased the odds of an affirmative response by 2.45 ($SE = .094$, $p < .001$), conditional on all other fixed and random effects. Although ratings of trustworthiness, friendliness, and intelligent also significantly predicted a Yes-response, these effects were more modest.

In the Disease Avoidance context, healthiness was the only significant predictor of the odds of responding "Yes" to the question, "Do you think this person has an illness?" A 1-unit increase in healthy ratings decreased the odds of an affirmative response by 1.79 ($SE = .06$, $p < .001$), conditional on all other fixed and random effects.

However, in the Threat/Self-Protection context, all of the traits were significant predictors of the odds of responding "Yes" to the question, "Do you think this person committed a crime?" Consistent with our hypothesis, trustworthiness ratings were most central in that trustworthiness had the largest effect on this response. A 1-unit increase in trustworthiness decreased the odds of an affirmative response by .94 (SE = .04, p < .001), conditional on all other fixed and random effects.

Exploratory Analyses

We conducted several post-hoc analyses to understand why the threat/self-protection context deviated from the expected pattern of results. First, based on the results from logistic regression, we identified the most central traits in each context as attractive, healthy, and trustworthy for the mate-seeking, disease avoidance, and self-protection contexts respectively. We then examined whether correlations between central traits with non-relevant traits (e.g., attractive~trustworthy, attractive~dominant in the mate-seeking context) were stronger than the correlations among non-relevant traits (e.g., trustworthy~dominant in the mate-seeking context) when targets were being evaluated in a goal-relevant context. In other words, we tested whether the interaction between *Trait-pair Relevance* (0 = a correlation between non-relevant traits, 1= a correlation between a central trait and a non-relevant trait) and *Goal Context* (0 = neutral context, 1 = goal-relevant context) was significant.

Results indicated that there was a significant interaction between Trait-pair Relevance and Goal Context for targets rated in the mate-seeking context (b = .045, SE = .01, p < .001). Thus, the correlations between attractiveness and all other traits were stronger than the correlations among all other traits by themselves (i.e., excluding attractiveness), when targets were rated in a mate-seeking context.

Results indicated the opposite effect for targets rated in the disease avoidance context (*b* = -.02, *SE* = .01, *p* = .004). Thus, the correlations between healthiness and all other traits were weaker than the correlations among all other traits by themselves (i.e., excluding healthiness), when targets were rated in a disease avoidance context.

Finally, there was no significant interaction in the threat/self-protection context (*b* = .004, *SE* = .01, *p* = .66). This indicates that the correlations between trustworthiness and all other traits did not differ in magnitude compared to the correlations among all other traits by themselves (i.e., excluding trustworthiness), when targets were rated in a self-protection context.

Overall, our analyses suggest that the goal relevance manipulation may have failed for participants in the threat/self-protection context, and that the structure of facial impressions shifts in our hypothesized direction (i.e., becoming more constrained/intercorrelatd) when participants are in contexts with strong goal affordances. Post-hoc analyses of how central traits impact other central traits raised more questions than they answered, which we discuss in the next section.

General Discussion

The present research tests how situational affordances shape the impression formation process, shifting the interrelations among traits (e.g., attractive, trustworthy) inferred from faces. We found evidence for our first hypothesis: situations that afford opportunities or obstacles to fulfill fundamental motives (e.g., mate-seeking, disease avoidance) cause the structure of facial impressions to become more strongly intercorrelated, constraining the way that impressions are formed. We observed this effect for two of the three fundamental motives examined in this study (mate-seeking, disease avoidance), but not for the motive of self-protection. Qualitative content analysis suggests that our contextual threat manipulation failed to make the self-protection

motive sufficiently salient for perceivers in this situation, offering one potential explanation for the discrepant findings.

We also evaluated the theoretical mechanism underlying these shifts in the face-trait space. In the mate-seeking condition, the central trait (attractive) was a much better predictor of behaviour relevant to the situational goal (mate-seeking) than the other traits. Moreover, this central trait seemed to influence impressions on other, less situationally relevant traits: correlations between attractiveness and other traits were stronger when the mate-seeking goal was relevant, relative to correlations among other traits (i.e., excluding attractive) in the face-trait space. Similarly, the central trait (healthy) was a much better predictor of behaviour related to the goal of disease avoidance than the other traits. However, contrary to our predictions, this central trait seemed to exert *less* influence on other, less situationally relevant traits. Correlations between healthy ratings and other trait ratings were weaker when the disease avoidance goal was relevant, relative to correlations among other traits (i.e., excluding healthy) in the face-trait space. Finally, although trustworthiness was the top predictor of behaviour related to the goal of self-protection, all other traits were significant predictors, and its relationship with other traits did not differ in the self-protection context.

Together, these results provide initial evidence that salient situational goals constrain the structure of trait impressions inferred from faces. This suggests that in the relatively automatic initial stages of impression formation, dynamic cognitive processes flexibly shift mappings between “facial feature space” and “conceptual trait space” to meet the opportunities or demands perceived in a situation (Brown et al., 2015; Smith & Collins, 2009; Stolier et al., 2020; Van Overwalle & Labiouse, 2004). Critically, we observed the same shifts in the face-trait space when aggregating across perceivers (indicating some consensus in how targets’ facial features

are represented in goal-relevant versus neutral contexts), and when aggregating across targets (indicating that the conceptual trait associations of perceivers—regardless of what targets look like—are changing in goal-relevant versus neutral contexts). Perceivers in these situations attend to traits and facial cues that are relevant to their goals (e.g., attractiveness is important for mate-seeking, health is important for disease avoidance), and their nascent impressions of the target on these relevant traits may then influence their overall impression of the target. Critically, given limited information about a target, the perceiver's evaluation of the target on these "relevant traits" heuristically guides their evaluations of the target on other attributes for which they lack more diagnostic information. Here we provide preliminary evidence for this theorized mechanism, showing that situations with strong affordances cause different trait impressions to be more strongly interrelated with one another.

In a situation which affords opportunities to find a mate, attractiveness—a potential indicator of reproductive health (Rhodes et al., 2001; Scheib et al., 1999; Tinlin et al., 2013)—may be a highly relevant attribute (Sacco & Brown, 2018; Schaller et al., 2017). Perceivers in this situation, influenced by the opportunity to fulfill their mate-seeking motive, may readily evaluate strangers on observable features (e.g., facial symmetry, adiposity) that shape their impressions of the relevant trait (e.g., attractiveness) according to the perceiver's prior associations. Thus, this perceiver forms an impression of the target's attractiveness. Given lack of diagnostic information about the target's other, less relevant attributes (e.g., intelligence, dominance), this initial attractiveness impression may then spread to other, less situationally-relevant trait impressions that are nonetheless correlated with attractiveness, according to mappings in the perceiver's mental trait space (Goldman et al., 1983; Nisbett & Wilson, 1977; Stolier et al., 2020; Stolier, Hehman, Keller, et al., 2018). This connectionist perspective

illustrates that representational mappings between "facial feature space" (e.g., symmetry, facial adiposity) and "conceptual trait space" dynamically influence one another (Monroe et al., 2017; Over & Cook, 2018; Read et al., 1997; Stolier, Hehman, Keller, et al., 2018), and is consistent with recent work that finds other contextual effects to impact the structure of the face-trait space, such as societal and personal stereotypes (Oh et al., 2019; Xie et al., 2021) and lay theories of personality (Stolier, Hehman, & Freeman, 2018; Stolier, Hehman, Keller, et al., 2018).

Although attractiveness—the central trait in the mate-seeking context—was more strongly linked to other "less-relevant" traits in the manner that we predicted, one unanticipated finding was that healthiness—the central trait in the disease avoidance context—did *not* have a stronger link to other, less-relevant traits. To the contrary, the relations among other traits (i.e., excluding healthy) became slightly stronger, while the relations between healthy and other traits became slightly weaker when targets were rated in a disease avoidance context. Although these exploratory patterns are correlational, and cannot be used to confirm whether or not impressions of the central trait directly impacted other traits, we speculate that the differences observed here reflect phenomenological differences in how these affordances are perceived (Dings, 2018; Siegel, 2014), in terms of their valence (positive vs. negative) and force (inviting vs. demanding action). Specifically, whereas the mate-seeking context affords opportunities to fulfill a desired goal (positive valence, and inviting approach behaviours), the disease-avoidance context creates obstacles to maintaining a desired goal (negative valence, demanding avoidant behaviour). To the extent that these phenomenological orientations of affordances are psychologically meaningful, they may impact impression formation differently.

Some research in the domain of social evaluations supports this interpretation. For example, humans are biased toward evaluating others positively when they have an affiliation

goal (Rim et al., 2013) or a romantic goal (S. A. Goodwin et al., 2002)—both of which invite perceivers to approach novel targets. In these contexts, people are motivated to form positive impressions of a target, consistent with trustworthiness and attractiveness halo effects observed in the literature (Asch, 1946; Goldman et al., 1983; Nisbett & Wilson, 1977; Verhulst et al., 2010). In contrast, a recent study on intuitions of targets' HIV risk shows that first impressions of HIV risk—formed within milliseconds of seeing a face—can be summarized along multiple components: one component captures trait impressions that are generally associated with valence (e.g., attractiveness, willingness to interact), and the other component captures perceptions of HIV risk (Renner et al., 2012). This suggests that perceptions of disease risk are dissociated from general impressions of the target. In other words, impressions of the central trait that is relevant to the goal of disease avoidance (i.e., healthy) may be decoupled from other trait impressions more generally, allowing perceivers to judge someone accurately (given their goal of avoiding disease) while still maintaining a positive impression of the target. However, future work is needed to test this theorized mechanism.

Overall, we provide novel evidence that situational affordances induce changes in the structure of the face-trait space. There are two practical implications of this work for future research on impression formation. Researchers interested in examining impressions in different contexts should consider which trait impressions might be most relevant in these contexts, because impressions on situation-relevant traits may impact how other impressions are formed by shifting the conceptual associations between traits. Second, conclusions from face impression research generated absent any situational affordances may not capture how people form impressions "in the wild", where opportunities and obstacles to fulfill various motives are often in flux. Critically, this work challenges the ecological validity of impression formation research

conducted in lab settings, in which participants are tasked with the artificial goal of evaluating targets without any opportunity to interact with these targets. This is particularly important because classic theories, which contend that trustworthiness is a primary trait dimension in impression formation, were developed using impressions formed in lab-based settings absent strong situational affordances (G. P. Goodwin et al., 2014; Kelley, 1950). Trustworthiness may be relatively less primary when specific situational goals are relevant during impression formation.

Limitations

The present research induced situational affordances by tasking participants with testing a mock smartphone application that would be released in their local communities. Although the cover story and study design may have increased the relevance of certain fundamental social motives (e.g., mate-seeking, disease avoidance), these manipulations were likely weaker than if participants evaluated targets who they could meet (e.g., before a real speed-dating event). Moreover, evidence from our qualitative analyses suggests that the manipulation failed in the threat context to credibly induce a situation that afforded obstacles to one's self-protection motive. The plausibility of using a smartphone application to detect criminal offenders was questioned by several participants, and even those who did not explicitly question the study design mentioned being skeptical that anyone had committed a crime, or being uncertain as to which criteria they should use to identify criminal offenders from the app. In contrast, dating apps are common in modern life, and participants may have found the mate-seeking context more plausible. Similarly, because the study took place during the COVID-19 pandemic, the cover story in the disease-avoidance context (i.e., developing an "illness detection app") was more likely to be accepted by participants. Despite the potentially weak manipulation of

situational affordances, we do find evidence of the face-trait space shifting in 2 of 3 contexts. The magnitude of these shifts may be a conservative estimate. Future research that adopts stronger manipulations may find the face-trait space to be even more constrained, as a function of the relevance and immediacy of the situational affordances in those contexts.

This study leveraged an experimental design to demonstrate that situational affordances caused the structure of facial impressions to become more constrained or intercorrelated in goal-relevant contexts. However, the theorized mechanism—that impressions on the central trait in each context influenced impressions on other, less-relevant traits—was not directly tested in a confirmatory manner in the current study design. Specifically, the central trait was identified using a proxy method of assessing which trait best predicted responses on a social judgment that was relevant to the situation (e.g., "Would you be interested in matching with this person?" in the dating context). However, we do not have direct evidence that impressions on this central trait were formed earlier in the impression formation process compared to other traits (i.e., a temporal distinction that would allow causal inference of the underlying mechanism). Future research which assesses the reaction times of various trait impressions formed in goal-relevant versus neutral contexts would allow a stricter test of this underlying mechanism, particularly if it leverages a within-subjects design.

Finally, the stimuli used in the current study do not represent the diverse population of individuals who rated them. Future work ought to explore how these situational affordances interact with ratings of more ethnically diverse targets. Although we limited our stimuli to White faces in order to isolate contextual effects, a rich body of work across the social cognition and impression formation literatures has demonstrated the striking influence of social categorical stereotypes on trait impressions formed from faces (Freeman et al., 2020; Kawakami et al., 2017;

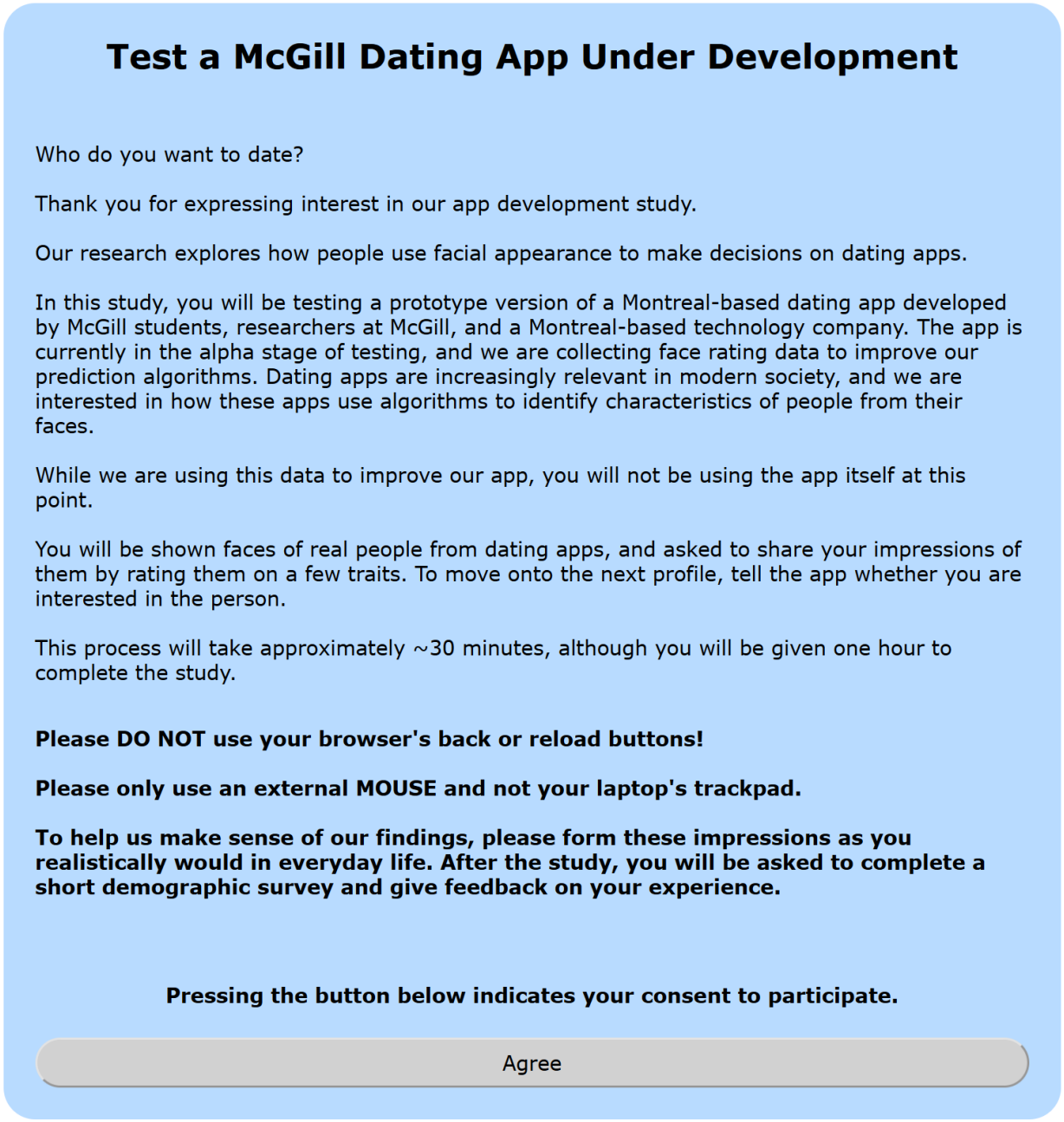
Xie et al., 2021). To the extent that members of different racial and gender categories are stereotyped to afford different interactions, the way that perceivers form impressions of White targets may not generalize to the way impressions are formed for other individuals.

