Title

Intergroup processes and the happy face advantage:

How social categories influence emotion categorization

Douglas Martin Jacqui Hutchison Agnieszka E. Konopka

Carolyn J. Dallimore Gillian Slessor Rachel Swainson

University of Aberdeen

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Address Correspondence To:

Doug Martin

School of Psychology

University of Aberdeen

Kings College

Old Aberdeen

Aberdeen, UK

AB24 3UB

+44 1224 273647

Email: doug.martin@abdn.ac.uk

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Statement of author contributions

DM – conceptualization, design, data collection, analysis, writing

JH – data collection, analysis, writing

RS – analysis, writing

CJD – data collection, writing

GS – data collection, writing

AEK – analysis

Abstract

There is abundant evidence that emotion categorization is influenced by the social category membership of target faces, with target sex and target race modulating the ease with which perceivers can categorize happy and angry emotional expressions. However, theoretical interpretation of these findings is constrained by gender and race imbalances in both the participant samples and target faces typically used when demonstrating these effects (e.g., most participants have been White women and most Black targets have been men). Across seven experiments, the current research used gender matched samples (Expt. 1a & 1b), gender and racial identity matched samples (Expt. 2a & 2b), and manipulations of social context (Expt. 3a-3b, & Expt. 4), to establish whether emotion categorization is influenced by interactions between the social category membership of perceivers and target faces. Supporting this idea, we found the presence and size of the happy face advantage was influenced by interactions between perceiver and target social categories, with reliable happy face advantages in reaction times for in-group targets but not necessarily for out-group targets. White targets and female targets were the only categories associated with a reliable happy face advantage that was independent of perceiver category. The interactions between perceiver and target social category were eliminated when targets were blocked by social category (e.g., a block of all White female targets; Expt. 3a & 3b) and accentuated when targets were associated with additional category information (i.e., in-group/out-group nationality; Expt. 4). These findings support the possibility that contextually sensitive intergroup processes influence emotion categorization.

Statement of limitations

The current research contains several limitations that place constraints on the generality of the findings. First, all participants in these experiments were younger adults from the UK and the USA whose racial identity was either White or Black; clearly this is not a representative sample of the general population; it is possible that people from different racial identities, particularly people of mixed racial identity, and people from cultural environments with greater or lesser racial diversity might exhibit different patterns of bias. Second, we only used targets from four social categories and did not control many aspects of the target stimuli to ensure equivalence across target categories; for example, we did not control for category prototypicality, emotional prototypicality, perceived attractiveness, and perceived age, all of which could influence social category modulation of emotion categorization if confounded with category membership. Third, we only used happy and angry facial expressions; given evidence that different emotional expressions can produce different patterns of emotion bias (e.g., Bijlstra et al., 2010), it is possible that different patterns of bias might occur when happy and angry faces are each paired with neutral faces or other emotional expressions.

Introduction

The aim of the current research is to establish whether emotion categorization is influenced by interactions between the social category membership of perceivers and target faces. Separate literatures suggest faces provide rapid indications as to a person's emotional state (e.g., Martin et al., 2012) and their social category memberships (e.g., Brewer, 1988; Fiske & Neuberg, 1990; Martin et al., 2015), with recent theoretical accounts suggesting that these processes might interact dynamically (Freeman & Ambady, 2011). Indeed, there have been numerous reports of interactions between the processes of face emotion categorization and social categorization, with the ease with which perceivers are able to categorize happy and angry emotional expressions modulated by both target sex (e.g., Becker et al., 2007; Craig & Lipp, 2018b; Hugenberg & Sczesny, 2006) and target race (e.g., Craig & Lipp, 2018b; Hugenberg, 2005). However, theoretical interpretation of existing findings is constrained by imbalances in the gender and race of both participant samples and target faces (e.g., most participants have been White females and most Black targets have been men). While such imbalances can constrain the generality of *any* psychological research (Simons et al., 2017), they are particularly problematic in the current context because people often perceive others differently dependent on whether they belong to the same category as themselves (i.e., the in-group) or a different category (i.e., the out-group; e.g., Kawakami, Friesen, & Fang, 2022; Tajfel & Turner, 1979). Addressing this issue, the current research used gender matched samples (Expt. 1), gender and racial identity matched samples (Expt. 2), and a manipulation of social context (Expt. 3 & Expt. 4) to determine whether emotion categorization is influenced by interactions between the social categories of targets and perceivers.

The term "happy face advantage" is often used to describe a phenomenon where people are faster to categorize happy faces than angry faces (Billings, Harrison, & Alden, 1993;), disgusted faces (Stalans & Wedding, 1985), sad faces (Feyereisen, Malet, & Martin, 1986), or emotionally neutral faces (Hugdahl et al., 1993). Leppänen and Hietanen (2003, 2004) suggested the happy face advantage might be driven by generalized asymmetries in emotion processing that favor positive information, such as those seen in a perception-speed advantage for positive words (e.g., Stenberg et al., 1998) and positive non-face images

(Lehr et al., 1966). However, a generalized advantage for processing positive expressions does not explain evidence that the happy face advantage is modulated by the social category to which a target face belongs.

There is abundant evidence that emotion categorization is modulated by the perceived sex and race of a target face. For female targets there is near universal support for a happy face advantage, with happy female faces categorized more quickly than angry female faces across many studies (e.g., Becker et al., 2007; Craig & Lipp, 2017; Craig & Lipp, 2018b; Hugenberg & Sczesny, 2006; Lipp et al., 2015b; Lipp et al., 2015a). For male targets evidence is more mixed, with some studies finding a happy face advantage (e.g., Craig & Lipp, 2017, Expt. 2; Hugenberg & Sczesny, 2006), some studies finding no such difference (e.g., Craig & Lipp, 2017, Expt. 1; Craig & Lipp, 2018b, Expt. 1a, Expt. 1b; Lipp et al., 2015b), and some studies finding an angry face advantage whereby angry male faces are categorized more quickly than happy male faces (e.g., Becker et al., 2007; Craig & Lipp, 2018a, Expt. 2). For White targets there is extensive evidence of a happy face advantage, with happy White targets categorized more quickly than angry White targets across many studies (e.g., Craig et al., 2012; Craig & Lipp, 2018b, Expt. 1a; Hugenberg, 2005). The evidence for Black targets is more mixed, with a few studies finding a happy face advantage (e.g., Craig et al., 2012, Expt. 1d, Expt. 2b; Craig & Lipp, 2018b, Expt. 1b), many studies finding no such difference (e.g., Craig et al., 2012, Expt. 1c, Expt. 2a, Expt. 3a; Craig & Lipp, 2018b, Expt. 1a; Lipp et al., 2015a), and some studies finding an angry face advantage whereby angry Black targets are categorized more quickly than happy Black targets (e.g., Craig et al., 2012, Expt. 1a; Hugenberg, 2005). There are several theories why target sex and race might modulate the happy face advantage; these include structural overlap (Becker et al., 2007; Zebrowitz et al., 2010), stereotype congruence (Bijlstra et al., 2010), and evaluative congruence (e.g., Craig et al., 2017; Hugenberg, 2005; Hugenberg & Sczesny, 2006).

The structural overlap account suggests social category modulation of emotion categorization is driven by overlap between facial features that signal emotions and those that signal social category membership (Becker et al., 2007; Zebrowitz et al., 2010). For example, it has been suggested that there is overlap in the physical face structures associated with both anger and masculinity (i.e., a heavier brow region; Ellison & Massaro, 1997), resulting in the facilitation of both emotion categorization and sex categorization of angry male targets (Becker et al., 2007). However, because the structural overlap account is based on perceptual signals from target faces that are similarly available to all perceivers, there is no reason to suggest that it would be influenced by the social category membership of perceivers. Thus, under the structural overlap account, one would not expect emotion categorization to be influenced by interactions between the social categories of targets and perceivers.

The stereotype congruence account suggests social category modulation of emotion categorization is driven by social category stereotypes of target faces (Bijlstra et al., 2010). For example, Bijlstra and colleagues found Dutch participants were faster to categorize Moroccan targets whose negative facial expressions were congruent with Dutch stereotypes of Moroccan people (i.e., angry) relative to when their negative facial expressions were incongruent with such stereotypes (i.e., sadness); however, it should be noted that these effects were only reliable in single-valence blocks when all targets were expressing negative emotions. However, because the stereotype congruence account is based on stereotypes of target faces that are similarly available to all perceivers (Devine, 1989), there is no reason to suggest that stereotype congruence would be influenced by the social category membership of perceivers. Thus, under the stereotype congruence explanation, one would not expect emotion categorization to be influenced by interactions between the social categories of targets and perceivers.

The evaluative congruence explanation suggests social category modulation of emotion categorization is driven by social category evaluations of target faces (e.g., Craig et al., 2017; Hugenberg, 2005; Hugenberg & Sczesny, 2006). Based on evaluative congruence a happy face advantage for a given category indicates perceivers hold a relatively positive evaluation of the category, whereas an angry face advantage indicates perceivers hold a relatively negative evaluation of the category. Thus, the widely reported happy face advantage for female and White targets is assumed to be a consequence of perceivers' relatively more positive evaluations of women (Eagly et al., 1991) and "own-race" members (Degner & Wentura, 2010; see Lindeberg et al., 2019a), whereas the angry face advantage sometimes found for male and Black targets is assumed to be the result of relatively more negative evaluations of men (Eagly et al., 1991; Hugenberg & Sczesny, 2006), Black people (Hugenberg, 2005; Nosek et al., 2002), and "other race" members (Degner & Wentura, 2010; see Lindeberg et al., 2019a). What drives evaluative congruence seems somewhat underspecified as it is a very broad umbrella under which many different phenomena might fall. For example, evaluative congruence might be driven by stereotype knowledge, attitudes, prejudice, or implicit associations. Similarly, evaluative congruence might be driven by relatively stable underlying individual differences, or it might be driven by dynamic contextually dependent associations. Dependent on what drives evaluative congruence, it is possible that emotion categorization might be influenced by interactions between the social categories of targets and perceivers; however, only if perceiver's evaluations are dependent on the categories to which they themselves belong.

Research examining intergroup processes suggests people's evaluations of others are indeed influenced by their own category membership (Tajfel & Turner, 1979; for reviews see Dovidio & Gaertner, 2010 & Hewstone et al., 2002). People often respond more positively to others when they belong to the same social group (the in-group) than when they belong to a different social group (the out-group). There is evidence that such intergroup bias can influence face processing (for a review see Kawakami et al., 2022), with in-group advantages in both face recognition (e.g., Meissner & Brigham, 2001) and emotion recognition (e.g., Beaupré & Hess, 2006; Elfenbein & Ambady, 2002; Friesen et al., 2019; Vingilis-Jaremko et al., 2020). While some previous research suggests intergroup bias might drive evaluative congruence and social category modulation of emotion categorization (Degner & Wentura, 2010; see Lindeberg et al., 2019a), this has seldom, if ever, been tested empirically in the context of the happy face advantage (although see Craig et al., 2017b, Expt. 2). If intergroup processes influence emotion categorization, one would expect social category modulation of emotion categorization to differ dependent on interactions between the relative category membership of perceivers and targets.

The possibility that emotion categorization is influenced by interactions between the social category membership of perceivers and target faces is compatible with much of the existing data on this topic. Much of the evidence of a happy face advantage for female targets but not male targets comes from research using samples of predominantly female perceivers (at least 66% of the sample were female and ~75% on average, in: Aguado, et al., 2009; Bijlstra, et al., 2010; Craig, et al., 2017a; Craig & Lipp, 2018b, Expt. 1a & Expt. 2; Craig & Lipp, 2017; Craig, et al., 2017b; Lipp et al., 2015a; Lipp, et al., 2015b; see Table 1). Indeed, there is evidence to suggest a happy face advantage for both female and male targets in several studies with more balanced gender ratios (no more than 60% of the sample were female and ~50% on average, in: Craig & Lipp, 2018b; Hugenberg & Sczesny, 2006; Lindeberg, Craig, & Lipp, 2019a; Lipp et al., 2015a; see Table 1). Similarly, much of the evidence of a happy face advantage for White targets but not Black or other race targets comes from research using samples of predominantly White perceivers (100% of the sample were White in: Bijlstra et al., 2010; Craig & Lipp, 2018b; Craig et al., 2012; Hugenberg & Bodenhausen, 2004; Hugenberg, 2005; Lipp et al., 2015b; see Table 1). Because much of the evidence for social category modulation of emotion categorization is based on participant samples who are predominantly female and/or White, it is not possible to ascertain whether these effects are driven by information associated with the targets (such as structural overlap or stereotype congruence), or by the category relationship between perceivers and targets (such as intergroup processes), or indeed whether these effects might be driven by multiple mechanisms.

Current Research

The overarching aim of the current research is to establish whether emotion categorization is influenced by interactions between the category membership of social perceivers and social targets. Across seven experiments, including three replications, we asked participants to make speeded emotion categorizations of happy and angry target faces. In each experiment the faces being categorized comprised equal numbers of unfamiliar faces from two social category dimensions: Target Sex (female & male) and Target Race (Black & White). The people who were categorizing the faces in each experiment were equal numbers of participants from different Perceiver Categories; in Experiment 1a and Experiment 1b we examined the influence of perceiver sex, in Experiment 2a and Experiment 2b. we examined the effects of both perceiver sex and perceiver racial identity, and in Experiment 3a, Experiment 3b, and Experiment 4 we examined the influence of intergroup context.

Table 1. Key papers documenting social category modulation of emotion categorization.