Conclusion

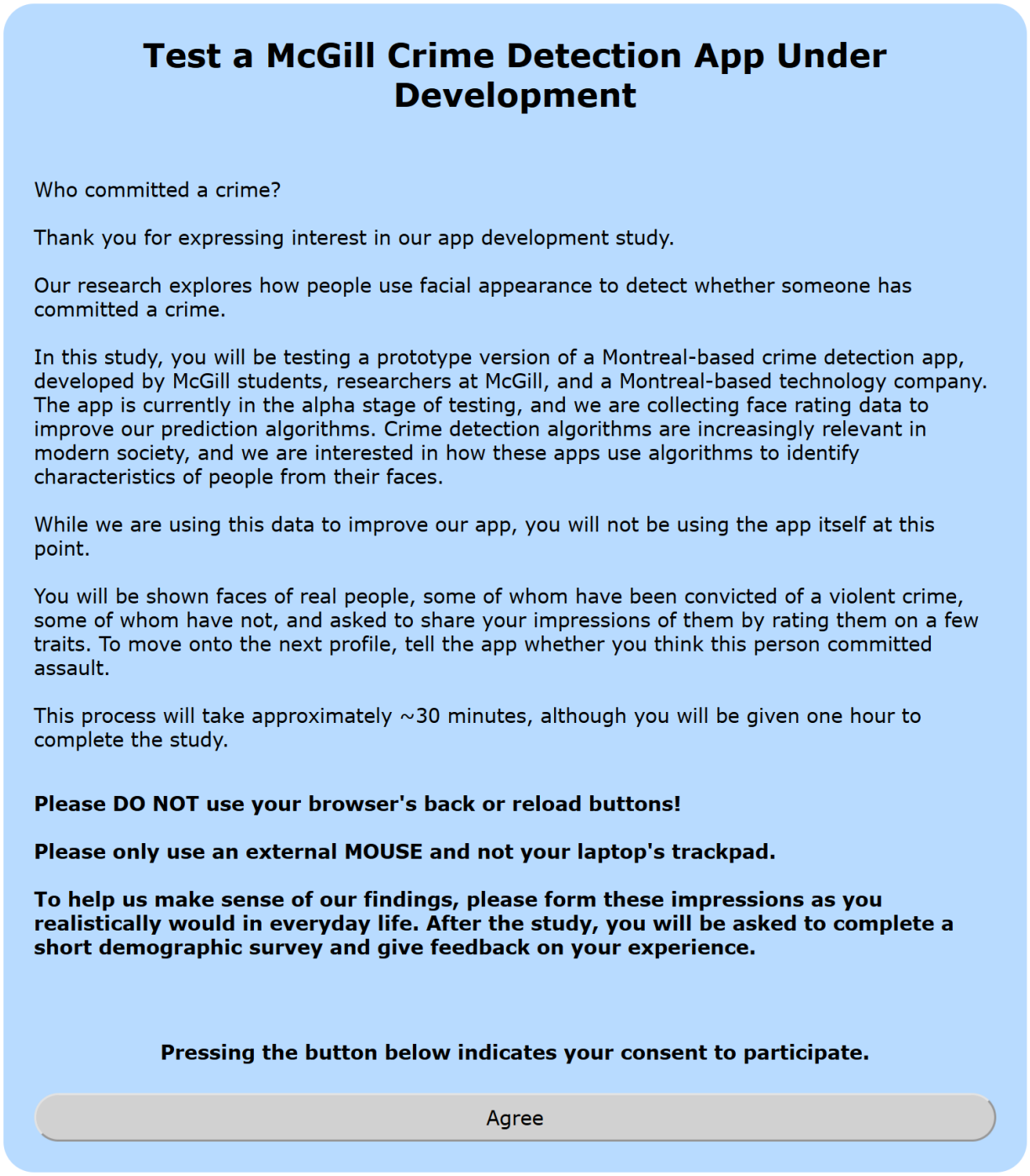
The present work experimentally tests how situational goals shape impression formation. We find that the structure of trait impressions inferred from faces shifts when fundamental social motives are made salient. Specifically, facial impressions become more strongly intercorrelated (i.e., tightly constrained) when perceivers are in a situation with relevant affordances (e.g., mate-seeking, disease avoidance), compared to a neutral context absent any relevant goals. Further, impressions on situationally relevant traits may influence downstream impressions on other, less "central" traits, in a differential manner depending on the valence of the situational affordances. These results advance our understanding of how first impressions are formed in different contexts, and have vast implications for the different strategies that humans may use to form impressions of strangers in various real-world settings.

Supplementary Materials

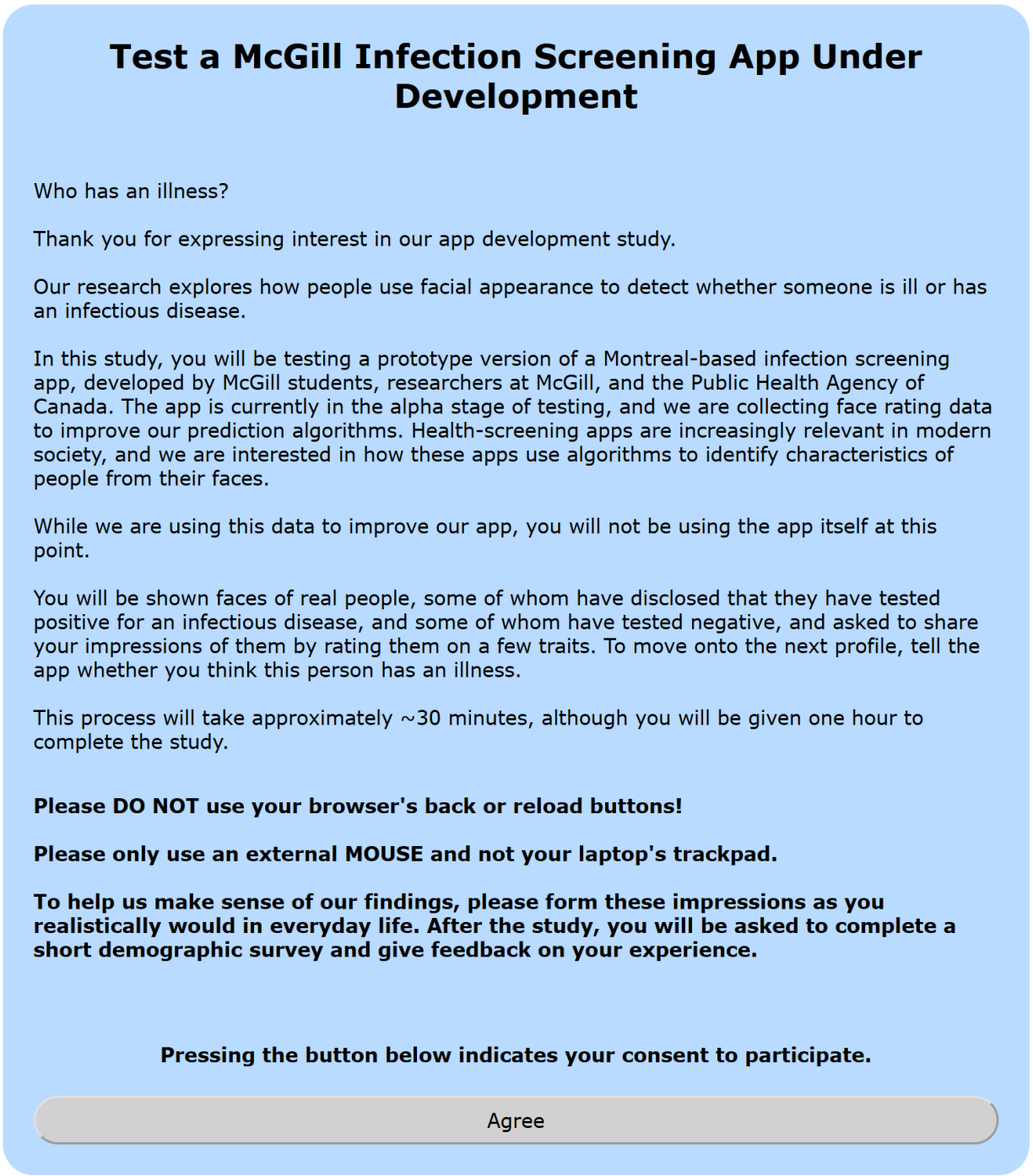
Study Instructions and Conditions



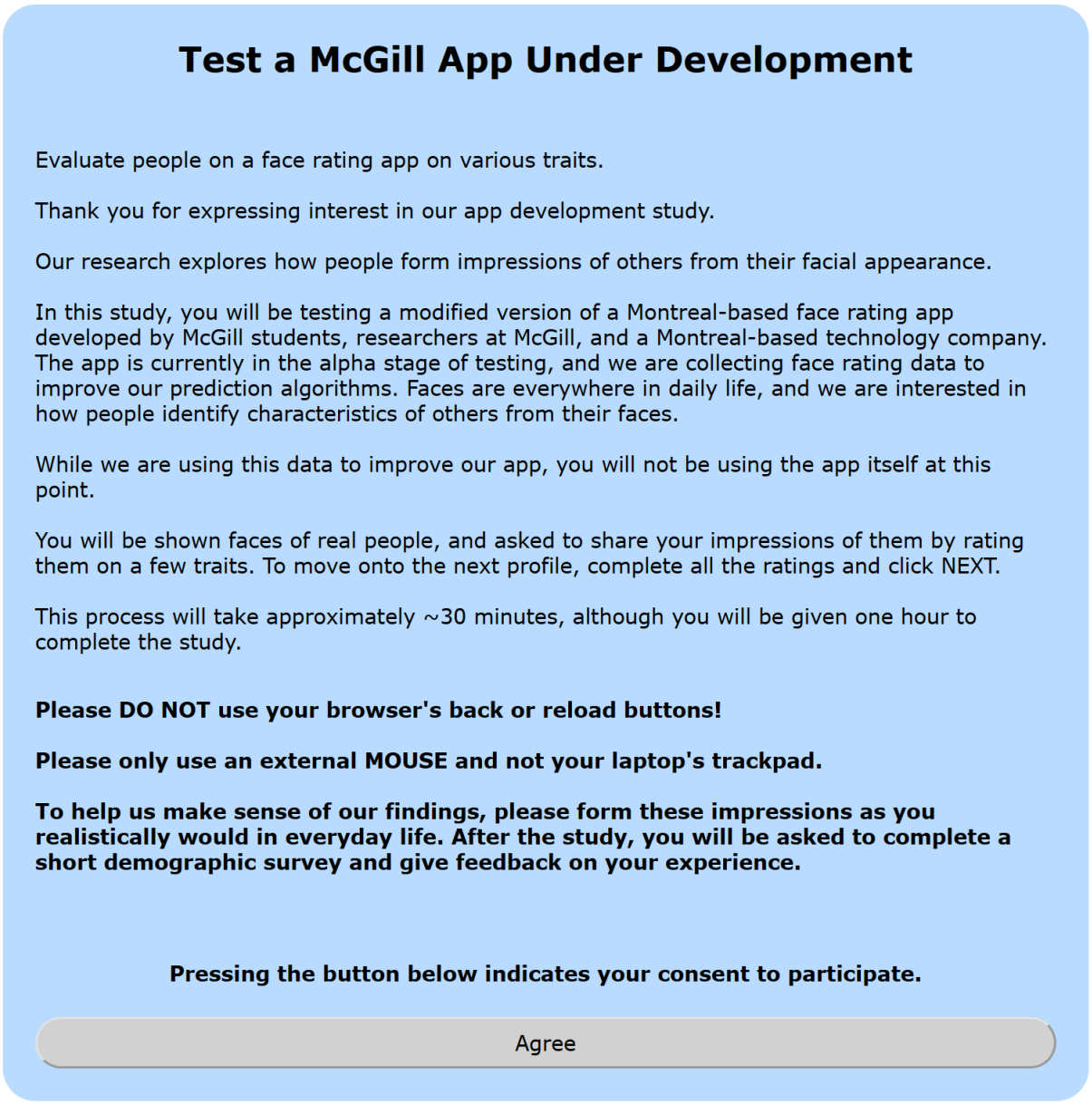
Supplementary Figure 1. Study instructions presented to participants randomly assigned to the Dating (i.e., mate-seeking) context.



Supplementary Figure 2. Study instructions presented to participants randomly assigned to the Threat (i.e., self-protection) context.

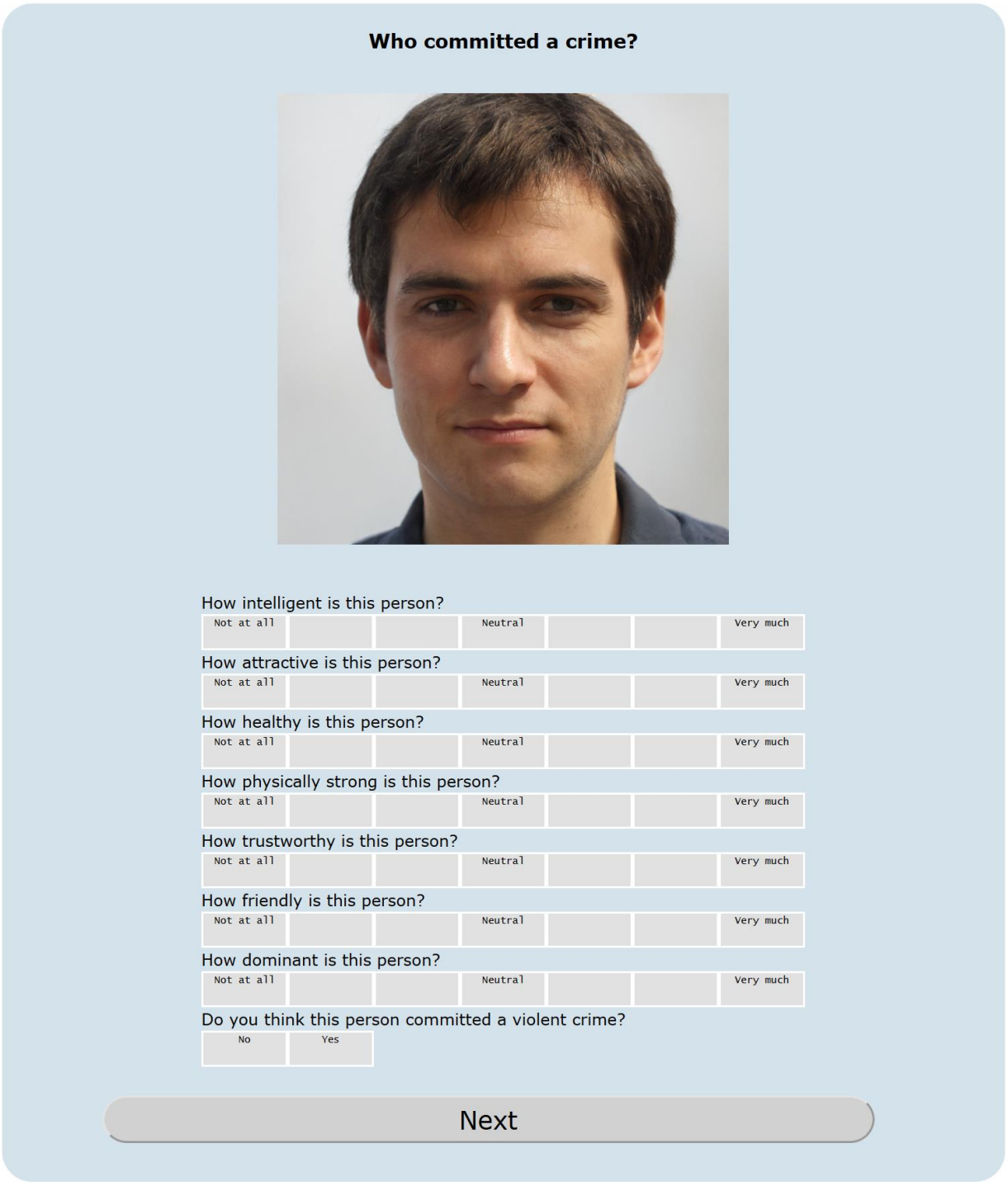


Supplementary Figure 3. Study instructions presented to participants randomly assigned to the Disease (i.e., disease avoidance) context.



Supplementary Figure 4. Study instructions presented to participants randomly assigned to the neutral (control) context.

Example Rating Task



Supplementary Figure 5. Example rating task taken from the threat/self-protection condition.

References

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 & Emotion*, *26*(3), 431–441. https://doi.org/10.1080/02699931.2012.666502

Asch, S. E. (1946). Forming impressions of personality. *The Journal of Abnormal and Social Psychology*, *41*(3), 258.

Ballew, C. C., & Todorov, A. (2007). Predicting political elections from rapid and unreflective face judgments. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(46), 17948–17953. https://doi.org/10.1073/pnas.0705435104

Bates, D., Mächler, M., Bolker, B. M., & Walker, S. C. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1). https://doi.org/10.18637/jss.v067.i01

Becker, D. V., Anderson, U. S., Neuberg, S. L., Maner, J. K., Shapiro, J. R., Ackerman, J. M., Schaller, M., & Kenrick, D. T. (2010). More memory bang for the attentional buck: Self-protection goals enhance encoding efficiency for potentially threatening males. *Social Psychological and Personality Science*, *1*(2), 182–189.

Bjornsdottir, R. T., & Rule, N. O. (2017). The visibility of social class from facial cues. *Journal of Personality and Social Psychology*, *113*(4), 530.

Blair, I. V. Y., Judd, C. M., & Chapleau, K. M. (2004). The influence of Afrocentric facial features in criminal sentencing. *Psychological Science*, *15*(10), 674–679.

Bohner, G., Moskowitz, G. B., & Chaiken, S. (1995). The interplay of heuristic and systematic processing of social information. *European Review of Social Psychology*, *6*(1), 33–68.

Brown, N. A., Neel, R., & Sherman, R. A. (2015). Measuring the evolutionarily important goals of situations: Situational affordances for adaptive problems. *Evolutionary Psychology*, *13*(3), 1474704915593662.

Chaiken, S., Giner-Sorolla, R., & Chen, S. (1996). *Beyond accuracy: Defense and impression motives in heuristic and systematic information processing.*

Cloutier, J., Mason, M. F., & Macrae, C. N. (2005). The perceptual determinants of person construal: Reopening the social-cognitive toolbox. *Journal of Personality and Social Psychology*, *88*(6), 885.

Conway, J. R., Catmur, C., & Bird, G. (2019). Understanding individual differences in theory of mind via representation of minds, not mental states. *Psychonomic Bulletin & Review*, *26*(3), 798–812.

Dings, R. (2018). Understanding phenomenological differences in how affordances solicit action. An exploration. *Phenomenology and the Cognitive Sciences*, *17*(4), 681–699.

Duarte, J., Siegel, S., & Young, L. (2012). Trust and credit: The role of appearance in peer-to-peer lending. *The Review of Financial Studies*, *25*(8), 2455–2484.

Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology*, *17*(2), 124–129. https://doi.org/10.1037/h0030377

Fessler, D. M. T., Holbrook, C., & Snyder, J. K. (2012). Weapons make the man (larger): Formidability is represented as size and strength in humans. *PloS One*, *7*(4).

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

Freeman, J. B., Stolier, R. M., & Brooks, J. A. (2020). Dynamic interactive theory as a domain-general account of social perception. In *Advances in Experimental Social Psychology* (Vol. 61, pp. 237–287). Elsevier.

Gibson, J. J. (1979). *The ecological approach to visual perception*. Houghton Mifflin.

Goldman, M., Cowles, M. D., & Florez, C. A. (1983). The halo effect of an initial impression upon speaker and audience. *The Journal of Social Psychology*, *120*(2), 197–201.

Goodwin, G. P., Piazza, J., & Rozin, P. (2014). Moral character predominates in person perception and evaluation. *Journal of Personality and Social Psychology*, *106*(1), 148.

Goodwin, S. A., Fiske, S. T., Rosen, L. D., & Rosenthal, A. M. (2002). The eye of the beholder: Romantic goals and impression biases. *Journal of Experimental Social Psychology*, *38*(3), 232–241.

Hehman, E., Carpinella, C. M., Johnson, K. L., Leitner, J. B., & Freeman, J. B. (2014). Early Processing of Gendered Facial Cues Predicts the Electoral Success of Female Politicians. *Social Psychological and Personality Science*, *5*(7), 815–824. https://doi.org/10.1177/1948550614534701

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*, *113*(4), 513–529.

Hester, N., Xie, S. Y., & Hehman, E. (2021). Little Between-Region and Between-Country Variance When Forming Impressions of Others. *Psychological Science*.

Holbrook, C., Galperin, A., Fessler, D. M. T., Johnson, K. L., Bryant, G. A., & Haselton, M. G. (2014). If looks could kill: Anger attributions are intensified by affordances for doing harm. *Emotion*, *14*(3), 455.

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

Hughes, B. L., Zaki, J., & Ambady, N. (2017). Motivation alters impression formation and related neural systems. *Social Cognitive and Affective Neuroscience*, *12*(1), 49–60.

Ittelson, W. H., & Cantril, H. (1954). *Perception; a transactional approach.*

Jaeger, B., Sleegers, W., Stern, J., Penke, L., & Jones, A. L. (2020). *The accuracy and meta-accuracy of personality impressions from faces*.

Jones, B. C., DeBruine, L. M., Flake, J. K., Aczel, B., Adamkovic, M., Alaei, R., Alper, S., Solas, S. Á., Andreychik, M. R., Ansari, D., Arnal, J. D., Babinčák, P., Balas, B., Baník, G., Krystian, Barzykowski, Baskin, E., Batres, C., Beaudry, J. L., … Chartier, C. R. (2018). Social perception of faces around the world: How well does the valence-

dominance model generalize across world regions? (Registered Report Stage 1). *Nature Human Behaviour*, 1–36. https://doi.org/10.31234/osf.io/n26dy

Karras, T., Laine, S., & Aila, T. (2019). A style-based generator architecture for generative adversarial networks. *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 4401–4410.

Kawakami, K., Amodio, D. M., & Hugenberg, K. (2017). Intergroup Perception and Cognition: An Integrative Framework for Understanding the Causes and Consequences of Social Categorization. In *Advances in Experimental Social Psychology* (1st ed., Vol. 55). Elsevier Inc. https://doi.org/10.1016/bs.aesp.2016.10.001

Kelley, H. H. (1950). The warm-cold variable in first impressions of persons. *Journal of Personality, 18*(4), 431–439.

Kenny, D. A. (2019). *Interpersonal perception: The foundation of social relationships*. Guilford Publications.

Kenrick, D. T., Neuberg, S. L., Griskevicius, V., Becker, D. V., & Schaller, M. (2010). Goal-driven cognition and functional behavior: The fundamental-motives framework. *Current Directions in Psychological Science*, *19*(1), 63–67.

Kok, R., Taubert, J., Van der Burg, E., Rhodes, G., & Alais, D. (2017). Face familiarity promotes stable identity recognition: Exploring face perception using serial dependence. *Royal Society Open Science*, *4*(3), 160685.

Lin, C., Keles, U., & Adolphs, R. (2021). Four dimensions characterize attributions from faces using a representative set of English trait words. *Nature Communications*, *12*(1), 1–15.

Macrae, C. N., & Bodenhausen, G. V. (2000). Social cognition: Thinking categorically about others. *Annual Review of Psychology*, *51*, 93–120. https://doi.org/10.1146/annurev.psych.51.1.93

Maner, J. K., Kenrick, D. T., Becker, D. V., Robertson, T. E., Hofer, B., Neuberg, S. L., Delton, A. W., Butner, J., & Schaller, M. (2005). Functional projection: How fundamental social motives can bias interpersonal perception. *Journal of Personality and Social Psychology*, *88*(1), 63.

Markman, A. B., & Otto, A. R. (2011). Cognitive systems optimize energy rather than information. *Behavioral and Brain Sciences*, *34*(4), 207.

McArthur, L. Z., & Baron, R. M. (1983). Toward an ecological theory of social perception. *Psychological Review*, *90*(3), 215–238. https://doi.org/10.1037//0033-295X.90.3.215

Mischel, W. (1968). *Personality and assessment*. Wiley Online Library.

Monroe, B. M., Laine, T., Gupta, S., & Farber, I. (2017). Using connectionist models to capture the distinctive psychological structure of impression formation. In *Computational social psychology* (pp. 38–60). Routledge.

Neel, R., Brown, N. A., & Sng, O. (2017). Evolutionary Perspectives on Situations. In *The Oxford Handbook of Psychological Situations* (p. 23). https://doi.org/10.1093/oxfordhb/9780190263348.013.9

Neuberg, S. L., & Fiske, S. T. (1987). Motivation and impression formation: Outcome dependency, attention, and individuating processes. *Journal of Personality and Social Psychology*, *53*(3), 431–444.

Nisbett, R. E., & Wilson, T. D. (1977). The halo effect: Evidence for unconscious alteration of judgments. *Journal of Personality and Social Psychology*, *35*(4), 250–256. https://doi.org/10.1037/0022-3514.35.4.250

Oh, D., Dotsch, R., Porter, J., & Todorov, A. (2019). Gender biases in impressions from faces: Empirical studies and computational models. *Journal of Experimental Psychology: General*.

Oldmeadow, J. A., Sutherland, C. A. M., & Young, A. W. (2013). Facial stereotype visualization through image averaging. *Social Psychological and Personality Science*, *4*(5), 615–623.

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

Orehek, E., Dechesne, M., Fishbach, A., Kruglanski, A. W., & Chun, W. Y. (2010). On the inferential epistemics of trait centrality in impression formation. *European Journal of Social Psychology*, *40*(7), 1120–1135.

Over, H., & Cook, R. (2018). Where do spontaneous first impressions of faces come from? *Cognition*, *170*, 190–200.

Rauthmann, J. F. (2016). Motivational Factors in the Perception of Psychological Situation Characteristics. *Social and Personality Psychology Compass*, *10*(2), 92–108. https://doi.org/10.1111/spc3.12239

Rauthmann, J. F., & Sherman, R. (2019). Toward a research agenda for the study of situation perceptions: A variance componential framework. *Personality and Social Psychology Review*, *23*(3), 238–266.

Rauthmann, J. F., Sherman, R. A., Nave, C. S., & Funder, D. C. (2015). Personality-driven situation experience, contact, and construal: How people's personality traits predict characteristics of their situations in daily life. *Journal of Research in Personality*, *55*, 98–111. https://doi.org/10.1016/j.jrp.2015.02.003

Read, S. J., Vanman, E. J., & Miller, L. C. (1997). Connectionism, parallel constraint satisfaction processes, and gestalt principles:(Re) introducing cognitive dynamics to social psychology. *Personality and Social Psychology Review*, *1*(1), 26–53.

Renner, B., Schmälzle, R., & Schupp, H. T. (2012). First impressions of HIV risk: It takes only milliseconds to scan a stranger. *PLoS One*, *7*(1), e30460.

Reynolds, K. J., & Oakes, P. J. (2000). Variability in impression formation: Investigating the role of motivation, capacity, and the categorization process. *Personality and Social Psychology Bulletin*, *26*(3), 355–373.

Rhodes, G., Zebrowitz, L. A., Clark, A., Kalick, S. M., Hightower, A., & McKay, R. (2001). Do facial averageness and symmetry signal health? *Evolution and Human Behavior : Official Journal of the Human Behavior and Evolution Society*, *22*(1), 31–46.

Rim, S., Min, K. E., Uleman, J. S., Chartrand, T. L., & Carlston, D. E. (2013). Seeing others through rose-colored glasses: An affiliation goal and positivity bias in implicit trait impressions. *Journal of Experimental Social Psychology*, *49*(6), 1204–1209.

Ross, L., & Nisbett, R. E. (1991). *The person and the situation: Perspectives of social psychology*. McGraw-Hill.

Sacco, D. F., & Brown, M. (2018). 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

Schaller, M., Kenrick, D. T., Neel, R., & Neuberg, S. L. (2017). Evolution and human motivation: A fundamental motives framework. *Social and Personality Psychology Compass*, *11*(6), e12319.

Scheib, J. E., Gangestad, S. W., & Thornhill, R. (1999). Facial attractiveness, symmetry and cues of good genes. *Proceedings of the Royal Society of London B: Biological Sciences*, *266*(1431), 1913–1917.

Schellenberg, S. (2008). The situation-dependency of perception. *The Journal of Philosophy*, *105*(2), 55–84.

Sherman, R. A., Rauthmann, J. F., Brown, N. A., Serfass, D. G., & Jones, A. B. (2015). The independent effects of personality and situations on real-time expressions of behavior and emotion. *Journal of Personality and Social Psychology*, *109*(5), 872–888. https://doi.org/10.1037/pspp0000036

Siegel, S. (2014). Affordances and the Contents of Perception. *Does Perception Have Content*, 39–76.

Smith, E. R., & Collins, E. C. (2009). Contextualizing Person Perception: Distributed Social Cognition. *Psychological Review*, *116*(2), 343–364. https://doi.org/10.1037/a0015072

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., & Freeman, J. B. (2020). Trait knowledge forms a common structure across social cognition. *Nature Human Behaviour*, *4*(4), 361–371.

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 of the United States of America*, *115*(37), 9210–9215. 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*.

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., Oldmeadow, J. A., & Young, A. W. (2016). Integrating social and facial models of person perception: Converging and diverging dimensions. *Cognition*, *157*, 257–267. https://doi.org/10.1016/j.cognition.2016.09.006

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

Tinlin, R. M., Watkins, C. D., Welling, L. L., DeBruine, L. M., Al-Dujaili, E. A., & Jones, B. C. (2013). Perceived facial adiposity conveys information about women's health. *British Journal of Psychology*, *104*(2), 235–248.

Todorov, A., Mandisodza, A. N., Goren, A., & Hall, C. C. (2005). Inferences of Competence from Faces Predict Election Outcomes. *Science*, *308*(5728), 1623–1626. https://doi.org/10.1126/science.1110589

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*(15), 1–27. https://doi.org/10.1146/annurev-psych-113011-143831

Turner, J. C., Oakes, P. J., Haslam, S. A., & McGarty, C. (1994). Self and collective: Cognition and social context. *Personality and Social Psychology Bulletin*, *20*(5), 454–463.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, *185*(4157), 1124–1131.

Van Overwalle, F., & Labiouse, C. (2004). A recurrent connectionist model of person impression formation. *Personality and Social Psychology Review*, *8*(1), 28–61.

Verhulst, B., Lodge, M., & Lavine, H. (2010). The attractiveness halo: Why some candidates are perceived more favorably than others. *Journal of Nonverbal Behavior*, *34*(2), 111–117.

Willis, J., & Todorov, A. (2006). First Impressions: Making Up Your Mind After a 100-Ms Exposure to a Face. *Psychological Science*, *17*(7), 592–598. https://doi.org/10.1111/j.1467-9280.2006.01750.x

Wilson, J. P., Hugenberg, K., & Rule, N. O. (2017). Racial Bias in Judgments of Physical Size and Formidability: From Size to Threat 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

Wilson, J. P., & Rule, N. O. (2015). Facial Trustworthiness Predicts Extreme Criminal-Sentencing Outcomes. *Psychological Science*, *26*(8), 1325–1331. https://doi.org/10.1177/0956797615590992

Xie, S. Y., Flake, J. K., & Hehman, E. (2019). Perceiver and target characteristics contribute to impression formation differently across race and gender. *Journal of Personality and Social Psychology*, *117*(2), 364.

Xie, S. Y., Flake, J. K., Stolier, R. M., Freeman, J. B., & Hehman, E. (2021). Facial impressions are predicted by the structure of group stereotypes. *Psychological Science*, *32*(12), 1979–1993. https://doi.org/10.1177/09567976211024259

Yang, Y., Read, S. J., & Miller, L. C. (2009). The Concept of Situations. *Social and Personality Psychology Compass*, *3*(6), 1018–1037. https://doi.org/10.1111/j.1751-9004.2009.00236.x

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 : An Official Journal of the Society for Personality and Social Psychology, Inc*, *7*(3), 194–215.

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

CHAPTER 7

GENERAL DISCUSSION

General Discussion

Every act of perceiving requires a person and a target, and both are embedded within their broader context (Hehman et al., 2018; Shoda et al., 2007; Smith & Collins, 2009). Toward a comprehensive understanding of impression formation requires taking these different contexts into consideration. To that end, this dissertation aimed to examine the interplay of perceiver × target × context characteristics on impression formation.

A socially contextualized perspective focuses the study of first impressions on two central issues: (1) quantitatively characterizing perceiver, target, and context influences on impressions, and (2) testing changes to the structural representation of trait impressions inferred from faces across a variety of contexts. Building on a rich theoretical literature integrating ecological perspectives on impression formation (Berry et al., 1993; McArthur & Baron, 1983; Oosterhof & Todorov, 2008; Zebrowitz, 1997), social-cognitive and computational models of face perception (Freeman et al., 2020; Kawakami et al., 2017; Macrae & Bodenhausen, 2000; Stolier, Hehman, Keller, et al., 2018), and the lens of situational affordances (Brown et al., 2015; Neel et al., 2017; Schaller et al., 2017), the present research aimed to address four key questions. How do perceivers' stereotypes contextualize their perceptions of targets who belong to different social categories? How might perceivers in different cultures, who hold different cultural associations, vary in the way that they form impressions of diverse targets? To what extent do day-to-day contexts experienced by people in the real world impact impression formation, compared to the appearance of targets or the idiosyncrasies of perceivers? And finally, how might situational affordances (i.e., opportunities or obstacles to fulfill one's goals) shape and constrain the impression formation process? By implementing computational and behavioural

methods, the four empirical chapters presented in this dissertation seek to provide novel insights into the impression formation process.