Study	N	N % Female	N % White	Target stimulus identity N	Target stimulus details	Task	Summary of key findings
Aguado et al. (2009) Expt. 1a	32	81%	nr	32	50% Female 100% White	Happy vs. Angry	Faster for happy female targets than happy male targets. Faster for angry male targets than angry female targets.
Aguado et al. (2009) Expt. 2	32	75%	nr	32	50% Female 100% White	Happy vs. Angry	Faster for happy female targets than happy male targets. Trend towards faster for angry male targets than angry female targets.
Aguado et al. (2009) Expt. 3	38	79%	nr	32	50% Female 100% White	Happy vs. Angry	Faster for happy female targets than happy male targets. Faster for angry male targets than angry female targets. AFA for male targets.
Becker et al. (2007) Expt. 2	38	45%	nr	12	50% Female 100% White	Happy vs. Angry	Faster for happy female targets than happy male targets. Faster for angry male targets than angry female targets.
Becker et al. (2007) Expt. 4	21	57%	nr	12	50% Female 100% White	Happy vs. Angry	Faster for happy female targets than happy male targets. Faster for angry male targets than angry female targets.
Bijlstra et al. (2010) Expt. 1	64	88%	100%	8	100% Male 50% White 50% Moroccan	Happy vs. Angry Happy vs. Sad	HFA for White targets. No HFA for Moroccan targets.
Bijlstra et al. (2010) Expt. 2	17	69%	100%	12	50% Female 100% White	Happy vs. Angry Happy vs. Sad	HFA for female targets. No HFA for male targets.
Craig et al. (2017a) Expt. 1	29	83%	100%	32	50% Female 50% White	Happy vs. Sad	HFA for White female targets when paired with White male targets. HFA for Black female targets when paired with White male targets. HFA for White male Targets when paired with Black male targets.
Craig et al. (2017a) Expt. 2	32	72%	100%	32	50% Female 50% White	Happy vs. Fear	HFA for White female targets when paired with White male targets. No HFA when Black female targets paired with White male targets. No HFA for White male Targets when paired with Black male Targets.
Craig et al. (2017a) Expt. 3	30	67%	100%	16	50% Female 50% White	Happy vs. Surprise	Complex interactions dependent on context (including interactions with participant sex).
Craig & Lipp (2017) Expt. 1	30	77%	nr	18	50% Female 100% White	Happy vs. Angry	HFA for female targets. No HFA for male targets.
Craig & Lipp (2017) Expt. 2	83	77%	nr	18	50% Female 100% White	Happy vs. Angry	HFA for female targets in single sex blocks. HFA for male targets in single sex blocks.
Craig & Lipp (2017) Expt. 3	29	72%	nr	18	50% Female 100% White	Happy vs. Neutral Angry vs. Neutral	HFA for female targets and male targets. AFA for male targets but not female targets.
Craig & Lipp (2017) Expt. 4	35	66%	nr	18	50% Female 100% White	Happy vs. Neutral Sad vs. Neutral	No HFA for female targets and male targets. SFA for male targets but not female targets.

Study	N	N % Female	N % White	Target stimulus identity N	Target stimulus details	Task	Summary of key findings
Craig & Lipp (2018a) Expt. 1	32	84%	nr	16	100% Male 100% White 50% Younger 50% Older	Happy vs. Angry	Faster for happy younger targets than happy older targets. No difference between angry younger targets and angry older targets.
Craig & Lipp (2018a) Expt. 2	28	57%	nr	16	100% Male 100% White 50% Younger 50% Older	Happy vs. Sad	Faster for happy younger targets than happy older targets. No difference between sad younger targets and angry older targets.
Craig & Lipp (2018b) Expt. 1a	35	86%	100%	32	50% Female 50% White	Happy vs. Angry	HFA for female targets but no HFA for male targets. HFA for White targets but no HFA for Black targets. Significant interaction with participant sex (but only 5 male participants).
Craig & Lipp (2018b) Expt. 1b	66	52%	100%	32	50% Female 50% White	Happy vs. Angry	HFA for female target but no HFA for male targets. HFA for White targets and HFA for Black targets.
Craig & Lipp (2018b) Expt. 2	37	70%	100%	32	50% Female 100% White 50% Younger 50% Older	Happy vs. Angry	HFA for younger female targets but no HFA for younger male targets. AFA for older male targets but no AFA for older female targets.
Craig et al. (2012) Expt. 1a	23	77%	100%	8	100% Male 50% White	Happy vs. Angry	HFA for White targets. AFA for Black targets.
Craig et al. (2012) Expt. 1b	23	77%	100%	8	100% Male 50% White	Happy vs. Angry	No differences.
Craig et al. (2012) Expt. 1c	23	77%	100%	2	100% Male 50% White	Happy vs. Angry	HFA for White targets. No HFA for Black targets.
Craig et al. (2012) Expt. 1d	23	77%	100%	40	100% Male 50% White	Happy vs. Angry	HFA for White targets. HFA for Black targets.
Craig et al. (2012) Expt. 2a	24	63%	100%	2	100% Male 50% White	Happy vs. Angry	HFA for White targets. No HFA for Black targets.
Craig et al. (2012) Expt. 2b	24	63%	100%	40	100% Male 50% White	Happy vs. Angry	HFA for White targets. HFA for Black targets.
Craig et al. (2012) Expt. 3a	25	76%	100%	40	100% Male 50% White	Happy vs. Angry	HFA for White targets. No HFA for Black targets.
Craig et al. (2012) Expt. 3b	25	76%	100%	40	100% Male 50% White	Happy vs. Angry	No differences.

Study	N	N % Female	N % White	Target stimulus identity N	Target stimulus details	Task	Summary of key findings
Craig et al. (2017b) Expt. 1	21	80%	100%	32	50% Female 50% White 50% Chinese	Happy vs. Angry	HFA for White female targets and Chinese female targets. HFA for White male targets and Chinese male targets when paired together but not when paired with female targets.
Craig et al. (2017b) Expt. 2	60	77%	47%	32	50% Female 50% White 50% Chinese	Happy vs. Angry	White participants: HFA for White female targets and Chinese female targets. White participants: HFA for White male targets and Chinese male targets when paired together but not when paired with female targets. Chinese participants: HFA for all targets except White male targets paired with Chinese male targets.
Hugenberg (2005) Expt. 1	22	59%	100%	8	100% Male 50% White	Happy vs. Angry	HFA for White targets. AFA for Black targets.
Hugenberg (2005) Expt. 2	22	59%	100%	8	100% Male 50% White	Happy vs. Angry Happy vs. Sad	HFA for White targets relative to both angry and sad. AFA and SFA for Black targets relative to happy.
Hugenberg & Sczesny (2006) Expt. 1	80	59%	100%	8	50% Female 100% White	Happy vs. Angry	HFA for female targets and male targets but larger for female targets. Faster for happy female targets than happy male targets. No difference for angry female targets and angry male targets. Interaction with participant sex, which is not explored in full but suggestion that the findings are stronger for Female Participants than Male Participants
Hugenberg & Sczesny (2006) Expt. 2	80	42%	100%	8	50% Female 100% White	Happy vs. Angry Happy vs. Sad	HFA for female targets and male targets relative to both angry and sad but larger for female targets. Faster for happy female targets than happy male targets.
Lipp et al. (2015a) Expt. 1	29	59%	100%	24	50% Female 50% White	Happy vs. Angry	HFA for White female targets paired with White male targets but no HFA for White male targets. HFA for White male targets when paired with Black male targets but no HFA for Black male targets.
Lipp et al. (2015a) Expt. 2	32	66%	100%	24	50% Female 50% White	Happy vs. Angry	HFA for White female targets paired with White male targets but no HFA for White male targets. HFA for Black female targets paired with White male targets but no HFA for White male targets. HFA for White male targets when paired with Black male targets but no HFA for Black male targets.

Study	N	N % Female	N % White	Target stimulus identity N	Target stimulus details	Task	Summary of key findings
Lipp et al. (2015b) Expt. 1a	24	83%	nr	32	50% Female 100% White	Happy vs. Angry	HFA for female targets but not male targets.
Lipp et al. (2015b) Expt. 1b	24	71%	nr	4	50% Female 100% White	Happy vs. Angry	HFA for both female targets and male targets
Lipp et al. (2015b) Expt. 2a	32	72%	nr	16	50% Female 50% White	Happy vs. Angry	HFA for female targets but not male targets.
Lipp et al. (2015b) Expt. 2b	32	75%	nr	4	50% Female 50% White	Happy vs. Angry	HFA for female targets but not male targets.
Lindeberg et al. (2019) Expt. 2	62	40%	74%	24	50% Female 100% White	Happy vs. Angry	HFA for both female targets and male targets.
Lindeberg et al. (2019) Expt. 3	62	44%	77%	24	50% Female 100% White	Happy vs. Angry	HFA for both female targets and male targets.
Lindeberg et al. (2019) Expt. 4	64	44%	78%	24	50% Female 100% White	Happy vs. Angry	Complex interactions dependent on context (including interactions with participant sex).
Smith et al. (2017) Expt. 2	49	61%	72%	96	50% Female 50% White	Happy vs. Neutral Angry vs. Neutral	Angry vs. Neutral: AFA for Black male targets, HFA for White female targets, no difference for Black female targets or White male targets. Happy vs. Neutral: HFA for White female targets and Black female targets but larger for Black female targets. HFA for White male targets and Black male targets but not moderated by race.
Stebbins & Vanous (2015) Expt. 1	45	51%	nr	32	50% Female 100% White	Happy vs. Angry	Faster for happy female targets than happy male targets. Faster for angry male targets than angry female targets. No interaction with participant sex.
Tipples (2019)	65	51%	nr	8	50% Female 100% White	Happy vs. Angry	Female participants faster for happy female targets than happy male targets, and faster for angry male targets than angry female targets. Male participants showed no differences between male targets and female targets.

Abbreviations: happy face advantage (HFA); angry face advantage (AFA); sad face advantage (SFA); not reported (nr).

Experiment 1a and Experiment 1b

If social category modulation of emotion categorization is driven by either structural overlap (Becker et al., 2007; Zebrowitz et al., 2010) or stereotype congruence (Bijlstra et al., 2010), we would not expect interactions between perceiver categories and target categories. Alternatively, if, as we suggest, social category modulation of emotion categorization is influenced by intergroup processes (e.g., Tajfel, et al., 1971), we would expect interactions between perceiver categories and target categories. Thus, we hypothesized there would be an interaction between Perceiver Sex, Target Sex, and Target Emotion. Similarly, because all participants in Experiment 1a and Experiment 1b were White, we also hypothesized there would be interaction between Target Race and Target Emotion.

Method – Experiment 1a

Transparency and Openness

We report how we determined our sample size, all data exclusions and replacements, all manipulations, and all measures in the study, and we follow the *Journal Article Reporting Standard* for reporting psychology research in scientific journals (Kazak, 2018). All data and analysis code have been made publicly available at the *Open Science Foundation* and can be accessed at https://osf.io/jh4zp/. The data were analyzed using R (R Core Team, 2021) and *lme4* (Bates, Maechler, & Bolker, 2012). The research materials are available from the corresponding author on request. The design and analysis strategy for Experiment 1a-3a were not pre-registered. In each case, we ran an original experiment (Expt. 1a, Expt. 2a, & Expt. 3a) and then ran a subsequent replication of the experiment (Expt. 1b, Expt. 2b, Expt. 3b). We found the hypothesized effects in both the original experiments and in the replications. We preregistered the design, hypotheses, and analysis strategy for Experiment 3b (https://osf.io/qs4pz) and Experiment 4 (https://osf.io/zbmun).

Design

Experiment 1a had a 2(Perceiver Sex: female perceivers vs. male perceivers) X 2(Target Sex: female targets vs. male targets) X 2(Target Race: Black targets vs. White targets) X 2(Target Emotion: angry targets vs. happy targets) mixed factorial design, with Perceiver Sex as the only between-subjects factor. Given the novel nature of the current experimental design, there were no equivalent previous experiments we could use to provide parameters to estimate the minimum sample size required to detect the predicted Perceiver Sex X Target Category X Target Emotion interactions. When we began collecting data in 2016, we did not specify an a priori sample size. As the data collection progressed, we opted to maximize the chance of finding a significant happy face advantage for each target type within each perceiver sex, by recruiting samples of female and male participants larger than the mean of the samples reporting a significant happy face advantage in published studies (N = 46; see Table A); this resulted in a total sample size of 96 participants (48 of whom were female and 48 of whom were male).

Participants

The data from 96 participants were included in the final sample (48 White females and 48 White males; age range = 17 – 29; age M = 20 years). We initially recruited 96 undergraduate students from the University of Aberdeen, who completed the experiment in-person in the lab for course credit. Participants from this sample were excluded if they exhibited excessively high error rates or excessively slow reaction times (both > 3 S.D. above the median); to ensure a gender-balanced sample, we then recruited new participants of the same gender to replace these participants. This process resulted in three male participants and four female participants being excluded and replaced.

Materials and Procedure

Participants were informed at the recruitment stage that they would be taking part in a study examining the speed and accuracy with which people can categorize emotional faces. Participants in Experiment 1a were tested either individually or in groups of up to twenty people; participants in Experiment 1b were tested online and we had no control over the physical environment in which they were tested.

The target face stimuli comprised 256 color digital headshot images of 128 unfamiliar people selected from the Chicago Face Database (Ma et al., 2015); faces were chosen by the lead researcher on the subjective basis that they were unambiguously representative of each social category (these subjective decisions were supported by pilot data, which indicated that people were able to rapidly identify the correct sex and race of each target). The face images included hair. In Experiment 1a the overall image cropped to a standardized size of 200 x 240 pixels (1280 x 1024 screen resolution); in Experiment 1b the size and proportion of the face images were identical to Experiment 1a (the Gorilla testing platform standardizes the size ratio of the images across different screen sizes by asking participants to calibrate their screen size using a credit card); participants were only able to complete the experiment on a laptop or desktop PC. The target faces were drawn equally from four social categories: Black females, Black males, White females, and White males. There were two images of each target face, one in which their expression was happy (i.e., smiling) and one in which their expression was angry (i.e., frowning). This meant there were 32 images in each of eight distinct social category and emotion sub-types – happy Black females, angry Black females, happy Black males, angry Black males, happy White females, angry White females, happy White males, and angry White males. Participants saw each identity only once, with either a happy or angry expression.