Summary of Main Findings

Contrary to the prevailing view that facial impressions are evoked by morphological features in a manner that is consistent across perceivers, **Chapter 3** provided new insights into how societal and personal stereotypes shape impressions of targets from different racial and gender groups. The research in this chapter took a novel approach to empirically connect two research traditions—face perception and stereotyping—and made methodological contributions by demonstrating how the structure of facial impressions and the structure of stereotype knowledge could be modelled and compared via their multidimensional relations to each other. In the first study, results from representational similarity analysis indicated that societal representations of facial impressions mapped onto the structure of societal stereotypes, shifting across racial and gender categories in stereotype-congruent ways. Specifically, the structure of ratings of female and male White, Black, and East Asian faces (e.g., "How competent does this person appear?") mapped onto the structure of ratings of these groups in the abstract (e.g., "Please indicate how people in society see Asian women on competence"). In the second study, a robust multilevel modelling approach revealed that differences in participants' idiosyncratic, learned stereotypical associations across social groups (e.g., "How likely is an aggressive Asian woman to be attractive?") uniquely predicted differences in the structure of their impressions of faces belonging to these respective social groups. Together, this work contributed novel evidence that the social category membership of targets provides context for impressions, evoking shifts in the structure of perceivers' facial impressions (Xie et al., 2021).

Using a similar analytic approach, **Chapter 4** extended this work by examining whether perceivers from different countries—who have fewer opportunities to acquire shared cultural associations—form impressions differently. Analyses of ~1.4 million trait ratings of faces across 41 countries extended the findings from Chapter 3 with a cross-cultural dataset, finding the structure of facial impressions to shift across racial and gender categories in a more nuanced manner, dependent upon the intersection of the target's race and gender. Facial impressions became more strongly intercorrelated for White women (cf. White men) as expected, but became less intercorrelated for Black and Latina women (cf. Black and Latino men), and did not differ between East Asian women and men. Moreover, these gender differences between Latino and Latina faces were significantly predicted by each country's cultural context, operationalized as gender-related outcomes captured by the WHO national index of gender inequality. As countries increased in gender inequality, facial impressions became structurally more intercorrelated for women than for men—and this effect was primarily driven by ratings of Latine faces. This work demonstrated that facial impressions shift as a function of social categories and cultural context, in a direction more nuanced than previously observed. Much like Chapter 3, results indicated that learned associations shape the conceptual associations that perceivers rely upon to form impressions of targets..

Chapter 5 explored the extent to which facial impressions varied across naturalistic contexts experienced by people going about their daily lives. Adopting a novel experience-sampling paradigm to track changes in 218 perceivers' experienced contexts (e.g., mood, environment, physiology, psychological situation) as they formed impressions of faces, Chapter 5 applied latent profile analysis to identify distinct "profiles" of qualitative contexts from the combination of 22 quantitative contextual variables, and then used a multilevel modelling

framework to decompose the variance in facial impressions into variance coming from perceiver differences, target differences, contextual differences, and their various interactions. Here, results indicated that the day-to-day contexts experienced by perceivers did *not* systematically shift facial impressions—and critically, this conclusion did not vary much across different perceivers experiencing different contexts. Consistent with previous work, target characteristics (e.g., facial cues) and more stable perceiver characteristics (e.g., personality, development)—as well as their interactions—were more important for driving facial impressions (Hehman et al., 2017; Hester et al., 2021; Heynicke et al., 2021; Xie et al., 2019). In line with this interpretation, secondary analyses revealed stable differences across perceivers in how they form impressions—participants who felt more energetic (over a two-week period) judged others as friendlier and more trustworthy, whereas those who felt hungrier and less angry judged others as more dominant and physically strong (Xie et al., in press).

Finally, **Chapter 6** experimentally tested how salient situational goals impacted the structure of trait impressions inferred from faces. Participants were assigned to 1 of 4 conditions (three goal-relevant contexts, one neutral context), and tasked with evaluating a mock smartphone application. Participants in the goal-relevant contexts received specific instructions that made a specific fundamental motive more salient, such being tasked with evaluating faces on a dating app (i.e., mate-seeking context), health screening app (i.e., disease avoidance context), or criminal offender detection app (i.e, self-protection context). For two of these three contexts in which situational affordances were made salient to the perceiver, affordances constrained the structure of facial impressions—which became more strongly intercorrelated—relative to a neutral context absent any situational affordances. However, this pattern was not observed in the self-protection context, likely due to a failed manipulation.

Building on the analytic approach introduced in Chapters 3-4, the research in Chapter 6 modelled the representational structure of facial impressions by using correlations between trait ratings inferred from faces, and statistically compared these structures across goal-relevant versus goal-neutral contexts within a rigorous, cross-classified multilevel framework. In summary, the results here indicated that perceivers form impressions differently when they experience situations that afford opportunities or obstacles relevant to fundamental social motives (e.g., disease avoidance, mate-seeking; Kenrick et al., 2010; Neel et al., 2017; Schaller et al., 2017), suggesting that situational goals shift observers' attention to goal-relevant traits that are "central" to that context, which then influence impressions on other less-central traits. However, future research is required to directly test this underlying mechanism.

Theoretical Implications

Together, these findings provide novel insights into how facial impressions are inferred, represented, and quantified across various contexts. Perceivers do not form impressions in a vacuum, but within the broader context of their society, circumstances, and immediate situation. While each study in Chapters 3-6 makes several original contributions, the overarching theme that coheres this dissertation is that contextual factors meaningfully influence the impression formation process, specifically by shifting the representational structure of facial impressions (i.e., face-trait space) which map onto perceivers' prior associations about the observable features in the target's face.

The Structuring Role of Contexts

First impressions are functionally important. They allow humans to predict others' mental states and behaviours and develop novel connections with strangers (McArthur & Baron, 1983; Oosterhof & Todorov, 2008; Todorov et al., 2015). When meeting someone for the first time,

perceivers have limited access to diagnostic information about the target, and must leverage the available evidence to form a useful initial impression (Gawronski, Geschke, et al., 2003). The findings from Chapters 3, 4, and 6 suggest that context helps the perceiver organize information in a manner similar to a map or scaffold, structuring the way that relevant conceptual associations (which serve as a template for first impressions) are represented and retrieved during impression formation. Prior associations which already exist in the perceiver's mind (e.g., a learned relationship between attractiveness and physical strength) are constrained by salient contextual information—becoming more or less correlated—to facilitate efficient impression formation. The effects of these structural changes are not trivial, and range in size depending on the specific conceptual associations being examined. For instance, the structure of facial impressions generally becomes more constrained when perceivers are in a dating/mate-seeking context compared to a neutral context, becoming more strongly intercorrelated by a magnitude of $r = |.07|$ on average. Zooming in on a specific pair of traits, the strength of the correlation between attractiveness and physical strength is $r = |.18|$ in a neutral context absent any relevant goals, and increases to $r = |.34|$ in a dating context, representing a .16 increase in associative strength. Thus, the structuring effect of contexts can be consequential in magnitude.

The multimodal approaches used in this dissertation demonstrate the utility of combining various behavioural, computational, and statistical methods to investigate the impact of context on impressions. Chapter 5 found that day-to-day contextual factors experienced by perceivers—whether alone or in interaction with perceiver and target characteristics—contributed negligible variance to trait ratings of faces (e.g., on trustworthiness, dominance). This suggests that individual trait impressions are not impacted by the real-world contexts that perceivers experienced at the time of forming each impression (e.g., fluctuations in mood, environment,

psychological situation). It is important to clarify that this result is not at odds with the conclusions of the other chapters in this dissertation. Whereas Chapter 5 found that between-context differences (i.e., operationalized as day-to-day contexts experienced by perceivers) accounted for minimal variance in impressions of any single trait, the work of other chapters examining the correlational structure of facial impressions (i.e., the face-trait space) focused on how different trait impressions covary across different contexts. This distinction between individual impressions and the broader structural relationships among impressions is important. For instance, Chapter 4 found that the structure of facial impressions varied across countries to a small extent (~13%), in contrast to other findings that the variance in any individual trait rating varies only minimally across countries (~1-2%; Hester et al., 2021). These distinctions imply that questions about the structure of trait impressions and questions about partitioning variance on individual impressions should be treated as theoretically distinct (Hester et al., 2021).

Social Categories Contextualize Targets

In the absence of strong task demands or situational goals that are personally relevant to the perceiver, the targets themselves may provide context during impression formation. Chapters 3-4 observed differences in the structure of facial impressions across targets' racial and gender category. These split-second social categorizations activate perceivers' prior stereotypical associations about a relevant social category, inducing changes to the structure of facial impressions (Freeman et al., 2020; Stolier, Hehman, Keller, et al., 2018; Xie et al., 2021). Previous research on stereotyping in first impressions suggests that perceivers are often likely to rely on generalized, stereotypical beliefs about others when they lack more diagnostic information about the individual target (Dovidio & Gaertner, 2000; Fiske & Neuberg, 1990), when they endorse stronger stereotypes (Gawronski, Ehrenberg, et al., 2003), or when they lack

the motivation to employ more individuating strategies to form impressions (Neuberg & Fiske, 1987). The findings from Chapters 3-4 support these predictions: absent any other information about the target, the target's race and gender elicit categorical stereotypes about that target, inducing shifts in the structure of facial impressions that are congruent with stereotypes specific to their race × gender group.

Nuances in the intersection of race and gender emerged in Chapter 4, which partially replicated the findings from Chapter 3 with a cross-cultural sample but additionally found that gender differences in the face-trait space varied as a function of targets' race. Consistent with recent research on intersectional stereotyping (Petsko et al., 2022; Petsko & Bodenhausen, 2020; Purdie-Vaughns & Eibach, 2008; Stolier & Freeman, 2016), these findings suggest that perceivers rely upon stereotypes of *one* especially salient social category (or one salient intersection of social categories) as a template during impression formation, instead of integrating information about multiple social categories in an additive manner. This is theoretically interesting because it suggests that, although social categorical information (e.g., race, gender) contextualize the impression formation process, some information may be privileged over others by the perceiver. In a later section, I discuss one potential avenue for future research that examines whether the information provided by targets' social categories or versus situational affordances might be preferentially used by the perceiver to form impressions of diverse targets in goal-relevant situations.

Critically, these biases in first impressions have practical implications for the perception and treatment of individuals belonging to different social categories. For example, facial impressions have real-world consequences within the political (Ballew & Todorov, 2007; Hehman, Carpinella, et al., 2014) and legal domains (Blair et al., 2004; Wilson & Rule, 2015).

To the extent that any two traits—for instance, trustworthiness and physical strength—are negatively stereotypically associated for Black men (but unrelated for White men), then sentencing decisions, which are influenced by facial impressions of trustworthiness (Wilson & Rule, 2015), may be more likely to be influenced by other attributes (i.e., physical strength) for Black versus White male defendants. In other words, impressions of a person's physical strength may heuristically influence impressions of that person's trustworthiness, and elicit less favourable sentencing decisions for members of one social category but not others. Indeed, given that defendants with faces stereotyped to match the crime are more likely to be found guilty (Macrae & Shepherd, 1989), perceivers' idiosyncratic stereotypic associations may contribute to downstream systematic biases in conviction rates across these social categories.

Situational Affordances Constrain Impressions

A major contribution of this dissertation comes from experimental evidence testing how situational affordances constrain impression formation. For example, during a pandemic, observing mask mandates and hand sanitizers in the environment may make the fundamental motive of disease avoidance more salient (Kenrick et al., 2010; Neel et al., 2017; Schaller et al., 2017), changing the way that perceivers form impressions of targets in those environments. Chapter 6 found that when goal affordances were manipulated to be more salient, the structure of trait impressions inferred from faces became more constrained and tightly intercorrelated, such that the associations between any given pair of traits (e.g., between healthiness and trustworthiness) were more strongly correlated on average. One or two trait impressions which were highly relevant to the situational goal (e.g., ratings of health were particularly important in a disease-avoidance context) might become central to the overall impression, influencing the

perceiver's impression of the target on other, less situationally relevant traits (e.g., attractive, intelligent) for which the perceiver lacks diagnostic information.

There are two additional theoretical mechanisms that may underlie these observed differences. First, in the absence of strong situational constraints on impression formation, the structure of facial impressions may become more differentiated (i.e., less intercorrelated) because perceivers evaluate targets in a more deliberative manner, taking the time to assess individually the target's trustworthiness, attractiveness, competence, etcetera by leveraging different evaluative criteria for each of those evaluations (Sritharan et al., 2010; Uleman, 1999; Zelli et al., 1996). However, even if perceivers do not engage in this style of deliberative reasoning—relying instead upon heuristic processing of social information (Bohner et al., 1995)—the impression formation process may still be more idiosyncratic to each perceiver, due to their own unique conceptual associations among trait concepts or among mappings between trait concepts and facial features. Perceivers have different prior associations and lay theories of personality, which they retrieve to form impressions of strangers (Stolier et al., 2020; Stolier, Hehman, Keller, et al., 2018). Thus, in the absence of strong situational goals which constrain the impression formation process, each perceiver may form impressions in a more idiosyncratic manner, causing the structure of facial impressions to be more differentiated (i.e., less intercorrelated) in the absence of strong contextual influences.

Critically, more work is needed to understand how impressions on a central (i.e., goal-relevant) trait impacts downstream impressions on other, less relevant traits. I return to this topic in a later section.

Bottom-up and Top-down Influences

Finally, the results of this dissertation converge with contemporary perspectives that highlight the dynamic, interactive nature of impression formation, in which "top-down" social categorical factors at the perceiver level (Chapters 3-4) interact with "bottom-up" target characteristics (e.g., facial morphology) to jointly shape person construal (Freeman et al., 2020; Hehman et al., 2018; Kawakami et al., 2017; Stolier, Hehman, & Freeman, 2018). For example, a perceiver may believe that trustworthy and healthy are slightly correlated. To the extent that they judge a face to be healthy based on a specific set of facial cues, that impression might influence judgments of trustworthiness in a manner consistent with their prior learned associations (Over & Cook, 2018; Stolier, Hehman, Keller, et al., 2018).

Critically, Chapter 6 provides evidence that situational affordances additionally shape this interactive process, influencing how top-down conceptual associations are organized in relation to each other—which ultimately impacts the final impression inferred from faces. The findings here are therefore consistent with the view that bottom-up processes and top-down processes both play an important role in impression formation, and suggest that contextual cues (in the environment) may induce top-down associations to be organized differently, changing how trait impressions are inferred from faces.

Limitations and Open Questions

The work conducted in this dissertation was motivated by the intuition that people do not form impressions in a vacuum, but within their broader contexts. Here, I aimed to quantitatively characterize the impact of a continuum of contexts on the impression formation process, addressing novel research questions that were previously difficult to tackle due to computational and methodological limitations. Although this body of work advances our understanding of the

role that context plays in shaping trait impressions from faces, this dissertation has limitations across the studies presented, and many questions still remain.

First, although the studies conducted in Chapters 3-4 empirically connect the face perception and social-cognitive literatures using a rigorous statistical approach, it is important to stress that these data are cross-sectional, which limits causal inference. However, drawing from theory and from recent literature that finds the face-trait space to vary across group boundaries such as gender (Oh et al., 2019; Sutherland et al., 2015), nationality (Jones et al., 2021; Sutherland et al., 2018), age (Oldmeadow et al., 2013), and race (Wilson, Remedios, et al., 2017), we speculate that stereotypic associations (at both the individual and societal level) constrain social impressions drawn from faces. This interpretation converges with modern models of social cognition, which contend that perceivers' top-down associations shape the structure of the face-trait space during impression formation (Freeman et al., 2020; Over & Cook, 2018; Stolier, Hehman, Keller, et al., 2018).

Second, the current set of studies focused on trait impressions that were inferred from still, static facial photographs. As such, the present design was still divorced from reality in some ways. There are many situations in which people see a stranger and notice, beyond the face, hairstyle, clothing, body shape and size, gait, and even features of other modalities (e.g., voice). Some research suggests that trait impressions from faces are correlated with impressions from bodies and voices (Fiske et al., 2007; Rezlescu et al., 2015), and faces do explain substantial variance in trait impressions (Hehman et al., 2018). Moreover, people regularly evaluate others from static photographs (e.g., dating apps, social media) in which targets are embedded in different contexts. For instance, target contexts such as visual scenery and the presence of other people can influence judgments of trustworthiness (Brambilla et al., 2018; Mattavelli et al.,

2021), emotion (Barrett & Kensinger, 2010), and attractiveness (Carragher et al., 2021). Although the focus on faces may be justified given their salience and centrality in social impressions, more studies involving richer and more dynamic stimuli would be preferable. Related to this point, perceivers do not ever expect to meet or interact with the targets they are evaluating. Virtual or in-person encounters may be needed to understand how personal relevance impacts the impression formation process, and future work could investigate how expectations to interact with an interaction partner motivates perceivers to form impressions differently.

This dissertation stimulates several questions that have yet to be addressed. First, situational affordances which vary in their valence (i.e., positive, negative) and force (i.e., demanding action, inviting action) may alter the impression formation process in distinct ways (Dings, 2018). In particular, opportunities to approach a person out of a desire to approach may cause trait impressions to be strongly constrained and centered on one or two relevant traits, consistent with our findings, whereas obstacles to maintaining one's goal which demand avoidant behaviour may influence trait impressions in more complex ways. To address this question, I am currently investigating how different features of situational affordances impact the way impressions are formed. Related to this point, experimental work that tests how "central" (i.e., goal-relevant) traits impact other less-relevant traits is needed. As a follow-up to the research conducted in Chapter 6, we are currently planning a study to causally test whether situational affordances induce impressions on a central trait, which takes temporal precedence compared to other less-relevant traits. Understanding how and why the face-trait space becomes more constrained when situational affordances are salient will provide more insight into previous findings in the impression formation literature, for instance showing an attractiveness halo effect (Goldman et al., 1983; Nisbett & Wilson, 1977; Verhulst et al., 2010) or a primacy effect of

trustworthiness impressions (Brambilla et al., 2011; Oosterhof & Todorov, 2008; Todorov et al., 2009).

Another open question that I am pursuing is how the intersectional identity of targets (i.e., along race, gender) interacts with situational affordances to shape impressions. The findings from Chapter 4 suggest that intersectional stereotyping limits the amount of information that perceivers use as a template to form impressions of novel targets (Petsko et al., 2022). For example, if the target is a Latino woman, perceivers may rely upon racial stereotypes to a greater extent (compared to gender stereotypes) to form impressions of this target. What happens when these already complex targets are being evaluated in a situation which affords various opportunities or obstacles to fulfill social motives? People afford specific interactions (Brown et al., 2015; Siegel, 2014), and to the extent that these affordances are consistent (or inconsistent) with stereotypes about a target's social category, the impression formation process may shift in multiple ways. Specifically, there are two competing hypotheses. First, when situational affordances are incompatible with target identity, I expect the affordance to be perceived as non-relevant and therefore ignored by the perceiver. Impressions of the target would rely on social categorical information and the perceiver's own learned stereotypes about that category. However, when situational affordances are compatible with target identity, I expect the affordance to be highly relevant, shifting the structure of trait impressions in a more extreme manner than if the perceiver rated the target in a goal-neutral context. Critically, when perceivers have multiple ambiguous sources of social information to rely upon for their impressions (as will often be the case in the real world), how might they selectively attend to or ignore this information? Understanding how and when contextual goals and affordances impact impression

formation will be helpful for understanding how impressions are made in certain real-world domains (e.g., dating, business, legal system).

Finally, there are many other contexts that may be psychologically meaningful for impression formation, but have yet to be examined. This dissertation takes a preliminary step in quantitatively characterizing the role that context plays on impression formation, but future work is needed to explore contextual and dyadic interactions using more naturalistic study designs.

Conclusion

This dissertation makes original theoretical and methodological contributions to our understanding of social perception. Across four studies, I show that trait impressions from faces are jointly influenced by the interplay of perceiver, target, and contextual factors. The social category of targets provide context for the perceiver, activating stereotypical associations—learned through idiosyncratic experiences or shared cultural experiences—to form an impression. These impressions are additionally influenced by the situational goals relevant to any given context. For instance, situations which afford opportunities to fulfill fundamental social motives (e.g., mate-seeking, disease avoidance) become more constrained, such that the structure of facial impressions becomes more strongly interrelated. Overall, stereotypical associations and situational affordances are important for shaping the structure of facial impressions, whereas day-to-day, real-world contexts play only a minimal role. This body of work demonstrates the utility of computational approaches to studying impression formation, by (1) quantitatively disentangling perceiver, target, and context influences on impressions, and (2) testing changes to the structural representation of facial impressions across a variety of contexts. Critically, a socially contextualized theory of perception can fundamentally broaden our understanding of how humans perceive other humans.

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.

Abele, A., & Petzold, P. (1994). How does mood operate in an impression formation task? An information integration approach. *European Journal of Social Psychology*, *24*(1), 173–187.

Adams, R. B., Garrido, C. O., Albohn, D. N., Hess, U., & Kleck, R. E. (2016). What Facial Appearance Reveals Over Time: When Perceived Expressions in Neutral Faces Reveal Stable Emotion Dispositions. *Frontiers in Psychology*, *7*(June), 1–13. https://doi.org/10.3389/fpsyg.2016.00986

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 & Emotion*, *26*(3), 431–441. https://doi.org/10.1080/02699931.2012.666502

Adolphs, R., Nummenmaa, L., Todorov, A., & Haxby, J. V. (2016). Data-driven approaches in the investigation of social perception. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1693), 20150367. https://doi.org/10.1098/rstb.2015.0367

Albright, L., Malloy, T. E., Dong, Q., Kenny, D. A., Fang, X., Winquist, L., & Yu, D. (1997). Cross-cultural consensus in personality judgments. *Journal of Personality and Social Psychology*, *72*(3), 558.

Ambady, N. (2010). The perils of pondering: Intuition and thin slice judgments. *Psychological Inquiry*, *21*(4), 271–278. https://doi.org/10.1080/1047840X.2010.524882

Ambady, N., Bernieri, F. J., & Richeson, J. A. B. T.-A. in E. S. P. (2000). *Toward a histology of social behavior: Judgmental accuracy from thin slices of the behavioral stream* (Vol. 32, pp. 201–271). Academic Press. https://doi.org/10.1016/S0065-2601(00)80006-4

Ambady, N., & Rosenthal, R. (1992). Thin slices of expressive behavior as predictors of interpersonal consequences: A meta-analysis. *Psychological Bulletin*, *111*(2), 256–274. https://doi.org/10.1037//0033-2909.111.2.256

Anderson, J. R. (1991). The adaptive nature of human categorization. *Psychological Review*, *98*(3), 409.

Asch, S. E. (1946). Forming impressions of personality. *The Journal of Abnormal and Social Psychology*, *41*(3), 258.

Assor, A., Aronoff, J., & Messé, L. A. (1981). Attribute relevance as a moderator of the effects of motivation on impression formation. *Journal of Personality and Social Psychology*, *41*(4), 789.

Ballew, C. C., & Todorov, A. (2007a). Predicting political elections from rapid and unreflective face judgments. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(46), 17948–17953. https://doi.org/10.1073/pnas.0705435104

Ballew, C. C., & Todorov, A. (2007b). Predicting political elections from rapid and unreflective face judgments. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(46), 17948–17953. https://doi.org/10.1073/pnas.0705435104

Banaji, M. R., & Hardin, C. D. (1996). Automatic stereotyping. *Psychological Science*, *7*(3), 136–141.

Bar, M., Neta, M., & Linz, H. (2006). Very first impressions. *Emotion*, *6*(2), 269.

Barden, J., & Petty, R. E. (2008). The mere perception of elaboration creates attitude certainty: Exploring the thoughtfulness heuristic. *Journal of Personality and Social Psychology*, *95*(3), 489.

Baron, R. M., & Boudreau, L. A. (1987). An ecological perspective on integrating personality and social psychology. *Journal of Personality and Social Psychology*, *53*(6), 1222.

Barrett, L. F., & Kensinger, E. A. (2010). Context is routinely encoded during emotion perception. *Psychological Science*, *21*(4), 595–599.

Barrett, L. F., Tugade, M. M., & Engle, R. W. (2004). Individual differences in working memory capacity and dual-process theories of the mind. *Psychological Bulletin*, *130*(4), 553.

Bates, D., Mächler, M., Bolker, B. M., & Walker, S. C. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1). https://doi.org/10.18637/jss.v067.i01

Bauer, D. J., & Curran, P. J. (2003a). Distributional assumptions of growth mixture models: Implications for overextraction of latent trajectory classes. *Psychological Methods*, *8*(3), 338.

Bauer, D. J., & Curran, P. J. (2003b). Distributional assumptions of growth mixture models: Implications for overextraction of latent trajectory classes. *Psychological Methods*, *8*(3), 338.

Beck, E. D., & Jackson, J. J. (2019). Within-Person Variability. *The Handbook of Personality Dynamics and Processes*.

Becker, D. V., Anderson, U. S., Neuberg, S. L., Maner, J. K., Shapiro, J. R., Ackerman, J. M., Schaller, M., & Kenrick, D. T. (2010). More memory bang for the attentional buck: Self-protection goals enhance encoding efficiency for potentially threatening males. *Social Psychological and Personality Science*, *1*(2), 182–189.

Berry, D. S., Wero, F., & Julia, L. (1993). Accuracy in face perception: A view from ecological psychology. *Journal of Personality*, *61*(4), 497–520.

Berry, D. S., & Zebrowitz, L. A. (1988). What's in a Face? Facial Maturity and the Attribution of Legal Responsibility. *Personality and Social Psychology Bulletin*, *14*(1), 23–33. https://doi.org/0803973233

Betsch, T., & Glöckner, A. (2010). Intuition in judgment and decision making: Extensive thinking without effort. *Psychological Inquiry*, *21*(4), 279–294.

Bjornsdottir, R. T., & Rule, N. O. (2017a). The visibility of social class from facial cues. *Journal of Personality and Social Psychology*, *113*(4), 530.

Bjornsdottir, R. T., & Rule, N. O. (2017b). The visibility of social class from facial cues. *Journal of Personality and Social Psychology*, *113*(4), 530.

Blair, I. V. Y., Judd, C. M., & Chapleau, K. M. (2004a). The influence of Afrocentric facial features in criminal sentencing. *Psychological Science*, *15*(10), 674–679.

Blair, I. V. Y., Judd, C. M., & Chapleau, K. M. (2004b). The influence of Afrocentric facial features in criminal sentencing. *Psychological Science*, *15*(10), 674–679.

Bonnefon, J.-F., Hopfensitz, A., & De Neys, W. (2015). Face-ism and kernels of truth in facial inferences. *Trends in Cognitive Sciences*, *19*(8), 421–422.

Borkenau, P., Mauer, N., Riemann, R., Spinath, F. M., & Angleitner, A. (2004). Thin slices of behavior as cues of personality and intelligence. *Journal of Personality and Social Psychology*, *86*(4), 599.

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*, 34–42.

Brandt, M. J., Sibley, C. G., & Osborne, D. (2019). What is central to political belief system networks? *Personality and Social Psychology Bulletin*, *45*(9), 1352–1364.

Brannon, S. M., & Gawronski, B. (2017). A Second Chance for First Impressions? Exploring the Context-(In)Dependent Updating of Implicit Evaluations. *Social Psychological and Personality Science*, *8*(3), 275–283. https://doi.org/10.1177/1948550616673875

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

Brown, N. A., Neel, R., & Sherman, R. A. (2015). Measuring the evolutionarily important goals of situations: Situational affordances for adaptive problems. *Evolutionary Psychology*, *13*(3), 1474704915593662.

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. In *Journal of Consulting Psychology* (Vol. 16, Issue 6, pp. 475–475). University of Chicago Press. https://doi.org/10.1037/h0053448

Burgoon, J. K., & Hoobler, G. D. (1994). Nonverbal signals. *Handbook of Interpersonal Communication*, *2*, 229–285.

Bürkner, P.-C. (2017). brms: An R Package for Bayesian Multilevel Models Using Stan. *Journal of Statistical Software*, *80*(1), 1–28. https://doi.org/10.18637/jss.v080.i01

Calder, A. J., & Young, A. W. (2005). Understanding the recognition of facial identity and facial expression. *Nature Reviews Neuroscience*, *6*(8), 641–651.

Carney, D. R., Colvin, C. R., & Hall, J. A. (2007). A thin slice perspective on the accuracy of first impressions. *Journal of Research in Personality*, *41*(5), 1054–1072. https://doi.org/10.1016/j.jrp.2007.01.004

Carpinella, C. M., Hehman, E., Freeman, J. B., & Johnson, K. L. (2015). The Gendered Face of Partisan Politics: Consequences of Facial Sex Typicality for Vote Choice. *Political Communication*, *August*, 1–18. https://doi.org/10.1080/10584609.2014.958260

Carragher, D. J., Thomas, N. A., & Nicholls, M. E. (2021). The dissociable influence of social context on judgements of facial attractiveness and trustworthiness. *British Journal of Psychology*.

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

Chartier, C., McCarthy, R., & Urry, H. (2018). The psychological science accelerator. *APS Observer*, *31*(3).

Choi, I., Nisbett, R. E., & Norenzayan, A. (1999). Causal attribution across cultures: Variation and universality. *Psychological Bulletin*, *125*(1), 47.

Cloutier, J., Mason, M. F., & Macrae, C. N. (2005). The perceptual determinants of person construal: Reopening the social-cognitive toolbox. *Journal of Personality and Social Psychology*, *88*(6), 885.

Cogsdill, E. J., Todorov, A., Spelke, E. S., & Banaji, M. R. (2014). Inferring character from faces a developmental study. *Psychological Science*, *25*(5), 1132–1139.

Cohen, C. E. (1981). Person categories and social perception: Testing some boundaries of the processing effects of prior knowledge. *Journal of Personality and Social Psychology*, *40*(3), 441–452. https://doi.org/10.1037/0022-3514.40.3.441

Collova, J. R., Sutherland, C. A. M., & Rhodes, G. (2019). Testing the functional basis of first impressions: Dimensions for children's faces are not the same as for adults' faces. *Journal of Personality and Social Psychology*.

Conner, T. S., Tennen, H., Fleeson, W., & Barrett, L. F. (2009). Experience sampling methods: A modern idiographic approach to personality research. *Social and Personality Psychology Compass*, *3*(3), 292–313.

Converse, P. D., Miloslavic, S. A., Lockamy, C. N., Sudduth, M. M., Piccone, K., Pathak, J., & DePaul-Haddock, A. M. (2013). Within-person variability in goal content and goal frame: Amount, patterns, antecedents, and consequences of variation in goal orientation over time. *Human Performance*, *26*(5), 374–389.

Conway, J. R., Catmur, C., & Bird, G. (2019). Understanding individual differences in theory of mind via representation of minds, not mental states. *Psychonomic Bulletin & Review*, *26*(3), 798–812.

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

Csikszentmihalyi, M., & Larson, R. (2014). Validity and reliability of the experience-sampling method. In *Flow and the foundations of positive psychology* (pp. 35–54). Springer.

Cuddy, A. J. C., Fiske, S. T., & Glick, P. (2004). When professionals become mothers, warmth doesn't cut the ice. *Journal of Social Issues*, *60*(4), 701–718.

Cuddy, A. J. C., Fiske, S. T., Kwan, V. S. Y., Glick, P., Demoulin, S., Leyens, J.-P., Bond, M. H., Croizet, J.-C., Ellemers, N., Sleebos, E., Htun, T. T., Kim, H.-J., Maio, G., Perry, J., Petkova, K., Todorov, V., Rodríguez-Bailón, R., Morales, E., Moya, M., … Ziegler, R. (2009). Stereotype content model across cultures: Towards universal similarities and

some differences. *British Journal of Social Psychology*, *48*(1), 1–33. https://doi.org/10.1348/014466608X314935

Cudeck, R., & Henly, S. J. (2003). *A realistic perspective on pattern representation in growth data: Comment on Bauer and Curran (2003).*

Daalmans, S., Hijmans, E., & Wester, F. (2017). From good to bad and everything in between: An analysis of genre differences in the representation of moral nature. *Journal of Media Ethics*, *32*(1), 28–44.

Darwin, C. (1872). The expression of the emotions in man and animals. In *The American Journal of the Medical Sciences*. Murray.

De Bruin, E. N. M., & Van Lange, P. A. M. (2000). What people look for in others: Influences of the perceiver and the perceived on information selection. *Personality and Social Psychology Bulletin*, *26*(2), 206–219.

DeBruine, L. M., & Jones, B. C. (2017). *Face Research Lab London Set. Figshare*. https://doi.org/10.6084/m9.figshare.5047666

Deska, J. C., Lloyd, E. P., & Hugenberg, K. (2018). Facing humanness: Facial width-to-height ratio predicts ascriptions of humanity. *Journal of Personality and Social Psychology*, *114*(1), 75–94. https://doi.org/10.1037/pspi0000110

Desmet, P. M. A., Vastenburg, M. H., & Romero, N. (2016). Mood measurement with Pick-A-Mood: Review of current methods and design of a pictorial self-report scale. *Journal of Design Research*, *14*(3), 241–279.