The experiment consisted of a single block of 128 trials. Each trial comprised the presentation of a fixation cross for 500 ms followed by a target face image for 300 ms after which the image disappeared; to encourage speeded responses participants had to make a response within 1650 ms of the onset of the face image. The inter-trial interval was 1200 ms. In Experiment 1a, participants made their response by pressing the left and right buttons on a computer mouse positioned centrally on the table in front of them; in Experiment 1b, participants made their responses using keyboard keys ("Z" & "M"). The meaning of the response buttons was counterbalanced across participants. The order of trial presentation was randomized and the computer recorded the latency and accuracy of responses.

Dependent measures and analysis strategy

Most of the previous research on this topic has used reaction time as the primary dependent measure, with some studies also including analysis of error rates/proportion correct responses. The rationale for using one dependent measure or both is not always clear; neither is it clear how one should interpret mixed findings from two dependent measures. Here we report and analyze both RTs and errors, with a happy face advantage indexed by faster RTs and/or fewer errors for happy targets than angry targets. We used *R* (R Core Team, 2021) and *lme4* (Bates et al., 2012) to perform linear mixed effects analyses of the relationship between correct emotion categorization RTs and errors, and perceiver and target factors. Raw correct RTs were analyzed using linear mixed effects regression (lmer), with RTs described for the analyses and reported in both Tables and Figures. Log-errors were analyzed with binomial general linear mixed effects regression (glmer), with Odds Ratios (OR).[1] described for the analyses and reported in Tables and proportion errors reported in Figures.

Results – Experiment 1a

There were a total of 12,288 valid trials across the 96 participants. Reaction times ranged from 80 ms to 1489 ms; we excluded 41 trials where reaction times were likely to be too fast to reflect a deliberative response to the stimulus (i.e., < 250ms); error rate on these trials was around chance (*M* errors = .54). We visually inspected of the distribution of correct RTs (*M* = 519 ms; SD = 157 ms), which revealed a long-righthand tail of relatively more longer reaction times; we addressed this issue by excluding trials with response times greater than 3 standard deviations of the mean, which resulted in the exclusion of a further 212 response times greater than 990 ms. Participants accurately categorized emotional expression on 94% of remaining trials; we excluded from the reaction time analysis trials on which errors were made (782 trials excluded). Thus, the final datasets comprised 12,035 for responses for error analysis and 11,253 correct response times for RT analysis.

[1] An OR is a measure of the likelihood of a particular outcome (see Szumilas, 2010). Where an OR equals 1, it indicates there is no difference in the likelihood of a particular outcome; thus, when lower and upper confidence intervals overlap 1 it indicates a null effect. When an OR is less than 1, it indicates a particular outcome is less likely to occur; thus, when lower and upper confidence intervals are both less than 1 it indicates an outcome is significantly less likely to occur. When an OR is greater than 1, it indicates a particular outcome is more likely to occur; thus, when lower and upper confidence intervals are both greater than 1 it indicates an outcome is significantly more likely to occur.

We used *R* v.4.3.2 (R Core Team, 2021) and *lme4* v.1.1.35.1 (Bates et al., 2012) to perform linear mixed effects analyses of the relationship between correct emotion categorization reaction times and errors, and perceiver and target factors. The model with the maximal random structure justified by the design included a four-way interaction between the four categorical variables of interest as well as random by-participant and by-item intercepts, random by-participant slopes for Target Sex, Target Race and Target Emotion, and random by-item slopes for Perceiver Sex (Brauer & Curtin, 2017). Regression-style contrast coding (-.5 and .5 for the two levels of each variable, with reference levels determined alphabetically) was used for all categorical variables. The bound optimization by quadratic approximation (bobyqa) with a set maximum of 200,000 iterations was used. When singularity issues were encountered in the full model, the random effect structure was simplified to the next best random effect structure (by iteratively removing random slopes for the variable that accounted for the smallest amount of variance). Including slopes for all variables resulted in singular fit warnings, with the exception of by-participant slopes for Target Emotion. The most complex models to converge for both RT and Errors included the specified fixed effects plus random by-participant slopes for Target Emotion and no by-item random slopes:

lmer (RT ~ 1 + Perceiver Sex * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |participant) + (1|item))

glmer (Errors ~ 1 + Perceiver Sex * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |participant) + (1|item))

We report models with the highest-level interactions between fixed effects and a reduced random effects structure that only includes random slopes that improved model fit (i.e., Target Emotion). We compared the fit of these models with the fit from the full models (i.e., models with and without random slopes that generated singular fit warnings), which inidicated the fits were nearly identical (nearly identical coefficients; nearly identical levels of statistical significance; nearly identical model comparison metrics like AIC, BIC, and log-likelihood; nearly identical predicted plots).

The full output for both above models can be found in Supplementary Table 1 (RT data) and Supplementary Table 2 (Error data). Both models indicated some significant main effects and interactions that were either subsumed by higher order interactions, or that were not predicted or of central theoretical interest. However, we restrict our description of the models to the predicted effects of primary theoretical interest (i.e., interactions between Target/Perceiver Categories and Target Emotion).

Interaction of Perceiver Sex, Target Sex, and Target Emotion

The RT model indicated the presence of the predicted Perceiver Sex X Target Sex X Target Emotion interaction ($\beta = 18$, $t = 2.16$, $p = .034$; see Figure 1a, top panel). We further examined this interaction by running separate Target Sex X Target Emotion tests for each Perceiver sex. For female perceivers, there was evidence of a Target Sex X Target Emotion interaction ($\beta = 19$, $t = 2.07$, $p = .040$; Bonferroni corrected pairwise comparisons revealed that female perceivers showed a significant happy face advantage for female targets (*M* diff = 28 ms, [95% CI = 11, 45], $t = 3.77$, $p < .001$), but did not show a happy face advantage for male targets (*M* diff = 9 ms, [95% CI = -8, 26], $t = 1.19$, $p = .47$). Whereas for male perceivers, there was no evidence of a Target Sex X Target Emotion interaction ($\beta = 2$, $t = .26$, $p = .80$) but there was evidence of an overall happy face advantage, as indicated by a significant main effect of Target Emotion ($\beta = 25$, $t = 4.97$, $p < .001$).

The Errors model also indicated the presence of the predicted Perceiver Sex X Target Sex X Target Emotion interaction ($\beta = .90$, $t = 2.92$, $p = .003$; see Figure 1a, bottom panel). We further examined this interaction by running separate Target Sex X Target Emotion tests for each Perceiver sex. For female perceivers, there was evidence of a Target Sex X Target Emotion interaction ($\beta = .78$, $t = 3.32$, $p < .001$; pairwise comparisons revealed that female perceivers showed a significant happy face advantage for female targets (Odds Ratio = 1.58, [95% CI = 1.04, 2.40], $t = 2.44$, $p = .029$), but no evidence of a happy face advantage for male targets (OR = .72, [95% CI = .49, 1.07], $t = 1.84$, $p = .13$). Whereas, for male perceivers there was no evidence of a Target Sex X Target Emotion interaction ($\beta = .13$, $t = .43$, $p = .67$) but there was some evidence of an overall happy face advantage, as indicated by a non-significant trend towards a main effect of Target Emotion (β = .34, t = 1.85, p = .064).

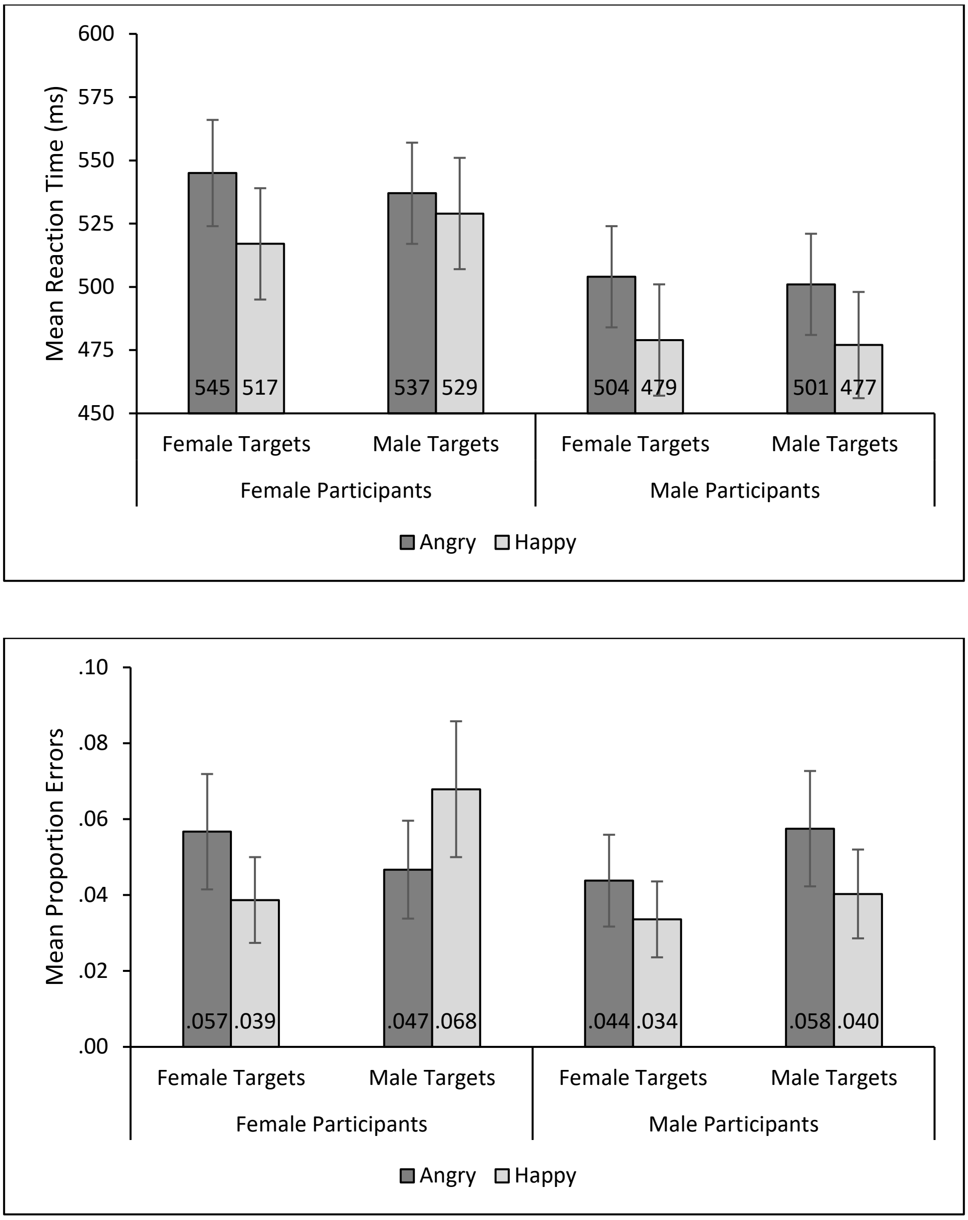


Figure 1a. Experiment 1a Mean reaction time (top panel) and mean proportion errors (bottom panel) by Perceiver sex, Target Sex, and Target Emotion. Error bars represent 95% confidence intervals.

Interaction of Target Race and Target Emotion

The RT model indicated evidence of the predicted Target Race X Target Emotion interaction (β = 22, *t* = 3.17, *p* = .002; see Figure 1b, top panel); pairwise comparisons revealed a significant happy face advantage for White targets (*M* diff = 33 ms, [95% CI = 22, 44], *t* = 5.86, *p* < .001), but no happy face advantage for Black targets (*M* diff = 10 ms, [95% CI = -1, 21], *t* = 1.84, *p* = .07).

The Errors model also indicated evidence of the predicted Target Race X Target Emotion interaction (β = .74, *t* = 3.55, *p* < .001; see Figure 1b, bottom panel); pairwise comparisons revealed a significant happy face advantage for White targets (OR = 1.71, [95% CI = 1.25, 2.32], *t* = 3.39, *p* < .001), but no happy face advantage for Black targets (OR = .81, [95% CI = .59, 1.12], *t* = 1.26, *p* = .207).