Devine, P. G. (1989). Stereotypes and prejudice: Their automatic and controlled components. *Journal of Personality and Social Psychology*, *56*(1), 5.

Devine, P. G., & Elliot, A. J. (1995). Are racial stereotypes really fading? The Princeton trilogy revisited. *Personality and Social Psychology Bulletin*, *21*(11), 1139–1150.

Dinno, A. (2014). *Gently clarifying the application of Horn's parallel analysis to principal component analysis versus factor analysis*.

Duarte, J., Siegel, S., & Young, L. (2012a). Trust and credit: The role of appearance in peer-to-peer lending. *The Review of Financial Studies*, *25*(8), 2455–2484.

Duarte, J., Siegel, S., & Young, L. (2012b). Trust and credit: The role of appearance in peer-to-peer lending. *The Review of Financial Studies*, *25*(8), 2455–2484.

Eckes, T. (2002). Paternalistic and envious gender stereotypes: Testing predictions from the stereotype content model. *Sex Roles*, *47*(3), 99–114.

Eggleston, A., Flavell, J. C., Tipper, S. P., Cook, R., & Over, H. (2021). Culturally learned first impressions occur rapidly and automatically and emerge early in development. *Developmental Science*, *24*(2), e13021.

Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology*, *17*(2), 124–129. https://doi.org/10.1037/h0030377

Elfenbein, H. A., Beaupré, M., Lévesque, M., & Hess, U. (2007). Toward a dialect theory: Cultural differences in the expression and recognition of posed facial expressions. *Emotion*, *7*(1), 131.

Elliot, A. J. (2006). The hierarchical model of approach-avoidance motivation. *Motivation and Emotion*, *30*(2), 111–116.

Engell, A. D., Haxby, J. V., & Todorov, A. (2007). Implicit trustworthiness decisions: Automatic coding of face properties in the human amygdala. *Journal of Cognitive Neuroscience*, *19*(9), 1508–1519.

Epskamp, S., Borsboom, D., & Fried, E. I. (2018). Estimating psychological networks and their accuracy: A tutorial paper. *Behavior Research Methods*, *50*(1), 195–212.

Epskamp, S., Cramer, A. O. J., Waldorp, L. J., Schmittmann, V. D., & Borsboom, D. (2012). qgraph: Network visualizations of relationships in psychometric data. *Journal of Statistical Software*, *48*(4), 1–18.

Epskamp, S., & Fried, E. I. (2018). A tutorial on regularized partial correlation networks. *Psychological Methods*, *23*(4), 617–634. https://doi.org/10.1037/met0000167

Farah, M. J., Wilson, K. D., Drain, M., & Tanaka, J. N. (1998). What is" special" about face perception? *Psychological Review*, *105*(3), 482.

Farroni, T., Johnson, M. H., Menon, E., Zulian, L., Faraguna, D., & Csibra, G. (2005). Newborns' preference for face-relevant stimuli: Effects of contrast polarity. *Proceedings of the National Academy of Sciences*, *102*(47), 17245–17250.

Ferran, C., & Watts, S. (2008). Videoconferencing in the field: A heuristic processing model. *Management Science*, *54*(9), 1565–1578.

Fessler, D. M. T., & Holbrook, C. (2013). 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., Pollack, J. S., & Hahn-Holbrook, J. (2014). Stranger danger: Parenthood increases the envisioned bodily formidability of menacing men. *Evolution and Human Behavior*, *35*(2), 109–117. https://doi.org/10.1016/j.evolhumbehav.2013.11.004

Fessler, D. M. T., Holbrook, C., & Snyder, J. K. (2012). Weapons make the man (larger): Formidability is represented as size and strength in humans. *PloS One*, *7*(4).

Finkel, E. J., Eastwick, P. W., & Matthews, J. (2007). Speed-dating as an invaluable tool for studying romantic attraction: A methodological primer. *Personal Relationships*, *14*(1), 149–166.

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.

Fleeson, W. (2004). Moving personality beyond the person-situation debate: The challenge and the opportunity of within-person variability. *Current Directions in Psychological Science*, *13*(2), 83–87.

Forgas, J. P. (1992). On mood and peculiar people: Affect and person typicality in impression formation. *Journal of Personality and Social Psychology*, *62*(5), 863.

Forgas, J. P., & Bower, G. H. (1987). Mood effects on person-perception judgments. *Journal of Personality and Social Psychology*, *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

Freeman, J. B., & Johnson, K. L. (2016). More than meets the eye: Split-second social perception. *Trends in Cognitive Sciences*, *20*(5), 362–374.

Freeman, J. B., Johnson, K. L., Ambady, N., & Rule, N. O. (2010). Sexual orientation perception involves gendered facial cues. *Personality and Social Psychology Bulletin*, *36*(10), 1318–1331.

Freeman, J. B., Pauker, K., Apfelbaum, E. P., & Ambady, N. (2010). Continuous dynamics in the real-time perception of race. *Journal of Experimental Social Psychology*, *46*(1), 179–185. https://doi.org/10.1016/j.jesp.2009.10.002

Freeman, J. B., Stolier, R. M., & Brooks, J. A. (2020a). Dynamic interactive theory as a domain-general account of social perception. In *Advances in Experimental Social Psychology* (Vol. 61, pp. 237–287). Elsevier.

Freeman, J. B., Stolier, R. M., & Brooks, J. A. (2020b). Dynamic interactive theory as a domain-general account of social perception. In *Advances in Experimental Social Psychology* (Vol. 61, pp. 237–287). Elsevier.

Freeman, J. B., Stolier, R. M., Ingbretsen, Z. A., & Hehman, E. A. (2014). Amygdala responsivity to high-level social information from unseen faces. *The Journal of Neuroscience: The Official Journal of the Society for Neuroscience*, *34*(32), 10573–10581. https://doi.org/10.1523/JNEUROSCI.5063-13.2014

Galdi, S., Gawronski, B., Arcuri, L., & Friese, M. (2012). Selective exposure in decided and undecided individuals: Differential relations to automatic associations and conscious beliefs. *Personality and Social Psychology Bulletin*, *38*(5), 559–569.

Gawronski, B., Ehrenberg, K., Banse, R., Zukova, J., & Klauer, K. C. (2003). It's in the mind of the beholder: The impact of stereotypic associations on category-based and individuating impression formation. *Journal of Experimental Social Psychology*, *39*(1), 16–30.

Gawronski, B., Geschke, D., & Banse, R. (2003). Implicit bias in impression formation: Associations influence the construal of individuating information. *European Journal of Social Psychology*, *33*(5), 573–589.

Gibson, J. J. (1979). *The ecological approach to visual perception*. Houghton Mifflin.

Gill, R., & Gill, R. M. (2007). *Gender and the Media*. Polity.

Goldman, M., Cowles, M. D., & Florez, C. A. (1983). The halo effect of an initial impression upon speaker and audience. *The Journal of Social Psychology*, *120*(2), 197–201.

Goodwin, G. P., Piazza, J., & Rozin, P. (2014). Moral character predominates in person perception and evaluation. *Journal of Personality and Social Psychology*, *106*(1), 148.

Graham, J. R., Harvey, C. R., & Puri, M. (2016). A corporate beauty contest. *Management Science*.

Groll, A., & Tutz, G. (2014). Variable selection for generalized linear mixed models by L 1-penalized estimation. *Statistics and Computing*, *24*(2), 137–154.

Guillaume, E., Baranski, E., Todd, E., Bastian, B., Bronin, I., Ivanova, C., Cheng, J. T., de Kock, F. S., Denissen, J. J. A., Gallardo-Pujol, D., Halama, P., Han, G. Q., Bae, J., Moon, J., Hong, R. Y., Hřebíčková, M., Graf, S., Izdebski, P., Lundmann, L., … Funder, D. C. (2016). The World at 7:00: Comparing the Experience of Situations Across 20 Countries. *Journal of Personality*, *84*(4), 493–509. https://doi.org/10.1111/jopy.12176

Guinote, A. (2007). Behaviour variability and the situated focus theory of power. *European Review of Social Psychology*, *18*(1), 256–295.

Hamilton, D. L., Driscoll, D. M., & Worth, L. T. (1989). Cognitive organization of impressions: Effects of incongruency in complex representations. *Journal of Personality and Social Psychology*, *57*(6), 925.

Hamilton, D. L., & Huffman, L. J. (1971). Generality of impression-formation processes for evaluative and nonevaluative judgments. *Journal of Personality and Social Psychology*, *20*(2), 200.

Hamilton, D. L., Katz, L. B., & Leirer, V. O. (1980). Cognitive representation of personality impressions: Organizational processes in first impression formation. *Journal of Personality and Social Psychology*, *39*(6), 1050.

Hansen, C. H., & Hansen, R. D. (1988). Finding the face in the crowd: An anger superiority effect. *Journal of Personality and Social Psychology*, *54*(6), 917–924. https://doi.org/10.1037/0022-3514.54.6.917

Harris, M. J., & Garris, C. P. (2008). *You never get a second chance to make a first impression: Behavioral consequences of first impressions.* Guilford Publications.

Haselton, M. G., & Nettle, D. (2006). The paranoid optimist: An integrative evolutionary model of cognitive biases. *Personality and Social Psychology Review*, *10*(1), 47–66.

Haxby, J., Hoffman, E., & Gobbini, M. (2000). The distributed human neural system for face perception. *Trends in Cognitive Sciences*, *4*(6), 223–233.

Hehman, E., Carpinella, C. M., Johnson, K. L., Leitner, J. B., & Freeman, J. B. (2014). Early Processing of Gendered Facial Cues Predicts the Electoral Success of Female Politicians. *Social Psychological and Personality Science*, *5*(7), 815–824. https://doi.org/10.1177/1948550614534701

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), 1–12. https://doi.org/10.1177/0146167215591495

Hehman, E., Ingbretsen, Z. A., & Freeman, J. B. (2014). The neural basis of stereotypic impact on multiple social categorization. *NeuroImage*, *101*, 704–711. https://doi.org/10.1016/j.neuroimage.2014.07.056

Hehman, E., Leitner, J. B., Deegan, M. P., & Gaertner, S. L. (2013). Facial structure is indicative of explicit support for prejudicial beliefs. *Psychological Science*, *24*(3), 289–296. https://doi.org/10.1177/0956797612451467

Hehman, E., Leitner, J. B., Deegan, M. P., & Gaertner, S. L. (2015). Picking teams: When dominant facial structure is preferred. *Journal of Experimental Social Psychology*, *59*, 51–59. https://doi.org/10.1016/j.jesp.2015.03.007

Hehman, E., Stolier, R. M., Freeman, J. B., Flake, J. K., & Xie, S. Y. (2018). Toward a comprehensive model of face impressions: What we know, what we do not, and paths forward. *Social and Personality Psychology Compass*, *13*(2), e12431. https://doi.org/10.1111/spc3.12431

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*, *113*(4), 513–529.

Hester, N., & Gray, K. (2018a). For Black men, being tall increases threat stereotyping and police stops. *Proceedings of the National Academy of Sciences*, *115*(11), 2711–2715. https://doi.org/10.1073/pnas.1714454115

Hester, N., & Gray, K. (2018b). For Black men, being tall increases threat stereotyping and police stops. *Proceedings of the National Academy of Sciences*, *115*(11), 2711–2715. https://doi.org/10.1073/pnas.1714454115

Hester, N., Xie, S. Y., & Hehman, E. (2021). Little Between-Region and Between-Country Variance When Forming Impressions of Others. *Psychological Science*.

Heynicke, M., Rau, R., Leising, D., Wessels, N., & Wiedenroth, A. (2021). Perceiver Effects in Person Perception Reflect Acquiescence, Positivity, and Trait-Specific Content: Evidence From a Large-Scale Replication Study. *Social Psychological and Personality Science*. https://doi.org/10.1177/19485506211039101

Hickendorff, M., Edelsbrunner, P. A., McMullen, J., Schneider, M., & Trezise, K. (2018). Informative tools for characterizing individual differences in learning: Latent class, latent profile, and latent transition analysis. *Learning and Individual Differences*, *66*, 4–15.

Hoffmann, J. A., von Helversen, B., & Rieskamp, J. (2013). Deliberation's blindsight: How cognitive load can improve judgments. *Psychological Science*, *24*(6), 869–879.

Holbrook, C., Fessler, D. M. T., & Navarrete, C. D. (2016). Looming large in others' eyes: Racial stereotypes illuminate dual adaptations for representing threat versus prestige as physical size. *Evolution and Human Behavior*, *37*(1), 67–78. https://doi.org/10.1016/j.evolhumbehav.2015.08.004

Holbrook, C., Galperin, A., Fessler, D. M. T., Johnson, K. L., Bryant, G. A., & Haselton, M. G. (2014). If looks could kill: Anger attributions are intensified by affordances for doing harm. *Emotion*, *14*(3), 455.

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

Horstmann, K. T., Rauthmann, J. F., & Sherman, R. A. (2017). Measurement of situational influences. *The SAGE Handbook of Personality and Individual Differences*, 465–484.

Horstmann, K. T., & Ziegler, M. (2019). Situational perception and affect: Barking up the wrong tree? *Personality and Individual Differences*, *136*, 132–139.

Hox, J. J., & Roberts, J. K. (2011). *Handbook of advanced multilevel analysis*. Psychology Press.

Hugenberg, K., & Sacco, D. F. (2008). Social categorization and stereotyping: How social categorization biases person perception and face memory. *Social and Personality Psychology Compass*, *2*(2), 1052–1072.

Hugenberg, K., Young, S. G., Bernstein, M. J., & Sacco, D. F. (2010). The categorization-individuation model: An integrative account of the other-race recognition deficit. *Psychological Review*, *117*(4), 1168.

Hughes, B. L., Zaki, J., & Ambady, N. (2017). Motivation alters impression formation and related neural systems. *Social Cognitive and Affective Neuroscience*, *12*(1), 49–60.

Hung, S.-M., Nieh, C.-H., & Hsieh, P.-J. (2016). Unconscious processing of facial attractiveness: Invisible attractive faces orient visual attention. *Scientific Reports*, *6*(1), 1–8.

Ito, T. A., & Urland, G. R. (2005). The influence of processing objectives on the perception of faces: An ERP study of race and gender perception. *Cognitive, Affective & Behavioral Neuroscience*, *5*(1), 21–36. https://doi.org/10.3758/CABN.5.1.21

Ittelson, W. H., & Cantril, H. (1954). *Perception; a transactional approach.*

Jaeger, B., Evans, A., & van Beest, I. (2019). *Facial appearances and electoral success: Does regional corruption moderate preferences for trustworthy-looking politicians?*

Jaeger, B., Sleegers, W., Stern, J., Penke, L., & Jones, A. L. (2020). *The accuracy and meta-accuracy of personality impressions from faces*.

Johnson, K. L., Freeman, J. B., & Pauker, K. (2012). Race is gendered: How covarying phenotypes and stereotypes bias sex categorization. *Journal of Personality and Social Psychology*, *102*(1), 116. https://doi.org/10.1037/a0025335

Jones, B. C., DeBruine, L. M., Flake, J. K., Aczel, B., Adamkovic, M., Alaei, R., Alper, S., Solas, S. Á., Andreychik, M. R., Ansari, D., Arnal, J. D., Babinčák, P., Balas, B., Baník, G., Krystian, Barzykowski, Baskin, E., Batres, C., Beaudry, J. L., … Chartier, C. R. (2018). Social perception of faces around the world: How well does the valence-dominance model generalize across world regions? (Registered Report Stage 1). *Nature Human Behaviour*, 1–36. https://doi.org/10.31234/osf.io/n26dy

Jones, B. C., DeBruine, L. M., Flake, J. K., Liuzza, M. T., Antfolk, J., Arinze, N. C., Ndukaihe, I. L. G., Bloxsom, N. G., Lewis, S. C., & Foroni, F. (2021). To which world regions does the valence–dominance model of social perception apply? *Nature Human Behaviour*, 1–9.

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

Karras, T., Laine, S., & Aila, T. (2019). A style-based generator architecture for generative adversarial networks. *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 4401–4410.

Kawakami, K., Amodio, D. M., & Hugenberg, K. (2017a). Intergroup Perception and Cognition: An Integrative Framework for Understanding the Causes and Consequences of Social Categorization. In *Advances in Experimental Social Psychology* (1st ed., Vol. 55). Elsevier Inc. https://doi.org/10.1016/bs.aesp.2016.10.001

Kawakami, K., Amodio, D. M., & Hugenberg, K. (2017b). Intergroup Perception and Cognition: An Integrative Framework for Understanding the Causes and Consequences of Social Categorization. In J. M. B. T.-A. in E. S. P. Olson (Ed.), *Advances in Experimental Social Psychology* (1st ed., Vol. 55). Elsevier Inc. https://doi.org/10.1016/bs.aesp.2016.10.001

Keating, C. F., Mazur, A., & Segall, M. H. (1981). A cross-cultural exploration of physiognomic traits of dominance and happiness. *Ethology and Sociobiology*, *2*(1), 41–48.