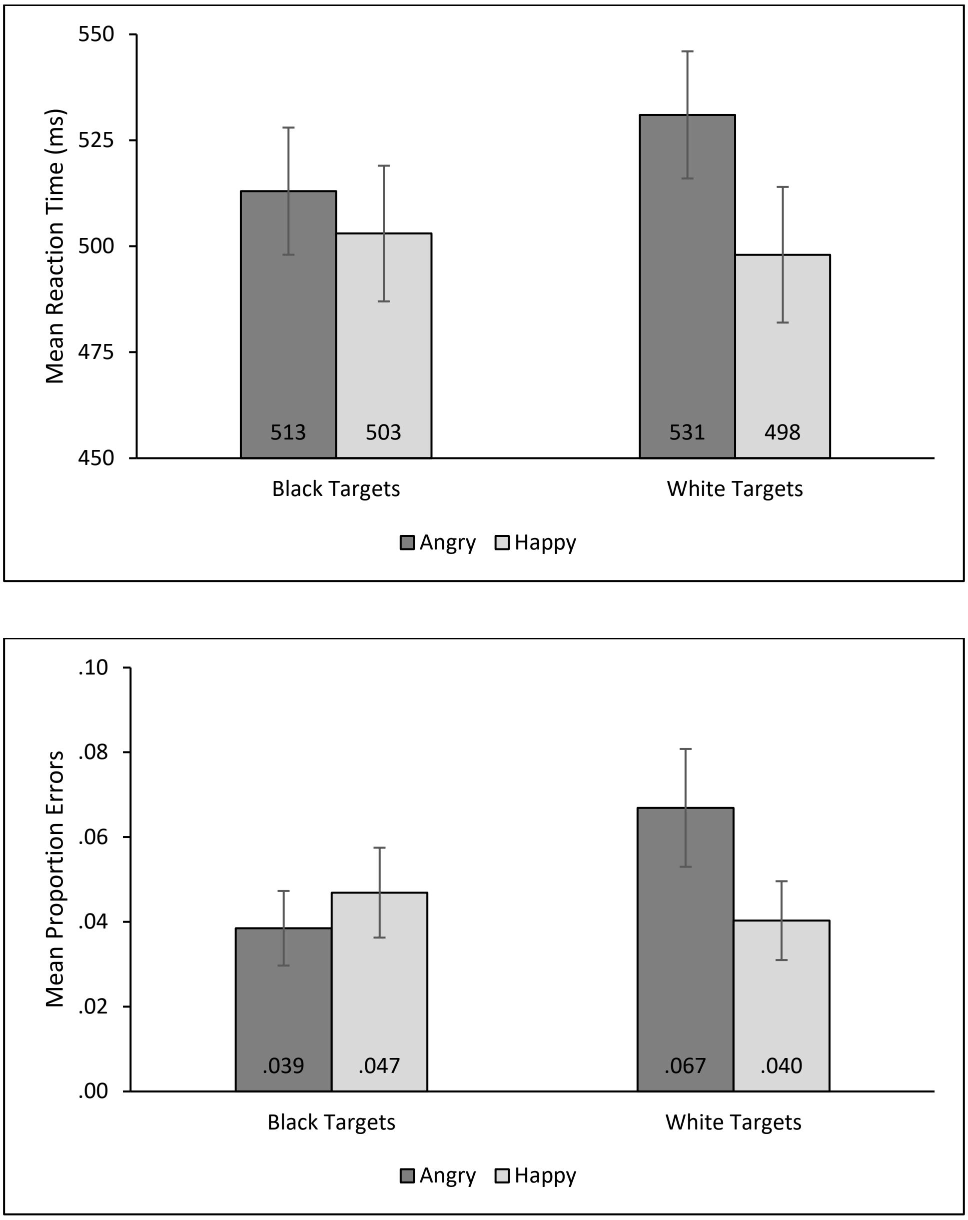


Figure 1b. Experiment 1a Mean reaction time (top panel) and mean proportion errors (bottom panel) by Target Race and Target Emotion. Error bars represent 95% confidence intervals.

Method – Experiment 1b

Experiment 1b was a replication of Experiment 1a conducted online. As the general method used was near identical to that of Experiment 1a, we only describe deviations from that method.

Participants

The data from 96 participants were included in the final sample (48 White females and 48 White males; age range = 18 – 29; age *M* = 22 years). We initially recruited 96 Scottish domiciled young adult (< 30-years-old) participants via the online recruitment platform *Prolific Academic* (www.prolific.ac), who completed the experiment remotely via the online testing platform *Gorilla* (www.gorilla.sc; Anwyl-Irvine, Massonnié, Flitton, Kirkham & Evershed, 2018), and were compensated around UK£2.50/US$3 for their time. We used pre-screen criteria available in *Prolific Academic*, which allow researchers to target participant recruitment at specific demographic groups based on participants' self-reported biographical information; we recruited only participants who self-identified as "Located in the UK", "Female" or "Male", and "White/Caucasian". Participants from this sample were excluded if they exhibited excessively high error rates or excessively slow reaction times (both > 3 S.D. above the median); to ensure a gender balanced sample, we then recruited new participants of the same gender to replace these participants. This process resulted in five male participants and five female participants being excluded and replaced following further recruitment.

Materials and Procedure

Participants were tested individually online. We had no control over the physical environment in which they were tested. Participants were only able to complete the experiment on a laptop or desktop PC. The size and proportion of the face images were identical to Experiment 1a when presented on a 28-inch monitor with 1280 x 1024 screen resolution; the Gorilla testing platform standardizes the size ratio of the images across different screen sizes by asking participants to calibrate their screen size using a credit card. In the online experiment, participants made their responses using keyboard keys ("Z" & "M"), rather then the mouse buttons used in Expt 1a. The meaning of the response buttons was counterbalanced across participants.

Results – Experiment 1b

There were a total of 12,288 valid trials across the 96 participants. Reaction times ranged from 182 ms to 50 seconds. We initially removed 266 outlying trials (see Expt. 1a for method). Participants accurately categorized emotional expression on 95% of remaining trials; we excluded from the reaction time analysis trials on which errors were made (571 trials excluded). Thus, the final datasets comprised 12,012 for responses for error analysis and 11,441 correct response times for RT analysis. To ensure consistency across experiments, we report the data from RT and Errors models that included the specified fixed effects plus random by-participant slopes for Target Emotion and no by-item random slopes; both the RT and Errors models converged. However, as in Expt. 1a, we compared the fit of these models with the fit from the full models, which indicated the fits were not significantly different. The full output for both above models can be found in Supplementary Table 3 (RT data) and Supplementary Table 4 (Error data).

Interaction of Perceiver Sex, Target Sex, and Target Emotion

The RT model indicated the presence of the predicted Perceiver Sex X Target Sex X Target Emotion interaction (β = 18, $t = 2.22$, $p = .027$; see Figure 2a, top panel). We further examined this interaction by running separate Target Sex X Target Emotion tests for each Perceiver sex. For female perceivers, there was evidence of a Target Sex X Target Emotion interaction (β = 24, $t = 2.67$, $p = .009$; pairwise comparisons indicated that female perceivers showed a significant happy face advantage for female targets (*M* diff = 35 ms, [95% CI = 18, 51], $t = 4.68$, $p < .001$), but did not show a happy face advantage for male targets (*M* diff = 10 ms, [95% CI = -6, 27], $t = 1.40$, $p = .33$). Whereas, for male perceivers there was no evidence of a Target Sex X Target Emotion interaction (β = 7, $t = .82$, $p = .41$) but there was evidence of an overall happy face advantage, as indicated by a significant main effect of Target Emotion (β = 15, $t = 2.70$, $p = .009$).

The Errors model also indicated the presence of the predicted Perceiver Sex X Target Sex X Target Emotion interaction (β = .94, $t = 2.66$, $p = .008$; see Figure 2a, bottom panel). We further examined this interaction by running separate Target Sex X Target Emotion tests for each Perceiver sex. For female perceivers, there was evidence of a Target Sex X Target Emotion interaction (β = .81, $t = 2.72$, $p = .007$; pairwise comparisons revealed that female perceivers showed a significant happy face advantage for female targets (OR = 1.67, [95% CI = 1.00, 2.78], $t = 2.25$, $p = .049$), but did not show a happy face advantage for male targets (OR = .75, [95% CI = .46, 1.20], $t = 1.38$, $p = .33$). Whereas, for male perceivers there was no evidence of a Target Sex X Target Emotion interaction (β = .14, $t = .50$, $p = .62$), nor was there evidence of a main effect of Target Emotion (β = .17, $t = .96$, $p = .34$).

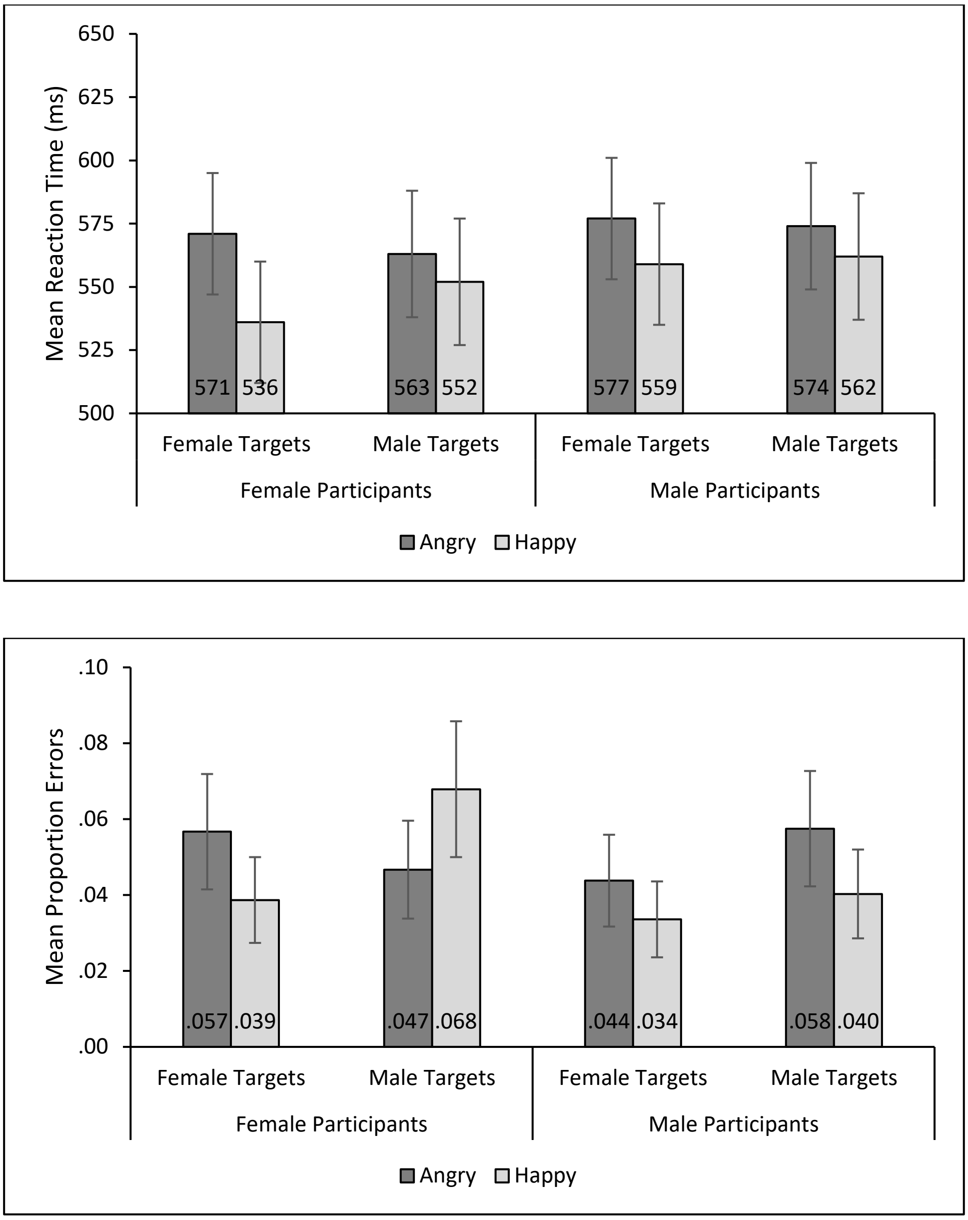


Figure 2a. Experiment 1b Mean reaction time (top panel) and mean proportion errors (bottom panel) by Perceiver sex, Target Sex, and Target Emotion. Error bars represent 95% confidence intervals.

Interaction of Target Race and Target Emotion

The RT model indicated evidence of the predicted Target Race X Target Emotion interaction (β = 23, t = 3.12, p = .002; see Figure 2b, top panel); pairwise comparisons revealed a significant happy face advantage for White targets (M diff = 31 ms, [95% CI = 19, 42], t = 5.19, p < .001), but no significant happy face advantage for Black targets (M diff = 7 ms, [95% CI = -4, 19], t = 1.22, p = .222). The Errors model also indicated evidence of the predicted Target Race X Target Emotion interaction ((β = .96**,** t = 4.13, p < .001; see Figure 2b, bottom panel); pairwise comparisons revealed a significant happy face advantage for White targets (OR = 1.80, [95% CI = 1.29, 2.53], t = 3.41, p < .001), but a significant angry face advantage for Black targets (OR = .69, [95% CI = .49, .98], t = 2.08, p = .038).