Kelley, H. H. (1950). The warm-cold variable in first impressions of persons. *Journal of Personality*, *18*(4), 431–439.

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. (2019). *Interpersonal perception: The foundation of social relationships*. Guilford Publications.

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

Kenny, D. A., & West, T. V. (2011). Similarity and agreement in self and other perception: A meta-analysis. *Personality and Social Psychology Review*, *14*(2), 196–213. https://doi.org/10.1177/1088868309353414

Kenrick, D. T., Neuberg, S. L., Griskevicius, V., Becker, D. V., & Schaller, M. (2010). Goal-driven cognition and functional behavior: The fundamental-motives framework. *Current Directions in Psychological Science*, *19*(1), 63–67.

Kimmel, M. S. (2000). *The gendered society*. Oxford University Press, USA.

Klapper, A., Dotsch, R., van Rooij, I., & Wigboldus, D. H. (2016). Do we spontaneously form stable trustworthiness impressions from facial appearance? *Journal of Personality and Social Psychology*, *111*(5), 655.

Knutson, B. (1996). Facial expressions of emotion influence interpersonal trait inferences. *Journal of Nonverbal Behavior*, *20*(3), 165–182.

Koehler, J. J. (1996). The base rate fallacy reconsidered: Descriptive, normative, and methodological challenges. *Behavioral and Brain Sciences*, *19*(1), 1–17.

Kok, R., Taubert, J., Van der Burg, E., Rhodes, G., & Alais, D. (2017). Face familiarity promotes stable identity recognition: Exploring face perception using serial dependence. *Royal Society Open Science*, *4*(3), 160685.

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

Kubota, J. T., & Ito, T. A. (2007). Multiple cues in social perception: The time course of processing race and facial expression. *Journal of Experimental Social Psychology*, *43*(5), 738–752. https://doi.org/10.1016/j.jesp.2006.10.023

Kunda, Z., & Thagard, P. (1996). Forming Impressions From Stereotypes, Traits, and Behaviors: A Parallel-Constraint-Satisfaction Theory. *Psychological Review*, *103*(2), 284–308.

Kunda, Z., Thagard, P., Kunda, Z., Thagard, P., Kintsch, W., & Ross, M. (1996). Forming Impressions From Stereotypes, Traits, and Behaviors: A Parallel-Constraint-Satisfaction Theory. *Psychological Review*, *103*(2), 284–308.

Lanza, S. T., Rhoades, B. L., Nix, R. L., Greenberg, M. T., & Group, C. P. P. R. (2010). Modeling the interplay of multilevel risk factors for future academic and behavior problems: A person-centered approach. *Development and Psychopathology*, *22*(2), 313–335.

Lay, C. H., & Jackson, D. N. (1969). Analysis of the generality of trait-inferential relationships. *Journal of Personality and Social Psychology*, *12*(1), 12.

Lerner, J. S., & Keltner, D. (2000). Beyond valence: Toward a model of emotion-specific influences on judgement and choice. *Cognition & Emotion*, *14*(4), 473–493.

Li, T., Cardenas-Iniguez, C., Correll, J., & Cloutier, J. (2016). The impact of motivation on race-based impression formation. *Neuroimage*, *124*, 1–7.

Lin, C., Keles, U., & Adolphs, R. (2021). Four dimensions characterize attributions from faces using a representative set of English trait words. *Nature Communications*, *12*(1), 1–15.

Livingston, R. W., & Pearce, N. A. (2009a). The teddy-bear effect: Does having a baby face benefit black chief executive officers? *Psychological Science*, *20*(10), 1229–1236.

Livingston, R. W., & Pearce, N. A. (2009b). The Teddy-Bear Effect Does Having a Baby Face Benefit Black Chief Executive Officers? *Psychological Science*, *20*(10), 1229–1236. https://doi.org/10.1111/j.1467-9280.2009.02431.x

Lorenzo, G. L., Biesanz, J. C., & Human, L. J. (2010). What is beautiful is good and more accurately understood. Physical attractiveness and accuracy in first impressions of personality. *Psychological Science*, *21*(12), 1777–1782. https://doi.org/10.1177/0956797610388048

Lorr, M. (1989). Models and methods for measurement of mood. In *The measurement of emotions* (pp. 37–53). Elsevier.

Ma, D. S., Correll, J., & Wittenbrink, B. (2015). The Chicago face database: A free stimulus set of faces and norming data. *Behavior Research Methods*. https://doi.org/10.3758/s13428-014-0532-5

Macrae, C. N., Bodenhausen, G. V., Schloerscheidt, A. M., & Milne, A. B. (1999). Tales of the unexpected: Executive function and person perception. *Journal of Personality and Social Psychology, 76*(2), 200.

Macrae, C. N., & Bodenhausen, G. V. (2000). Social cognition: Thinking categorically about others. *Annual Review of Psychology*, *51*, 93–120. https://doi.org/10.1146/annurev.psych.51.1.93

Macrae, C. N., & Shepherd, J. W. (1989). Do criminal stereotypes mediate juridic judgements? *British Journal of Social Psychology*, *28*(2), 189–191.

Maner, J. K., Kenrick, D. T., Becker, D. V., Robertson, T. E., Hofer, B., Neuberg, S. L., Delton, A. W., Butner, J., & Schaller, M. (2005). Functional projection: How fundamental social motives can bias interpersonal perception. *Journal of Personality and Social Psychology*, *88*(1), 63.

Markman, A. B., & Otto, A. R. (2011). Cognitive systems optimize energy rather than information. *Behavioral and Brain Sciences*, *34*(4), 207.

Marsh, H. W., Lüdtke, O., Trautwein, U., & Morin, A. J. S. (2009). Classical latent profile analysis of academic self-concept dimensions: Synergy of person-and variable-centered approaches to theoretical models of self-concept. *Structural Equation Modeling: A Multidisciplinary Journal*, *16*(2), 191–225.

Martin, A. E., & Slepian, M. L. (2021). The primacy of gender: Gendered cognition underlies the Big Two dimensions of social cognition. *Perspectives on Psychological Science*, *16*(6), 1143–1158.

Martin, C. L., & Ruble, D. (2004). Children's search for gender cues: Cognitive perspectives on gender development. *Current Directions in Psychological Science*, *13*(2), 67–70.

Martin, C. L., Ruble, D. N., & Szkrybalo, J. (2002). Cognitive theories of early gender development. *Psychological Bulletin*, *128*(6), 903.

Mason, M. F., Cloutier, J., & Macrae, C. N. (2006). On construing others: Category and stereotype activation from facial cues. *Social Cognition*, *24*(5), 540–562.

Mason, M. F., Tatkow, E. P., & Macrae, C. N. (2005). The look of love. *Psychological Science*, *16*(3), 236–239. https://doi.org/10.1111/j.0956-7976.2005.00809.x

Mattavelli, S., Masi, M., & Brambilla, M. (2021). Not Just About Faces in Context: Face–Context Relation Moderates the Impact of Contextual Threat on Facial Trustworthiness. *Personality and Social Psychology Bulletin*, 01461672211065933.

Matthews, G., Jones, D. M., & Chamberlain, A. G. (1990). Refining the measurement of mood: The UWIST mood adjective checklist. *British Journal of Psychology*, *81*(1), 17–42.

McArthur, L. Z., & Apatow, K. (1984). Impressions of baby-faced adults. *Social Cognition*, *2*(4), 315–342. https://doi.org/10.1521/soco.1984.2.4.315

McArthur, L. Z., & Baron, R. M. (1983). Toward an ecological theory of social perception. *Psychological Review*, *90*(3), 215–238. https://doi.org/10.1037//0033-295X.90.3.215

McArthur, L. Z., & Berry, D. S. (1987). Cross-cultural agreement in perceptions of babyfaced adults. *Journal of Cross-Cultural Psychology*, *18*(2), 165–192.

Merz, E. L., & Roesch, S. C. (2011). A latent profile analysis of the Five Factor Model of personality: Modeling trait interactions. *Personality and Individual Differences*, *51*(8), 915–919.

Mesquita, B., Barrett, L. F., & Smith, E. R. (2010). *The mind in context*. Guilford Press.

Mischel, W. (1968). *Personality and assessment*. Wiley Online Library.

Monroe, B. M., & Read, S. J. (2008). A general connectionist model of attitude structure and change: The ACS (Attitudes as Constraint Satisfaction) model. *Psychological Review*, *115*(3), 733.

Montepare, J. M., & Dobish, H. (2003). The contribution of emotion perceptions and their overgeneralizations to trait impressions. *Journal of Nonverbal Behavior*, *27*(4), 237–254.

Montepare, J. M., & Zebrowitz-McArthur, L. (1989). Children's perceptions of babyfaced adults. *Perceptual and Motor Skills*, *69*(2), 467–472.

Neel, R., Brown, N. A., & Sng, O. (2017). Evolutionary Perspectives on Situations. In *The Oxford Handbook of Psychological Situations* (p. 23). https://doi.org/10.1093/oxfordhb/9780190263348.013.9

Neel, R., Kenrick, D. T., White, A. E., & Neuberg, S. L. (2016). Individual differences in fundamental social motives. *Journal of Personality and Social Psychology*, *110*(6), 887.

Neuberg, S. L., & Fiske, S. T. (1987a). Motivation and impression formation: Outcome dependency, attention, and individuating processes. *Journal of Personality and Social Psychology*, *53*(3), 431–444.

Neuberg, S. L., & Fiske, S. T. (1987b). Motivational influences on impression formation: Outcome dependency, accuracy-driven attention, and individuating processes. *Journal of Personality and Social Psychology*, *53*(3), 431–444.

Nisbett, R. E., & Wilson, T. D. (1977). The halo effect: Evidence for unconscious alteration of judgments. *Journal of Personality and Social Psychology*, *35*(4), 250–256. https://doi.org/10.1037/0022-3514.35.4.250

Nobandegani, A. S., Castanheira, K. da S., Otto, A. R., & Shultz, T. R. (2018). Over-representation of extreme events in decision-making: A rational metacognitive account. *ArXiv Preprint ArXiv:1801.09848*.

Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural Equation Modeling: A Multidisciplinary Journal*, *14*(4), 535–569.

Oh, D., Dotsch, R., Porter, J., & Todorov, A. (2019). Gender biases in impressions from faces: Empirical studies and computational models. *Journal of Experimental Psychology: General*.

Oldmeadow, J. A., Sutherland, C. A. M., & Young, A. W. (2013). Facial stereotype visualization through image averaging. *Social Psychological and Personality Science*, *4*(5), 615–623.

Olivola, C. Y., Funk, F., & Todorov, A. (2014). Social attributions from faces bias human choices. *Trends in Cognitive Sciences*, *18*(11), 566–570.

Olivola, C. Y., Tingley, D., & Todorov, A. (2018). Republican voters prefer candidates who have conservative-looking faces: New evidence from exit polls. *Political Psychology*, *39*(5), 1157–1171.

Olivola, C. Y., & Todorov, A. (2010a). Elected in 100 milliseconds: Appearance-Based Trait Inferences and Voting. *Journal of Nonverbal Behavior*, *34*(2), 83–110. https://doi.org/10.1007/s10919-009-0082-1

Olivola, C. Y., & Todorov, A. (2010b). 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 of the United States of America*, *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

Opsahl, T., Agneessens, F., & Skvoretz, J. (2010). Node centrality in weighted networks: Generalizing degree and shortest paths. *Social Networks*, *32*(3), 245–251.

Orehek, E., Dechesne, M., Fishbach, A., Kruglanski, A. W., & Chun, W. Y. (2010). On the inferential epistemics of trait centrality in impression formation. *European Journal of Social Psychology*, *40*(7), 1120–1135.

Otto, A. R., & Daw, N. D. (2019). The opportunity cost of time modulates cognitive effort. *Neuropsychologia*, *123*, 92–105.

Over, H., & Cook, R. (2018). Where do spontaneous first impressions of faces come from? *Cognition*, *170*, 190–200.

Parrigon, S., Woo, S. E., Tay, L., & Wang, T. (2017). CAPTION-ing the situation: A lexically-derived taxonomy of psychological situation characteristics. *Journal of Personality and Social Psychology*, *112*(4), 642.

Pastor, D. A., Barron, K. E., Miller, B. J., & Davis, S. L. (2007). A latent profile analysis of college students' achievement goal orientation. *Contemporary Educational Psychology*, *32*(1), 8–47.

Pendry, L. F., & Macrae, C. N. (1994). Stereotypes and mental life: The case of the motivated but thwarted tactician. *Journal of Experimental Social Psychology*, *30*(4), 303–325.

Peugh, J., & Fan, X. (2013a). Modeling unobserved heterogeneity using latent profile analysis: A Monte Carlo simulation. *Structural Equation Modeling: A Multidisciplinary Journal*, *20*(4), 616–639.

Peugh, J., & Fan, X. (2013b). Modeling unobserved heterogeneity using latent profile analysis: A Monte Carlo simulation. *Structural Equation Modeling: A Multidisciplinary Journal*, *20*(4), 616–639.

Plaks, J. E., Grant, H., & Dweck, C. S. (2005). Violations of implicit theories and the sense of prediction and control: Implications for motivated person perception. *Journal of Personality and Social Psychology*, *88*(2), 245.

Plaks, J. E., Levy, S. R., & Dweck, C. S. (2009). Lay theories of personality: Cornerstones of meaning in social cognition. *Social and Personality Psychology Compass*, *3*(6), 1069–1081.

Porter, S., ten Brinke, L., & Gustaw, C. (2010). Dangerous decisions: The impact of first impressions of trustworthiness on the evaluation of legal evidence and defendant culpability. *Psychology, Crime & Law*, *16*(6), 477–491.

Post, R., Haberman, J., Iwaki, L., & Whitney, D. (2012). The frozen face effect: Why static photographs may not do you justice. *Frontiers in Psychology*, *3*, 22.

Prabhakaran, R., Green, A. E., & Gray, J. R. (2014). Thin slices of creativity: Using single-word utterances to assess creative cognition. *Behavior Research Methods*, *46*(3), 641–659. https://doi.org/10.3758/s13428-013-0401-7

Raftery, A. E. (1995). Bayesian model selection in social research. *Sociological Methodology*, 111–163.

Rammstedt, B., & John, O. P. (2007). Measuring personality in one minute or less: A 10-item short version of the Big Five Inventory in English and German. *Journal of Research in Personality*, *41*(1), 203–212.

Ratner, K. G., & Amodio, D. M. (2013). Seeing "us vs. Them": Minimal group effects on the neural encoding of faces. *Journal of Experimental Social Psychology*, *49*(2), 298–301. https://doi.org/10.1016/j.jesp.2012.10.017

Rau, R., Carlson, E. N., Back, M. D., Barranti, M., Gebauer, J. E., Human, L. J., Leising, D., & Nestler, S. (2021). What is the structure of perceiver effects? On the importance of global positivity and trait-specificity across personality domains and judgment contexts. *Journal of Personality and Social Psychology*, *3*(120), 745–764.

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

Rauthmann, J. F. (2016). Motivational Factors in the Perception of Psychological Situation Characteristics. *Social and Personality Psychology Compass*, *10*(2), 92–108. https://doi.org/10.1111/spc3.12239

Rauthmann, J. F., Gallardo-Pujol, D., Guillaume, E. M., Todd, E., Nav, C. S., Sherman, R. A., Ziegler, M., Jones, A. B., & Funder, D. C. (2014). The situational Eight DIAMONDS: A

taxonomy of major dimensions of situation characteristics. *Journal of Personality and Social Psychology*, *107*(4), 677–718. https://doi.org/10.1037/a0037250

Rauthmann, J. F., & Sherman, R. (2019). Toward a research agenda for the study of situation perceptions: A variance componential framework. *Personality and Social Psychology Review*, *23*(3), 238–266.

Rauthmann, J. F., & Sherman, R. A. (2015). Ultra-brief measures for the situational eight DIAMONDS domains. *European Journal of Psychological Assessment*.

Rauthmann, J. F., & Sherman, R. A. (2018). The Description of Situations: Towards replicable domains of psychological situation characteristics. *Journal of Personality and Social Psychology*, *114*(3), 482–488. https://doi.org/10.1037/pspp0000162

Rauthmann, J. F., Sherman, R. A., Nave, C. S., & Funder, D. C. (2015). Personality-driven situation experience, contact, and construal: How people's personality traits predict characteristics of their situations in daily life. *Journal of Research in Personality*, *55*, 98–111. https://doi.org/10.1016/j.jrp.2015.02.003

Re, D. E., DeBruine, L. M., Jones, B. C., & Perrett, D. I. (2013). Facial cues to perceived height influence leadership choices in simulated war and peace contexts. *Evolutionary Psychology*, *11*(1), 89–103. https://doi.org/10.1177/147470491301100109

Read, S. J., Vanman, E. J., & Miller, L. C. (1997). Connectionism, parallel constraint satisfaction processes, and gestalt principles:(Re) introducing cognitive dynamics to social psychology. *Personality and Social Psychology Review*, *1*(1), 26–53.