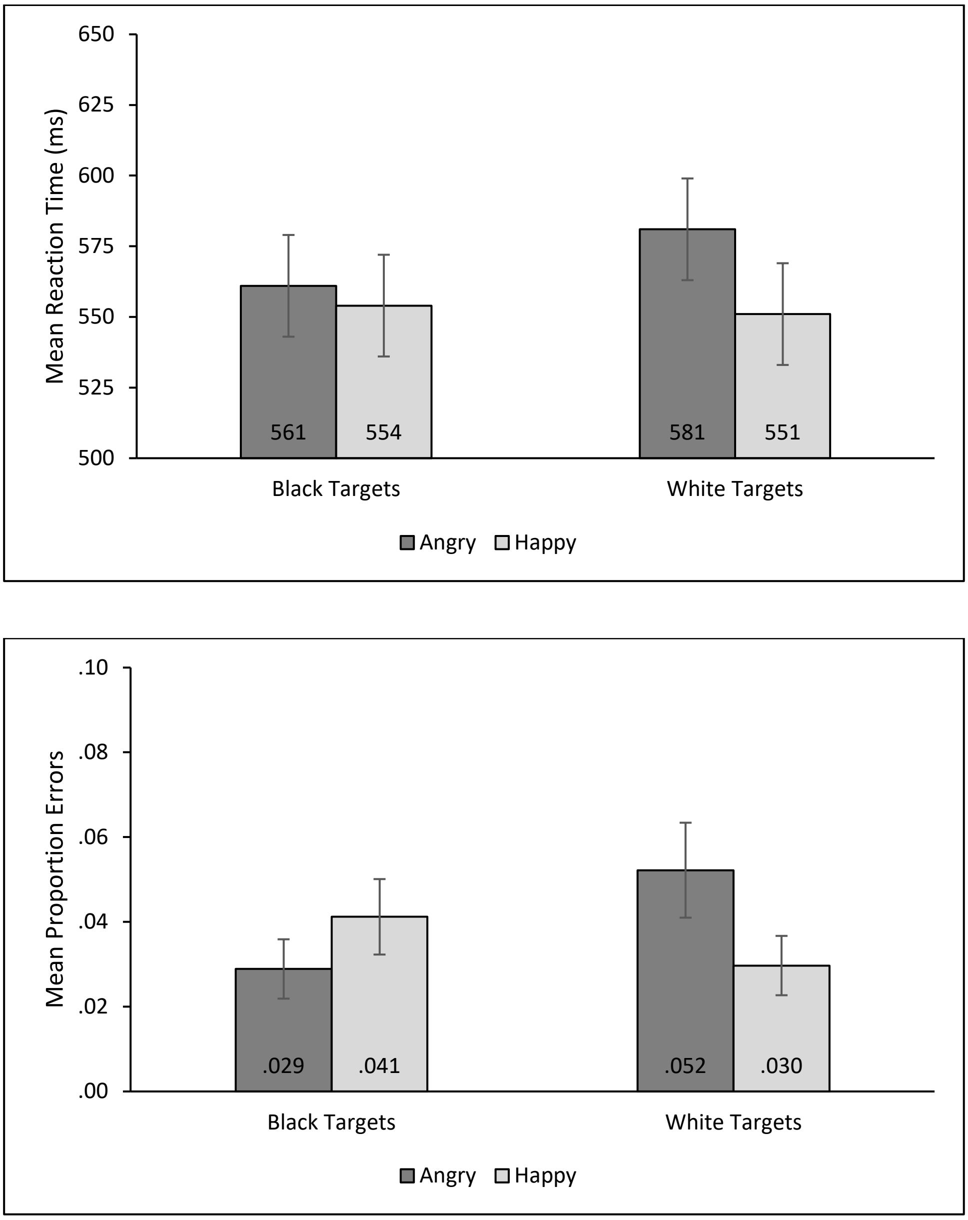


Figure 2b. Experiment 1b Mean reaction time (top panel) and mean proportion errors (bottom panel) by Target Race and Target Emotion. Error bars represent 95% confidence intervals.

Discussion – Experiment 1a and Experiment 1b

Experiments 1a and 1b support the idea that emotion categorization is influenced by interactions between the category membership of social perceivers and social targets. As hypothesized, we found evidence that emotion categorization was influenced by interactions between perceiver sex and target sex. Female perceivers showed a happy face advantage only for female targets, yet male perceivers showed a happy face advantage for both female and male targets (at least in reaction times). While the effects from Experiment 1a and Experiment 1b support the possibility that social category modulation of emotion categorization might be influenced by intergroup processes, they also suggest the overall effects are not simply driven by in-group favoritism. If this were the case, then we might have expected male perceivers to show a happy face advantage only for male targets. Also, we do not know whether these effects generalize to other intergroup category relationships. The pattern of responses White perceivers showed towards White and Black targets suggests the effects of intergroup bias might extend to race, yet one cannot generalize from White perceivers alone. We address this limitation in Experiment 2.

Experiment 2a and Experiment 2b

The aim of Experiment 2a and 2b was to establish whether emotion categorization is influenced by interactions between the category membership of social perceivers and social targets using gender and racial identity matched samples (i.e., equal numbers Black female, Black male, White female, & White male perceivers). Replicating the findings from Experiment 1a and 1b, we hypothesized there would be an interaction between Perceiver Sex, Target Sex, and Target Emotion; extending these findings, we hypothesized there would be an interaction between Perceiver Race, Target Race, and Target Emotion.

Method – Experiment 2a

Participants

The data from 192 participants were included in the final sample (48 Black females, 48 Black males, 48 White females, & 48 White males; age range = 16 – 33; age *M* = 24 years). We initially recruited 192 young UK domiciled adult participants via the online recruitment platform *Prolific Academic* (www.prolific.ac), who completed the experiment remotely via the online testing platform *Gorilla* (www.gorilla.sc), and were compensated around UK£2.50/US$3 for their time. We used pre-screen criteria available in *Prolific Academic* to recruit only participants who self-identified as Located in the UK", "Female" or "Male", and "White/Caucasian" or "Black/British". Participants from this sample were excluded if they exhibited excessively high error rates or excessively slow reaction times (both > 3 S.D. above the median); to ensure a gender and racial identity balanced sample, we then recruited new participants of the same gender and racial identity to replace these participants. This process resulted in three White female, four White male, three Black female, and three Black male participants being excluded and replaced following further recruitment.

Design

The experiment had a 2(Perceiver Sex: female perceivers vs. male perceivers) X 2(Perceiver Race: Black perceivers vs. White perceivers) X 2(Target Sex: female targets vs. male targets) X

2(Target Race: Black targets vs. White targets) X 2(Target Emotion: angry targets vs. happy targets) mixed factorial design, with Perceiver Sex and Perceiver Race as between-subjects factors.

Materials and Procedure

The materials and procedure were identical to those used in Experiment 1b.

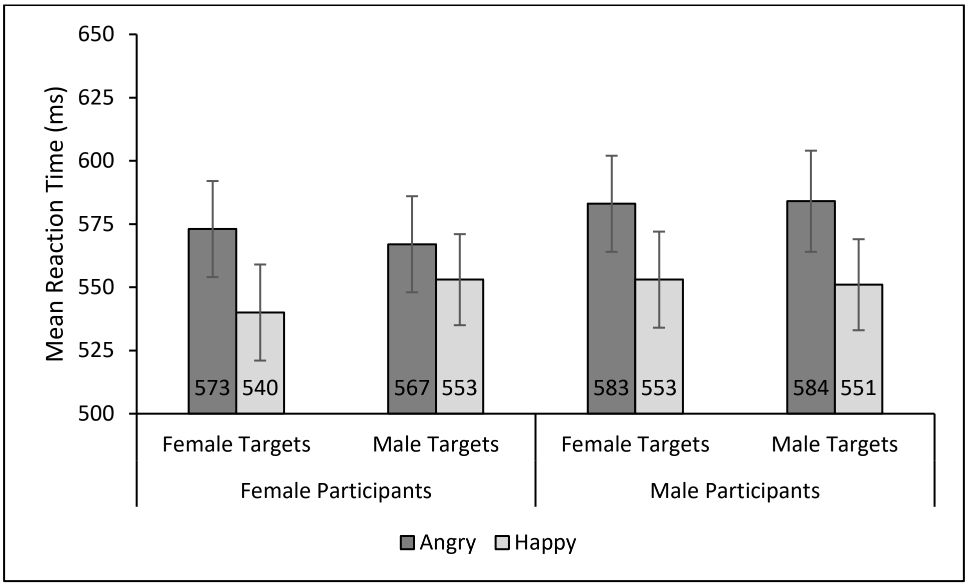
Results – Experiment 2a

There were a total of 24,576 valid trials across the 192 participants. Reaction times ranged from 42 ms to 50 seconds. We initially removed 662 outlying trials (see Expt. 1a for method). Participants accurately categorized emotional expression on 94% of remaining trials; we excluded from the RT analysis trials on which errors were made (1334 trials excluded). Thus, the final datasets comprised 23,914 for responses for error analysis and 22,580 correct response times for RT analysis. To ensure consistency across experiments, we report the data from RT and Errors models that included the specified fixed effects plus random by-participant slopes for Target Emotion and no by-item random slopes; both the RT and Errors models converged. Comparison of the fit of these models with the fit from the full models, inidicated the fits were not significantly different. The full output for both above models can be found in Supplementary Table 5 (RT data) and Supplementary Table 6 (Error data).

Interaction of Perceiver Sex, Target Sex, and Target Emotion

The RT model indicated the presence of the predicted Perceiver Sex X Target Sex X Target Emotion interaction (β = 22, t = 3.72, p < .001; see Figure 3a, top panel). We further examined this interaction by running separate Target Sex X Target Emotion tests for each Perceiver sex. For female perceivers, there was evidence of a Target Sex X Target Emotion interaction (β = 20**,** ***t* =** 2.47, p = .015; pairwise comparisons indicated female perceivers showed a significant happy face advantage for female targets (*M* diff = 33 ms, [95% CI = 19, 48], t = 5.26, p < .001) but not male targets (*M* diff = 14 ms, [95% CI = -.53, 28], t = 2.16, p = .062). Whereas, for male perceivers there was no evidence of a Target Sex X Target Emotion interaction (β = 2**,** ***t* =** .23, p = .82) but there was evidence of an overall happy face advantage, as indicated by a significant main effect of Target Emotion (β = 31**,** ***t* =** 6.70, p < .001).

The Errors model also indicated the presence of the predicted Perceiver Sex X Target Sex X Target Emotion interaction (β = .76**,** t = 3.27, p = .001; see Figure 3a, bottom panel). We further examined this interaction by running separate Target Sex X Target Emotion tests for each Perceiver sex. For female perceivers, there was evidence of a Target Sex X Target Emotion interaction (β = .76**,** ***t* =** 3.23, p = .001; pairwise comparisons indicated female perceivers showed a significant happy face advantage for female targets (OR = 1.84, [95% CI = 1.21, 2.78], t = 3.29, p = .002) but not for male targets (OR = .86, [95% CI = .58, 1.29], t = .82, p = .83). Whereas for male perceivers there was no evidence of a Target Sex X Target Emotion interaction (β = .08**,** ***t* =** .33, p = .74) but there was evidence of an overall happy face advantage, as indicated by a significant main effect of Target Emotion (β = 43**,** ***t* =** 2.74, p = .006).



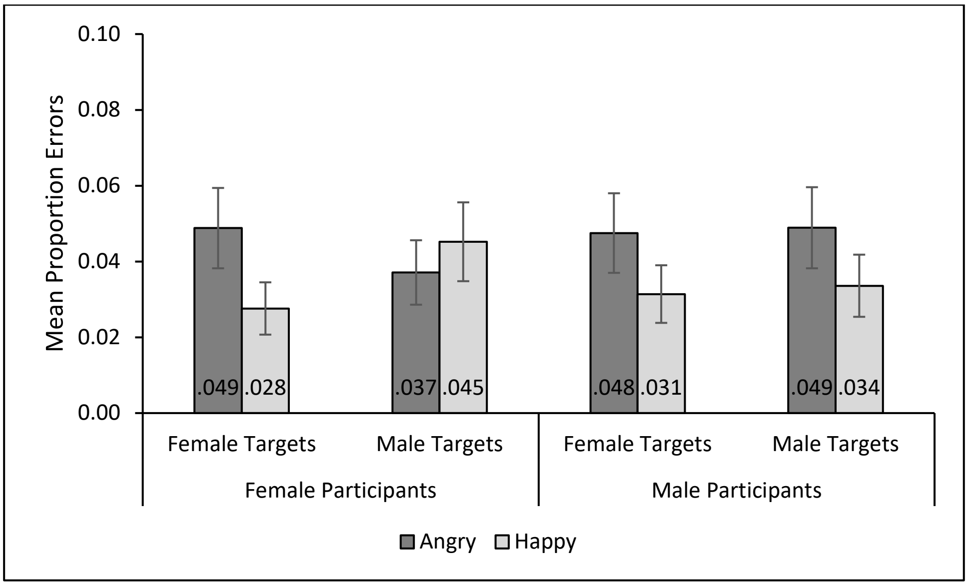


Figure 3a. Experiment 2a Mean reaction time (top panel) and mean proportion errors (bottom panel) by Perceiver Sex, Target Sex and Target Emotion. Error bars represent 95% confidence intervals.

Interaction of Perceiver Race, Target Race, and Target Emotion

The RT model indicated the presence of the predicted Perceiver Race X Target Race X Target Emotion interaction (β = 16, $t = 2.70$, $p = .007$; see Figure 3b, top panel). We further examined this interaction by running separate Target Race X Target Emotion tests for each Perceiver Race. For Black perceivers, there was no evidence of a Target Race X Target Emotion interaction (β = 6, $t = .81$, $p = .42$) but there was evidence of an overall happy face advantage, as indicated by a significant main effect of Target Emotion (β = 33, $t = 6.85$, $p < .001$). Whereas, for White perceivers there was evidence of a Target Race X Target Emotion interaction (β = 22, $t = 3.15$, $p = .002$; pairwise comparisons indicated White perceivers showed a significant happy face advantage for White targets (*M* diff = 32 ms, [95% CI = 20, 45], $t = 5.72$, $p < .001$) but not Black targets (*M* diff = 10 ms, [95% CI = -3, 23], $t = 1.79$, $p = .15$).

The Errors model also indicated the predicted Perceiver Race X Target Race X Target Emotion interaction (β = .50, $t = 2.14$, $p = .032$; see Figure 3b, bottom panel). We further examined this interaction by running separate Target Race X Target Emotion tests for each Perceiver Race. For Black perceivers there was evidence of a Target Race X Target Emotion interaction (β = .45, $t = 2.11$, $p = .035$; pairwise comparisons indicated Black perceivers showed a significant happy face advantage for White targets (OR = 1.82, [95% CI = 1.20, 2.75], $t = 3.25$, $p = .002$) but not for Black targets (OR = 1.17, [95% CI = .77, 1.78], $t = .82$, $p = .83$). Similarly, for White perceivers there was evidence of a Target Race X Target Emotion interaction (β = .99, $t = 4.32$, $p < .001$); pairwise comparisons indicated White perceivers also showed a significant happy face advantage for White targets (OR = 2.10, [95% CI = 1.41, 3.11], $t = 4.21$, $p < .001$) but not for Black targets (OR = .78, [95% CI = .52, 1.16], $t = 1.42$, $p = .31$).