Revelle, W. (2018). *psych: Procedures for Psychological, Psychometric, and Personality Research*.

Reynolds, K. J., & Oakes, P. J. (2000). Variability in impression formation: Investigating the role of motivation, capacity, and the categorization process. *Personality and Social Psychology Bulletin*, *26*(3), 355–373.

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

Rights, J. D., & Sterba, S. K. (2019). Quantifying explained variance in multilevel models: An integrative framework for defining R-squared measures. *Psychological Methods*, *24*(3), 309.

Ro, T., Russell, C., & Lavie, N. (2001). Changing faces: A detection advantage in the flicker paradigm. *Psychological Science*, *12*(1), 94–99.

Robins, R. W., John, O. P., & Caspi, A. (1998). The typological approach to studying personality. *Methods and Models for Studying the Individual*, 135–160.

Rogers, K. H., & Biesanz, J. C. (2014). The Accuracy and Bias of Interpersonal Perceptions in Intergroup Interactions. *Social Psychological and Personality Science*, *5*(8), 918–926. https://doi.org/10.1177/1948550614537307

Rosch, E., & Lloyd, B. B. (1978). *Cognition and categorization*.

Rosenberg, J., Beymer, P., Anderson, D., van Lissa, C. J., & Schmidt, J. (2019). TidyLPA: An R package to easily carry out Latent Profile Analysis (LPA) using open-source or commercial software. *Journal of Open Source Software*, *4*(44), 978.

Ross, L., & Nisbett, R. E. (1991). *The person and the situation: Perspectives of social psychology*. McGraw-Hill.

Rudman, L. A., & Glick, P. (2001). Prescriptive gender stereotypes and backlash toward agentic women. *Journal of Social Issues*, *57*(4), 743–762.

Rule, N. O. (2011). The influence of target and perceiver race in the categorisation of male sexual orientation. *Perception*, *40*(7), 830–839.

Rule, N. O., & Ambady, N. (2008). Brief exposures: Male sexual orientation is accurately perceived at 50ms. *Journal of Experimental Social Psychology*, *44*(4), 1100–1105. https://doi.org/10.1016/j.jesp.2007.12.001

Rule, N. O., Ambady, N., Adams Jr, R. B., Ozono, H., Nakashima, S., Yoshikawa, S., & Watabe, M. (2010). Polling the face: Prediction and consensus across cultures. *Journal of Personality and Social Psychology*, *98*(1), 1.

Rule, N. O., Ambady, N., & Hallett, K. C. (2009). Female sexual orientation is perceived accurately, rapidly, and automatically from the face and its features. *Journal of Experimental Social Psychology*, *45*(6), 1245–1251. https://doi.org/10.1016/j.jesp.2009.07.010

Rule, N. O., Krendl, A. C., Ivcevic, Z., & Ambady, N. (2013). Accuracy and consensus in judgments of trustworthiness from faces: Behavioral and neural correlates. *Journal of Personality and Social Psychology*, *104*(3), 409–426. https://doi.org/10.1037/a0031050

Ruscher, J. B., Fiske, S. T., & Schnake, S. B. (2000). The motivated tactician's juggling act: Compatible vs. Incompatible impression goals. *British Journal of Social Psychology*, *39*(2), 241–256.

Sacco, D. F., & Brown, M. (2018). 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

Schaller, M., Kenrick, D. T., Neel, R., & Neuberg, S. L. (2017). Evolution and human motivation: A fundamental motives framework. *Social and Personality Psychology Compass*, *11*(6), e12319.

Schellenberg, S. (2008). The situation-dependency of perception. *The Journal of Philosophy*, *105*(2), 55–84.

Schmittmann, V. D., Jahfari, S., Borsboom, D., Savi, A. O., & Waldorp, L. J. (2015). Making large-scale networks from fMRI data. *PloS One*, *10*(9).

Sczesny, S., Bosak, J., Neff, D., & Schyns, B. (2004). Gender stereotypes and the attribution of leadership traits: A cross-cultural comparison. *Sex Roles*, *51*(11–12), 631–645.

Sczesny, S., Spreemann, S., & Stahlberg, D. (2006). Masculine = competent? Physical appearance and sex as sources of gender-stereotypic attributions. *Swiss Journal of Psychology*, *65*(1), 15–23. https://doi.org/10.1024/1421-0185.65.1.15

Secord, P. F., & Bevan, W. (1956). Personalities in Faces: III. A cross cultural comparison of impressions of physiognomy and personality in faces. *The Journal of Social Psychology*, *43*(2), 283-288. https://doi.org/10.1017/CBO9781107415324.004

Shah, A. K., & Oppenheimer, D. M. (2008). Heuristics made easy: An effort-reduction framework. *Psychological Bulletin*, *134*(2), 207.

Sherman, R. A., Rauthmann, J. F., Brown, N. A., Serfass, D. G., & Jones, A. B. (2015). The independent effects of personality and situations on real-time expressions of behavior and emotion. *Journal of Personality and Social Psychology*, *109*(5), 872–888. https://doi.org/10.1037/pspp0000036

Shoda, Y., Cervone, D., & Downey, G. (2007). *Persons in context: Building a science of the individual*. Guilford Press.

Sinclair, L., & Kunda, Z. (2000). Motivated stereotyping of women: She's fine if she praised me but incompetent if she criticized me. *Personality and Social Psychology Bulletin*, *26*(11), 1329–1342.

Smith, E. R., & Collins, E. C. (2009). Contextualizing Person Perception: Distributed Social Cognition. *Psychological Review*, *116*(2), 343–364. https://doi.org/10.1037/a0015072

Sritharan, R., Heilpern, K., Wilbur, C. J., & Gawronski, B. (2010). I think I like you: Spontaneous and deliberate evaluations of potential romantic partners in an online dating context. *European Journal of Social Psychology*, *40*(6), 1062–1077.

Stecker, J., Bürkner, P.-C., Hellmann, J., Nestler, S., & Back, M. (2020). *Prejudice at First Sight? First Impressions of Refugees are More Strongly Influenced by Targets' and Perceivers' Individual Characteristics Than by Sheer Group Affiliation*. https://doi.org/10.31234/osf.io/wt6kr

Stewart, L. H., Ajina, S., Getov, S., Bahrami, B., Todorov, A., & Rees, G. (2012). Unconscious evaluation of faces on social dimensions. *Journal of Experimental Psychology: General*, *141*(4), 715.

Stolier, R. M., & Freeman, J. B. (2016). Neural pattern similarity reveals the inherent intersection of social categories. *Nature Neuroscience*, *19*(November 2015), 1–8. https://doi.org/10.1038/nn.4296

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., & Freeman, J. B. (2020). Trait knowledge forms a common structure across social cognition. *Nature Human Behaviour*, *4*(4), 361–371.

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 of the United States of America*, *115*(37), 9210–9215. https://doi.org/10.1073/pnas.1807222115

Sutherland, C. A. M., Burton, N. S., Wilmer, J. B., Blokland, G. A. M., Germine, L., Palermo, R., Collova, J. R., & Rhodes, G. (2020). Individual differences in trust evaluations are shaped mostly by environments, not genes. *Proceedings of the National Academy of Sciences*, *117*(19), 10218–10224.

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*.

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., Rhodes, G., Burton, N. S., & Young, A. W. (2019). Do facial first impressions reflect a shared social reality? *British Journal of Psychology*, *0*(0). https://doi.org/10.1111/bjop.12390

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

Sutherland, C. A. M., Young, A. W., & Rhodes, G. (2017). Facial first impressions from another angle: How social judgements are influenced by changeable and invariant facial properties. *British Journal of Psychology*, *108*(2), 397–415. https://doi.org/10.1111/bjop.12206

Swets, J. A. (1964). *Signal detection and recognition in human observers: Contemporary readings.* John Wiley & Sons, Ltd.

Tajfel, H., Billig, M. G., Bundy, R. P., & Flament, C. (1971). Social categorization and intergroup behaviour. *European Journal of Social Psychology*, *1*(2), 149–178. https://doi.org/10.1002/ejsp.2420010202

Tein, J.-Y., Coxe, S., & Cham, H. (2013). Statistical power to detect the correct number of classes in latent profile analysis. *Structural Equation Modeling: A Multidisciplinary Journal*, *20*(4), 640–657.

Thai, S., & Page-Gould, E. (2018). ExperienceSampler: An open-source scaffold for building smartphone apps for experience sampling. *Psychological Methods*, *23*(4), 729.

Theeuwes, J., & Van der Stigchel, S. (2006). Faces capture attention: Evidence from inhibition of return. *Visual Cognition*, *13*(6), 657–665.

Thompson, E. R. (2007). Development and validation of an internationally reliable short-form of the positive and negative affect schedule (PANAS). *Journal of Cross-Cultural Psychology*, *38*(2), 227–242.

Tibshirani, R. (1996). Regression shrinkage and selection via the lasso. *Journal of the Royal Statistical Society: Series B (Methodological)*, *58*(1), 267–288.

Tingley, D. (2014). Face-Off: Facial Features and Strategic Choice. *Political Psychology*, *35*(1), 35–55. https://doi.org/10.1111/pops.12041

Todorov, A., Baron, S. G., & Oosterhof, N. N. (2008). Evaluating face trustworthiness: A model based approach. *Social Cognitive and Affective Neuroscience*, *3*(2), 119–127. https://doi.org/10.1093/scan/nsn009

Todorov, A., Mandisodza, A. N., Goren, A., & Hall, C. C. (2005). Inferences of Competence from Faces Predict Election Outcomes. *Science*, *308*(5728), 1623–1626. https://doi.org/10.1126/science.1110589

Todorov, A., Olivola, C. Y., Dotsch, R., & Mende-Siedlecki, P. (2015a). Social Attributions from Faces: Determinants, Consequences, Accuracy, and Functional Significance. *Annual Review of Psychology*, *66*(15), 1–27. https://doi.org/10.1146/annurev-psych-113011-143831

Todorov, A., Olivola, C. Y., Dotsch, R., & Mende-Siedlecki, P. (2015b). Social Attributions from Faces: Determinants, Consequences, Accuracy, and Functional Significance. *Annual Review of Psychology*, *66*(15), 1–27. https://doi.org/10.1146/annurev-psych-113011-143831

Todorov, A., & Oosterhof, N. N. (2011). Modeling social perception of faces. *IEEE Signal Processing Magazine*, *28*(2), 117–122.

Todorov, A., Pakrashi, M., & Oosterhof, N. N. (2009). Evaluating Faces on Trustworthiness After Minimal Time Exposure. *Social Cognition*, *27*(6), 813–833. https://doi.org/10.1521/soco.2009.27.6.813

Todorov, A., & Porter, J. M. (2014). Misleading First Impressions: Different for Different Facial Images of the Same Person. *Psychological Science*, *May*. https://doi.org/10.1177/0956797614532474

Turner, J. C., Hogg, M. A., Oakes, P. J., Reicher, S. D., & Wetherell, M. S. (1987). *Rediscovering the social group: A self-categorization theory.* Basil Blackwell.

Turner, J. C., Oakes, P. J., Haslam, S. A., & McGarty, C. (1994). Self and collective: Cognition and social context. *Personality and Social Psychology Bulletin*, *20*(5), 454–463.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, *185*(4157), 1124–1131.

Uleman, J. S. (1999). Spontaneous versus intentional inferences in impression formation. *Dual-Process Theories in Social Psychology*, 141–160.

Valentine, K. A., Li, N. P., Penke, L., & Perrett, D. I. (2014). Judging a Man by the Width of His Face: The Role of Facial Ratios and Dominance in Mate Choice at Speed-Dating Events. *Psychological Science*, *25*(3), 806–811. https://doi.org/10.1177/0956797613511823

Van Overwalle, F., & Labiouse, C. (2004). A recurrent connectionist model of person impression formation. *Personality and Social Psychology Review*, *8*(1), 28–61.

Varnum, M. E., Grossmann, I., Kitayama, S., & Nisbett, R. E. (2010). The origin of cultural differences in cognition: The social orientation hypothesis. *Current Directions in Psychological Science*, *19*(1), 9–13.

Verhulst, B., Lodge, M., & Lavine, H. (2010). The attractiveness halo: Why some candidates are perceived more favorably than others. *Journal of Nonverbal Behavior*, *34*(2), 111–117.

Vernon, R. J. W., Sutherland, C. A. M., Young, A. W., & Hartley, T. (2014). Modeling first impressions from highly variable facial images. *Proceedings of the National Academy of Sciences*, *111*(32), E3353–E3361. https://doi.org/10.1073/pnas.1409860111

Vigil, J. M. (2010). Political leanings vary with facial expression processing and psychosocial functioning. *Group Processes & Intergroup Relations*, *13*(5), 547–558.

Walker, M., & Vetter, T. (2016). Changing the personality of a face: Perceived big two and big five personality factors modeled in real photographs. *Journal of Personality and Social Psychology*, *110*(4), 609–624. https://doi.org/10.1037/pspp0000064

Watson, D., & Tellegen, A. (1985). Toward a consensual structure of mood. *Psychological Bulletin*, *98*(2), 219.

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

Wheeler, L., & Reis, H. T. (1991). Self-recording of everyday life events: Origins, types, and uses. *Journal of Personality*, *59*(3), 339–354.

Willis, J., & Todorov, A. (2006). First Impressions: Making Up Your Mind After a 100-Ms Exposure to a Face. *Psychological Science*, *17*(7), 592–598. https://doi.org/10.1111/j.1467-9280.2006.01750.x

Wilson, J. P., Hugenberg, K., & Rule, N. O. (2017). Racial Bias in Judgments of Physical Size and Formidability: From Size to Threat 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

Wilson, J. P., Remedios, J. D., & Rule, N. O. (2017). Interactive effects of obvious and ambiguous social categories on perceptions of leadership: When double-minority status may be beneficial. *Personality and Social Psychology Bulletin*, *43*(6), 888–900.

Wilson, J. P., & Rule, N. O. (2015a). Facial Trustworthiness Predicts Extreme Criminal-Sentencing Outcomes. *Psychological Science*, *26*(8), 1325–1331. https://doi.org/10.1177/0956797615590992

Wilson, J. P., & Rule, N. O. (2015b). Facial Trustworthiness Predicts Extreme Criminal-Sentencing Outcomes. *Psychological Science*, *26*(8), 1325–1331. https://doi.org/10.1177/0956797615590992

Winston, J. S., Strange, B. A., O'Doherty, J., & Dolan, R. J. (2002). Automatic and intentional brain responses during evaluation of trustworthiness of faces. *Nature Neuroscience*, *5*(3), 277–283.

Xie, S. Y., Flake, J. K., & Hehman, E. (2019). Perceiver and target characteristics contribute to impression formation differently across race and gender. *Journal of Personality and Social Psychology*, *117*(2), 364.

Xie, S. Y., Flake, J. K., Stolier, R. M., Freeman, J. B., & Hehman, E. (2021). Facial impressions are predicted by the structure of group stereotypes. *Psychological Science*, *32*(12), 1979–1993. https://doi.org/10.1177/09567976211024259

Yang, Y., Read, S. J., & Miller, L. C. (2009). The Concept of Situations. *Social and Personality Psychology Compass*, *3*(6), 1018–1037. https://doi.org/10.1111/j.1751-9004.2009.00236.x

Zebrowitz, L. A. (1997). *Reading faces: Window to the soul?* Westview Press.

Zebrowitz, L. A. (2004). The origin of first impressions. *Journal of Cultural and Evolutionary Psychology*, *2*(1–2), 93–108.

Zebrowitz, L. A. (2006). Finally, faces find favor. *Social Cognition*, *24*(5), 657–701.

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 : An Official Journal of the Society for Personality and Social Psychology, Inc*, *7*(3), 194–215.

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., & McDonald, S. M. (1991). The impact of litigants' baby-facedness and attractiveness on adjudications in small claims courts. *Law and Human Behavior*, *15*(6), 603.

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. (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

Zebrowitz, L. A., Montepare, J. M., & Lee, H. K. (1993). They don't all look alike: Individual impressions of other racial groups. *Journal of Personality and Social Psychology*, *65*(1), 85.

Zebrowitz, L. A., Voinescu, L., & Collins, M. A. (1996). "Wide-eyed" and" crooked-faced": Determinants of perceived and real honesty across the life span. *Personality and Social Psychology Bulletin*, *22*(12), 1258–1269.

Zelli, A., Cervone, D., & Huesmann, L. R. (1996). Behavioral experience and social inference: Individual differences in aggressive experience and spontaneous versus deliberate trait inference. *Social Cognition*, *14*(2), 165–190.