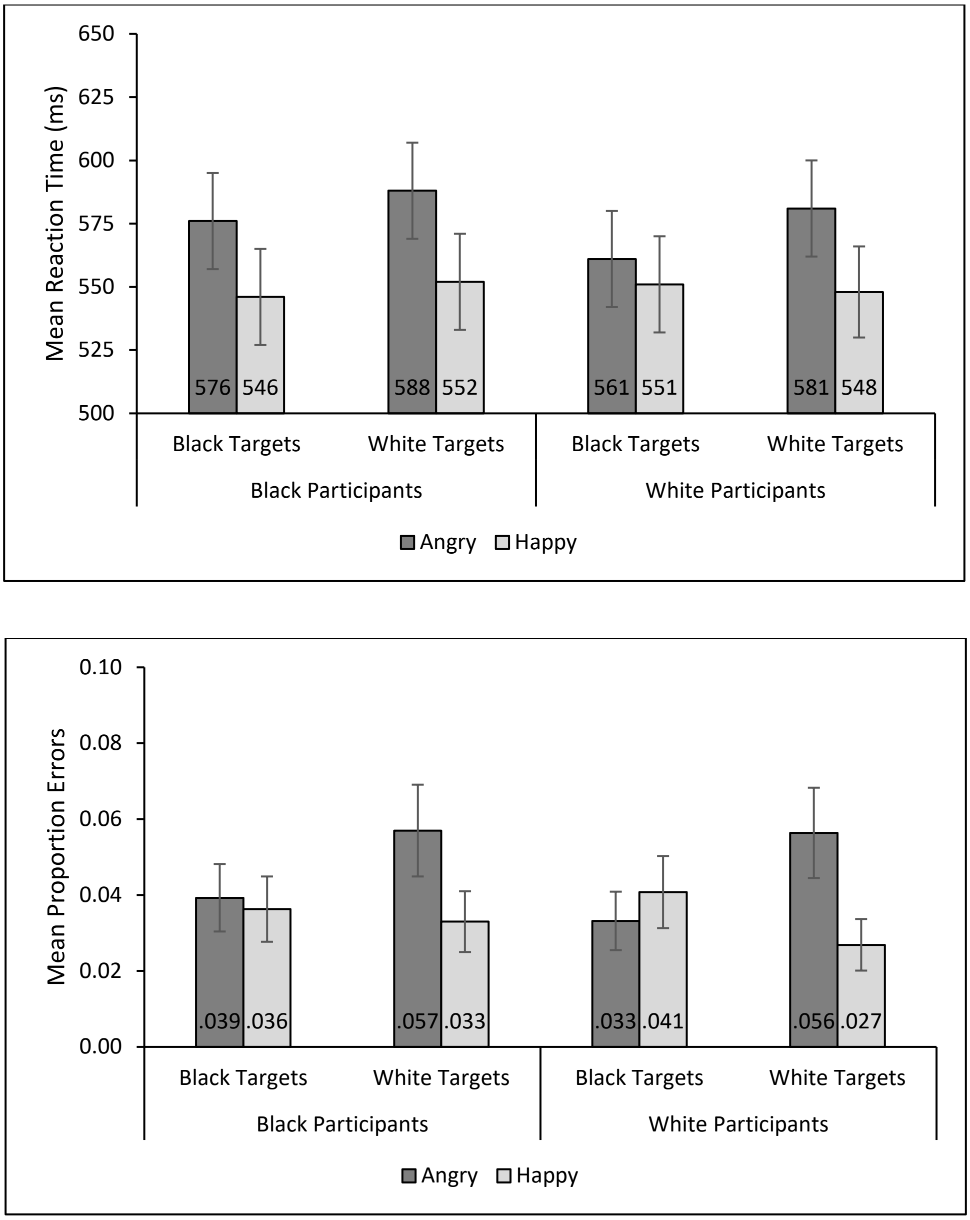


Figure 3b. Experiment 2a Mean reaction time (top panel) and mean proportion errors (bottom panel) by Participant Race, Target Race, and Target Emotion. Error bars represent 95% confidence intervals.

Method – Experiment 2b

Experiment 2b was a replication of Experiment 2a with revised recruitment and exclusion criteria.

Participants

The data from 201 participants were included in the final sample (51 Black women, 49 Black men, 49 White women, & 52 White men; age range = 18 – 33; age *M* = 25 years). In Experiment 2b we aimed to have a final sample of around 192 participants, with approximately equal numbers of Black women, Black men, White women, and White men. In the previous Experiments we excluded 8% of participants from the original sample because they exhibited excessively high error rates or excessively slow reaction times (both > 3 S.D. above the median); to ensure a gender-balanced and race-balanced sample, we then recruited new participants of the same gender and race to replace the excluded participants. However, the process of excluding and replacing participants has been identified as a potential cause of alpha error inflation (see Simmons et al., 2016). To address this issue, in Experiment 2b we over-recruited our initial sample by around 10% to allow us to exclude outlier participants based on their performance relative to the entire sample, whilst still leaving sufficient power to test our hypotheses. To this end, we initially recruited 212 young adult US domiciled participants (53 from each perceiver category), via the online recruitment platform *Prolific Academic* (www.prolific.ac), who completed the experiment remotely via the online testing platform *Gorilla* (www.gorilla.sc), and were compensated around UK£2.50/US$3 for their time. We used pre-screen criteria available in *Prolific Academic* to recruit only participants who self-identified as “Located in the USA”, “Female” or “Male”, and “White/Caucasian” or “Black/African American”. We excluded participants if they exhibited excessively high error rates or excessively slow reaction times (both > 3 S.D. above the median); this resulted in the exclusion of 11 participants.

Design, Materials, and Procedure

The design, materials, and procedure were identical to those used in Experiment 2a.

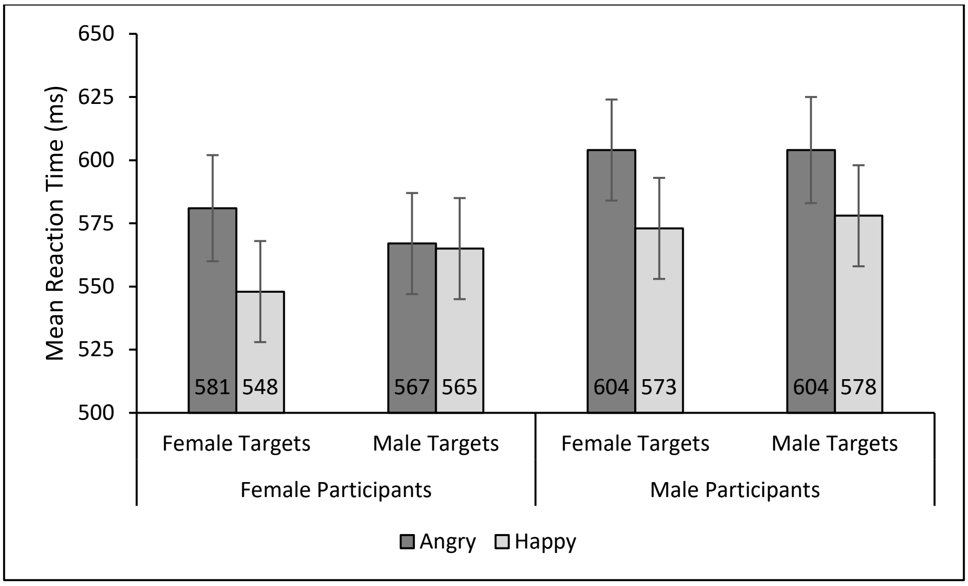
Results – Experiment 2b

There were a total of 25,729 valid trials across the 201 participants. Reaction times ranged from 1 ms to 93 seconds. We initially removed 976 outlying trials (see Expt. 1a for method). Participants accurately categorized emotional expression on 93% of remaining trials; we excluded from the RT analysis trials on which errors were made (1722 trials excluded). Thus, the final datasets comprised 24,752 for responses for error analysis and 23,030 correct response times for RT analysis. To ensure consistency across experiments, we report the data from RT and Errors models that included the specified fixed effects plus random by-participant slopes for Target Emotion and no by-item random slopes; both the RT and Errors models converged. Comparison of the fit of these models with the fit from the full models, inidicated the fits were not significantly different. The full output for both above models can be found in Supplementary Table 7 (RT data) and Supplementary Table 8 (Error data).

Interaction of Perceiver Sex, Target Sex, and Target Emotion

The RT model indicated the presence of the predicted Perceiver Sex X Target Sex X Target Emotion interaction ($\beta = 25$, $t = 4.33$, $p < .001$; see Figure 4a, top panel). We further examined this interaction by running separate Target Sex X Target Emotion tests for each Perceiver Sex. For female perceivers, there was evidence of a Target Sex X Target Emotion interaction ($\beta = 26$, $t = 3.62$, $p < .001$); pairwise comparisons indicated female perceivers showed a significant happy face advantage for female targets (*M* diff = 33 ms, [95% CI = 21, 45], $t = 6.06$, $p < .001$) but not male targets (*M* diff = 7 ms, [95% CI = -5, 19], $t = 1.31$, $p = .38$). Whereas for male perceivers, there was no evidence of a Target Sex X Target Emotion interaction ($\beta = 1$, $t = .16$, $p = .88$) but there was evidence of an overall happy face advantage, as indicated by a significant main effect of Target Emotion ($\beta = 29$, $t = 7.49$, $p < .001$).

The Errors model also indicated the presence of the predicted Perceiver Sex X Target Sex X Target Emotion interaction ($\beta = .84$, $t = 4.02$, $p < .001$; see Figure 4a, bottom panel). We further examined this interaction by running separate Target Sex X Target Emotion tests for each Perceiver Sex. For female perceivers, there was evidence of a Target Sex X Target Emotion interaction ($\beta = .81$, $t = 4.79$, $p < .001$; pairwise comparisons indicated that female perceivers showed a significant happy face advantage for female targets (OR = 1.66, [95% CI = 1.21, 2.17], $t = 3.64$, $p < .001$), but showed an angry face advantage for male targets (OR = .72, [95% CI = .54, .96], $t = 2.57$, $p = .021$). Whereas for male perceivers, there was no evidence of a Target Sex X Target Emotion interaction ($\beta = .05$, $t = .27$, $p = .79$) but there was evidence of an overall happy face advantage, as indicated by a significant main effect of Target Emotion ($\beta = .29$, $t = 2.54$, $p = .011$).



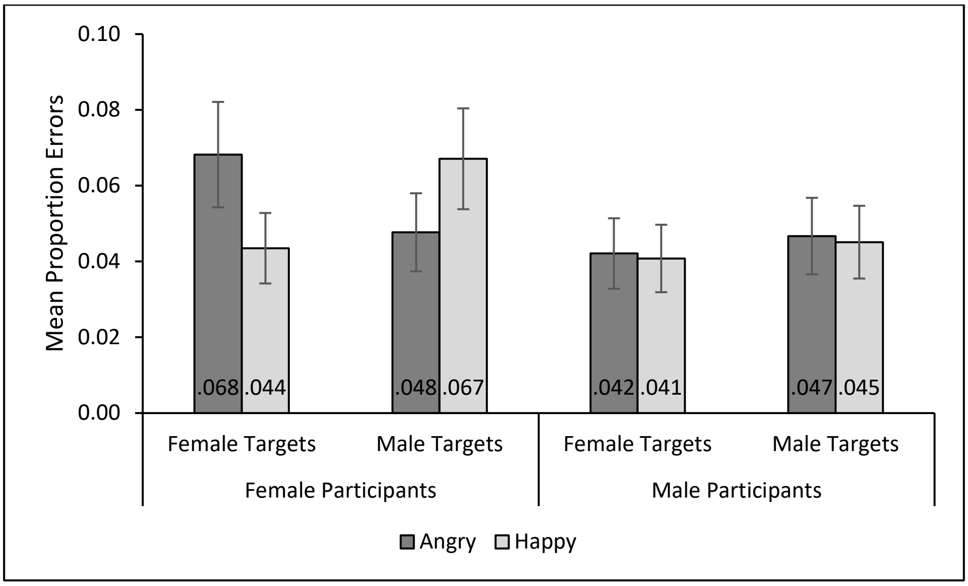


Figure 4a. Experiment 2b Mean reaction time (top panel) and mean proportion errors (bottom panel) by Perceiver Sex, Target Sex and Target Emotion. Error bars represent 95% confidence intervals.

Interaction of Perceiver Race, Target Race, and Target Emotion

The RT model indicated the presence of the predicted Perceiver Race X Target Race X Target Emotion interaction (β = 22**,** *t* = 3.70, *p* < .001; see Figure 4b, top panel). We further examined this interaction by running separate Target Race X Target Emotion tests for each Perceiver Race. For Black perceivers, there was no evidence of a Target Race X Target Emotion interaction (β = 6**,** ***t* =** .85, *p* = .40) but there was evidence of an overall happy face advantage, as indicated by a significant main effect of Target Emotion (β = 28**,** ***t* =** 7.32, *p* < .001). Whereas, for White perceivers there was evidence of a Target Race X Target Emotion interaction (β = 25**,** ***t* =** 3.55, *p* < .001; pairwise comparisons indicated White perceivers showed a significant happy face advantage for White targets (*M* diff = 33 ms, [95% CI = 22, 45], *t* = 6.39, *p* < .001) but not Black targets (*M* diff = 9 ms, [95% CI = -3, 21], *t* = 1.71, *p* = .18).

The Errors model also indicated the predicted Perceiver Race X Target Race X Target Emotion interaction (β = .83**,** *t* = 3.96, *p* < .001; see Figure 4b, bottom panel). We further examined this interaction by running separate Target Race X Target Emotion tests for each Perceiver Race. For Black perceivers there was evidence of a Target Race X Target Emotion interaction (β = .35**,** ***t* =** 2.14, *p* = .033; pairwise comparisons indicated Black perceivers showed a significant happy face advantage for White targets (OR = 1.49, [95% CI = 1.11, 2.01], *t* = 3.01, *p* = .001) but not for Black targets (OR = 1.05, [95% CI = .77, 1.42], *t* = .34, *p* = 1.00). Similarly, for White perceivers there was evidence of a Target Race X Target Emotion interaction (β = 1.08**,** ***t* =** 6.25, *p* < .001); pairwise comparisons indicated that like Black perceivers White perceivers showed a significant happy face advantage for White targets (OR = 1.92, [95% CI = 1.43, 2.57], *t* = 5.02, *p* < .001), but unlike black perceivers they also showed and angry face advantage for Black targets (OR = .66, [95% CI = .49, .88], *t* = 3.21, *p* = .003).

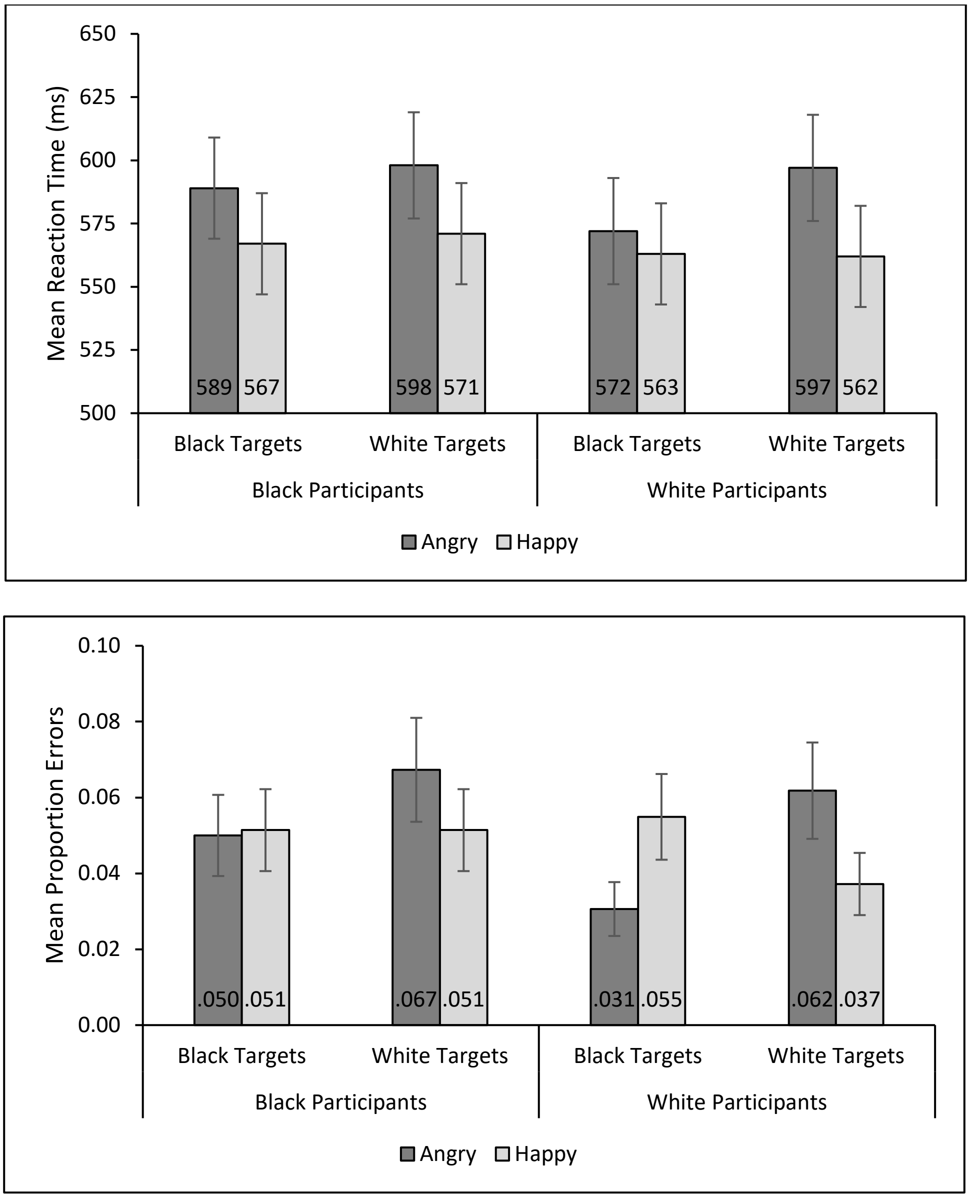


Figure 4b. Experiment 2b Mean reaction time (top panel) and mean proportion errors (bottom panel) by Participant Race, Target Race, and Target Emotion. Error bars represent 95% confidence intervals.

Discussion – Experiment 2a and Experiment 2b

Experiment 2a and 2b provide further support for the idea that emotion categorization is influenced by interactions between the category membership of social perceivers and social targets. Replicating the findings from Experiment 1a and 1b, as hypothesized, we found evidence that emotion categorization was influenced by interactions between perceiver sex and target sex. Female perceivers showed a happy face advantage only for female targets, yet male perceivers showed a happy face advantage for both female and male targets. Extending the findings from Experiment 1a and 1b, as hypothesized, we found evidence that emotion categorization was influenced by interactions between perceiver race and target race. White perceivers showed a happy face advantage only for White targets, yet Black perceivers showed a happy face advantage for both Black and White targets (although this pattern was more mixed in errors).

While the results from our first four experiments suggest emotion categorization is influenced by interactions between the category membership of social perceivers and social targets, it is not clear whether these effects are driven by stable underlying intergroup evaluations or whether they are driven by current intergroup context. Because people belong to many different social categories across a wide range of social category dimensions, whether another person is perceived to belong to an in-group or an out-group is dependent on the social context of the encounter (e.g., Crisp et al., 2001; Dovidio & Gaertner, 1993). If this were the case, then changing the social context in which targets appear might change the nature of the effects – we explored this possibility in Experiment 3.

Experiment 3a and Experiment 3b

The aim of Experiments 3a and 3b was to establish whether social category modulation of emotion categorization is driven by relatively stable context independent intergroup evaluations or whether the effects are dependent on dynamic contextually sensitive intergroup evaluations. We presented targets in single category blocks (e.g., a block of all White male targets followed by a block of Black female targets and so on) thereby eliminating the intergroup overlap between target categories whilst maintaining the intergroup overlap between perceiver and target categories. If the perceiver-target interactions in Experiment 1a to 2b were the result of dynamic contextually driven intergroup evaluations, one would only expect to find perceiver-target interactions in specific task contexts; therefore, we hypothesized that, unlike in the previous four experiments, there would not be any perceiver-target interactions when targets appeared in single category blocks but instead there would be an overall happy face advantage (i.e., a main effect of emotion). Alternatively, if the pattern of effects seen in the previous experiments were caused by stable underlying intergroup evaluations, one would expect to find these irrespective of the task context (including when targets appear in single category blocks).

Method – Experiment 3a

Participants

The data from 200 participants were included in the final sample for analysis (49 Black females, 51 Black males, 50 White females, & 50 White males; age range = 18 – 30; age M = 24 years). We initially recruited 212 young adult US domiciled participants (53 from each perceiver category), via the online recruitment platform *Prolific Academic* (www.prolific.ac), who completed the experiment remotely via the online testing platform *Gorilla* (www.gorilla.sc), and were compensated around UK£2.50/US$3 for their time. We used pre-screen criteria available in *Prolific Academic* to recruit only participants who self-identified as “Located in the USA”, “Female” or “Male”, and “White/Caucasian” or “Black/African American”. We excluded participants if they did not complete all trials or if they exhibited excessively high error rates or excessively slow reaction times (both > 3 S.D. above the median). This resulted in the exclusion of 12 participants.

Design

The experiment had a 2(Perceiver Sex: female perceivers vs. male perceivers) X 2(Perceiver Race: Black perceivers vs. White perceivers) X 2(Target Sex: female targets vs. male targets) X 2(Target Race: Black targets vs. White targets) X 2(Target emotion: angry targets vs. happy targets) mixed factorial design, with Perceiver Sex and Perceiver Race as between-subjects factors.

Materials and Procedure

The materials were identical to Experiment 2. The only difference to the procedure was that rather than all trials appearing in a single block with all targets randomly intermingled, trials were chunked into four single sex, single race blocks (i.e., one block of 32 trials comprising only images of angry and happy Black female targets, one block of 32 trials comprising only images of angry and happy Black male targets, one block of 32 trials comprising only images of angry and happy White female targets, one block of 32 trials comprising only images of angry and happy White male targets; block order was counterbalanced across participants).

Trial exclusion criteria

The trial exclusion criteria were identical to those described for Experiment 2.

Analysis plan

The analysis plan was identical to that described for Experiment 2.

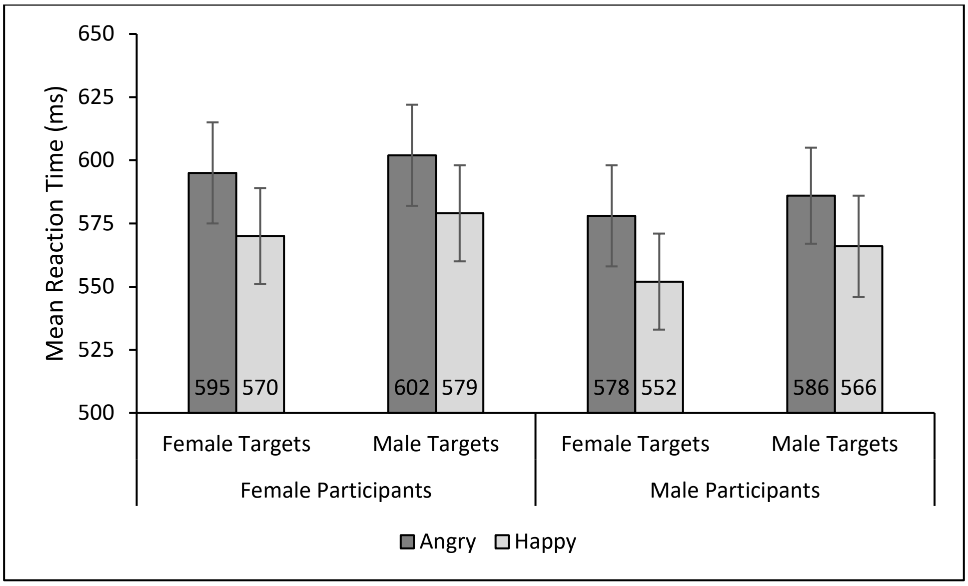
Results – Experiment 3a

There were a total of 25,600 valid trials across the 200 participants. Reaction times ranged from 13 ms to 69 seconds. We initially removed 851 outlying trials (see Expt. 1a for method). Participants accurately categorized emotional expression on 95% of remaining trials; we excluded from the RT analysis trials on which errors were made (1349 trials excluded). Thus, the final datasets comprised 24,749 responses for error analysis and 23,400 correct response times for RT analysis. To ensure consistency across experiments, we report the data from RT and Errors models that included the specified fixed effects plus random by-participant slopes for Target Emotion and no by-item random slopes; both the RT and Errors models converged. Comparison of the fit of these models with the fit from the full models indicated the fit of the more parsimonious RT model was significantly better than the fit of the maximal model, whereas for errors there was no significant difference between the fit of the parsimonious and full models; however, the pattern of the significant effects of interest for all models were identical. The full output for both above models can be found in Supplementary Table 9 (RT data) and Supplementary Table 10 (Error data).

Interaction of Perceiver Sex, Target Sex, and Target Emotion

The RT model indicated there was no evidence of a significant Perceiver Sex X Target Sex X Target Emotion interaction (*β* = 11, *t* = 1.70, *p* = .089; see Figure 5a, top panel); nor were there any significant higher order interactions involving Perceiver Sex, Target Sex, and Target Emotion (all *β* < 28, *t* < 1.10). However, there was evidence of an overall happy face advantage, as indicated by a significant main effect of Target Emotion (β = 23**,** ***t* =** 5.56, *p* < .001).

Similarly, the Errors model indicated there was no evidence of a Perceiver Sex X Target Sex X Target Emotion interaction (β = .07, *t* = .30, *p* = .76; see Figure 5a, bottom panel); nor were there any significant higher order interactions involving Perceiver Sex, Target Sex, and Target Emotion (all *β* < .30, *t* < .33). There was no evidence of an overall happy face advantage, with no significant main effect of Target Emotion (β = .16**,** ***t* =** 1.55, *p* = .121).



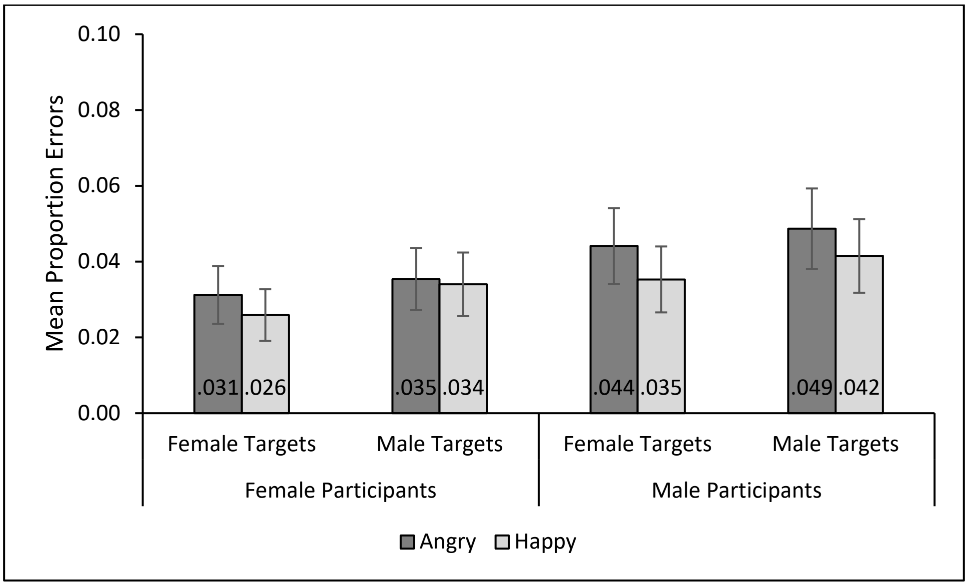


Figure 5a. Experiment 3a Mean reaction time (top panel) and mean proportion errors (bottom panel) by Perceiver Sex, Target Sex and Target Emotion. Error bars represent 95% confidence intervals.

Interaction of Perceiver Race, Target Race, and Target Emotion

The RT model indicated there was no evidence of a significant Perceiver Race X Target Race X Target Emotion interaction (β = 7, t = 1.05, p = .29; see Figure 5b, top panel); nor were there any significant higher order interactions involving Perceiver Race, Target Race, and Target Emotion (all β < .98, t < .09).

Similarly, the Errors model indicated there was no evidence of a Perceiver Race X Target Race X Target Emotion interaction (β = .23, t = 1.00, p = .32; see Figure 5b, bottom panel); nor were there any significant higher order interactions involving Perceiver Race, Target Race, and Target Emotion (all β < .63, t < 1.38).

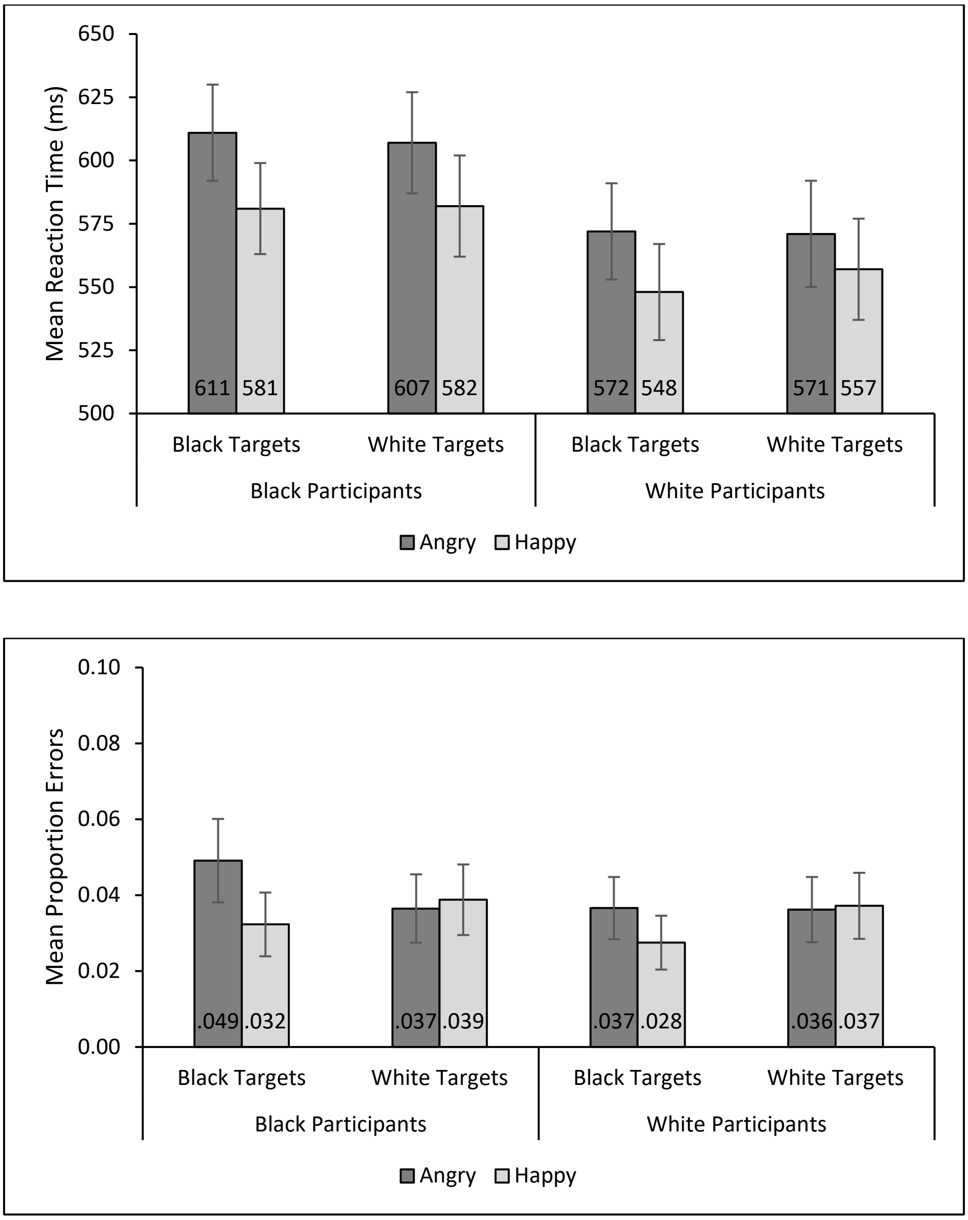


Figure 5b. Experiment 3a Mean reaction time (top panel) and mean proportion errors (bottom panel) by Perceiver Race, Target Race and Target Emotion. Error bars represent 95% confidence intervals.

Method – Experiment 3b

Experiment 3b was a preregistered replication of Experiment 3a. See: https://osf.io/qs4pz.

Participants

The data from 191 participants were included in the final sample for analysis (48 Black females, 44 Black males, 50 White females, & 49 White males; age range = 18 – 35; age *M* = 27 years). We initially recruited 212 young adult US domiciled participants (53 from each perceiver category), via the online recruitment platform *Prolific Academic* (www.prolific.ac), who completed the experiment remotely via the online testing platform *Gorilla* (www.gorilla.sc), and were compensated around UK£2.50/US$3 for their time. We used pre-screen criteria available in *Prolific Academic* to recruit only participants who self-identified as "Located in the USA", "Female" or "Male", and "White/Caucasian" or "Black/African American". We excluded participants if they did not complete all trials or if they exhibited excessively high error rates or excessively slow reaction times (both > 3 S.D. above the median). This resulted in the exclusion of 21 participants.

Design, Materials, and Procedure

The design, materials, and procedure were identical to those used in Experiment 3a.

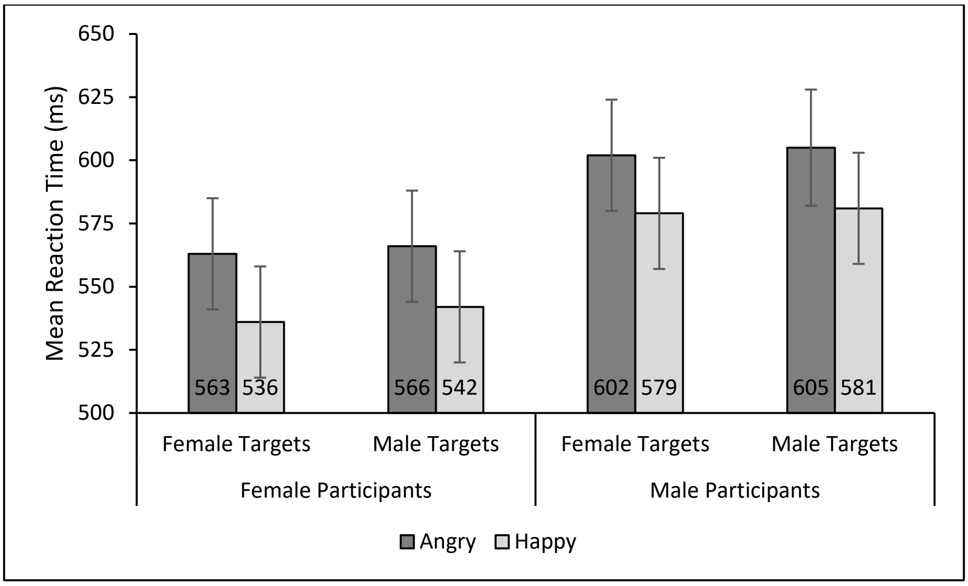
Results – Experiment 3b

There were a total of 24,448 valid trials across the 191 participants. Reaction times ranged from 1 ms to 85 seconds. We initially removed 856 outlying trials (see Expt. 1a for method). Participants accurately categorized emotional expression on 93% of remaining trials; we excluded from the RT analysis trials on which errors were made (1972 trials excluded). Thus, the final datasets comprised 23,593 responses for error analysis and 21,981 correct response times for RT analysis. To ensure consistency across experiments, we report the data from RT and Errors models that included the specified fixed effects plus random by-participant slopes for Target Emotion and no by-item random slopes; both the RT and Errors models converged. Comparison of the fit of these models with the fit from the full models indicated the fit of the maximal RT model was significantly better than the fit of the more parsimonious model, whereas for errors there was no significant difference between the fit of the parsimonious and full model; however, the pattern of the significant effects of interest for all models were identical. The full output for both above models can be found in Supplementary Table 11 (RT data) and Supplementary Table 12 (Error data).

Interaction of Perceiver Sex, Target Sex, and Target Emotion

The RT model indicated there was no evidence of a significant Perceiver Sex X Target Sex X Target Emotion interaction (β = 4, t = .75, p = .453; see Figure 6a, top panel); there was a non-predicted significant interaction of Perceiver Sex X Target Sex X Target Race X Target Emotion (β = 27, t = 2.32); there were no other significant higher order interactions involving Perceiver Sex, Target Sex, and Target Emotion (all β < 22, t < 1.92). However, there was evidence of an overall happy face advantage, as indicated by a significant main effect of Target Emotion (β = 25, t = 6.20, p < .001).

The Errors model indicated there was no Perceiver Sex X Target Sex X Target Emotion interaction (β = .14, t = .65, p = .515; see Figure 6a, bottom panel); there was a non-predicted significant interaction of Perceiver Sex X Perceiver Race X Target Sex X Target Emotion (β = 1.04, t = 2.36); there were no other significant higher order interactions involving Perceiver Sex, Target Sex, and Target Emotion (all β < .54, t < 1.22). There was no evidence of an overall happy face advantage, with no significant main effect of Target Emotion (β = .06, t = .60, p = .551).



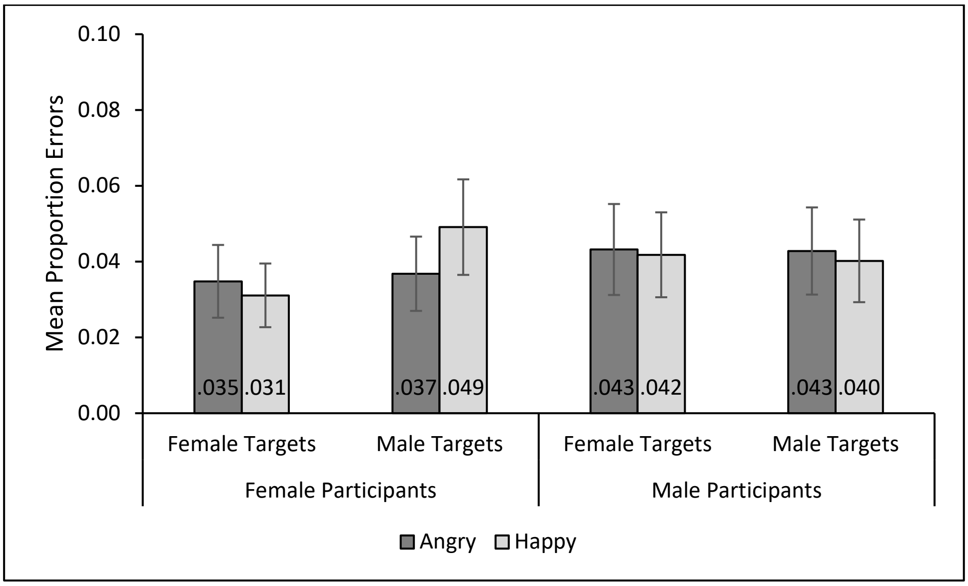


Figure 6a. Experiment 3b Mean reaction time (top panel) and mean proportion errors (bottom panel) by Perceiver Sex, Target Sex and Target Emotion. Error bars represent 95% confidence intervals.

Interaction of Perceiver Race, Target Race, and Target Emotion

The RT model indicated there was no evidence of a significant Perceiver Race X Target Race X Target Emotion interaction ($\beta = 1$, $t = .23$, $p = .816$; see Figure 6b, top panel); nor were there any significant higher order interactions involving Perceiver Race, Target Race, and Target Emotion (all $\beta < 22$, $t < 1.92$).

Similarly, the Errors model indicated there was no evidence of a Perceiver Race X Target Race X Target Emotion interaction ($\beta < .001$, $t < .001$, $p = .998$; see Figure 6b, bottom panel); nor were there any significant higher order interactions involving Perceiver Race, Target Race, and Target Emotion (all $\beta < .43$, $t < .96$).

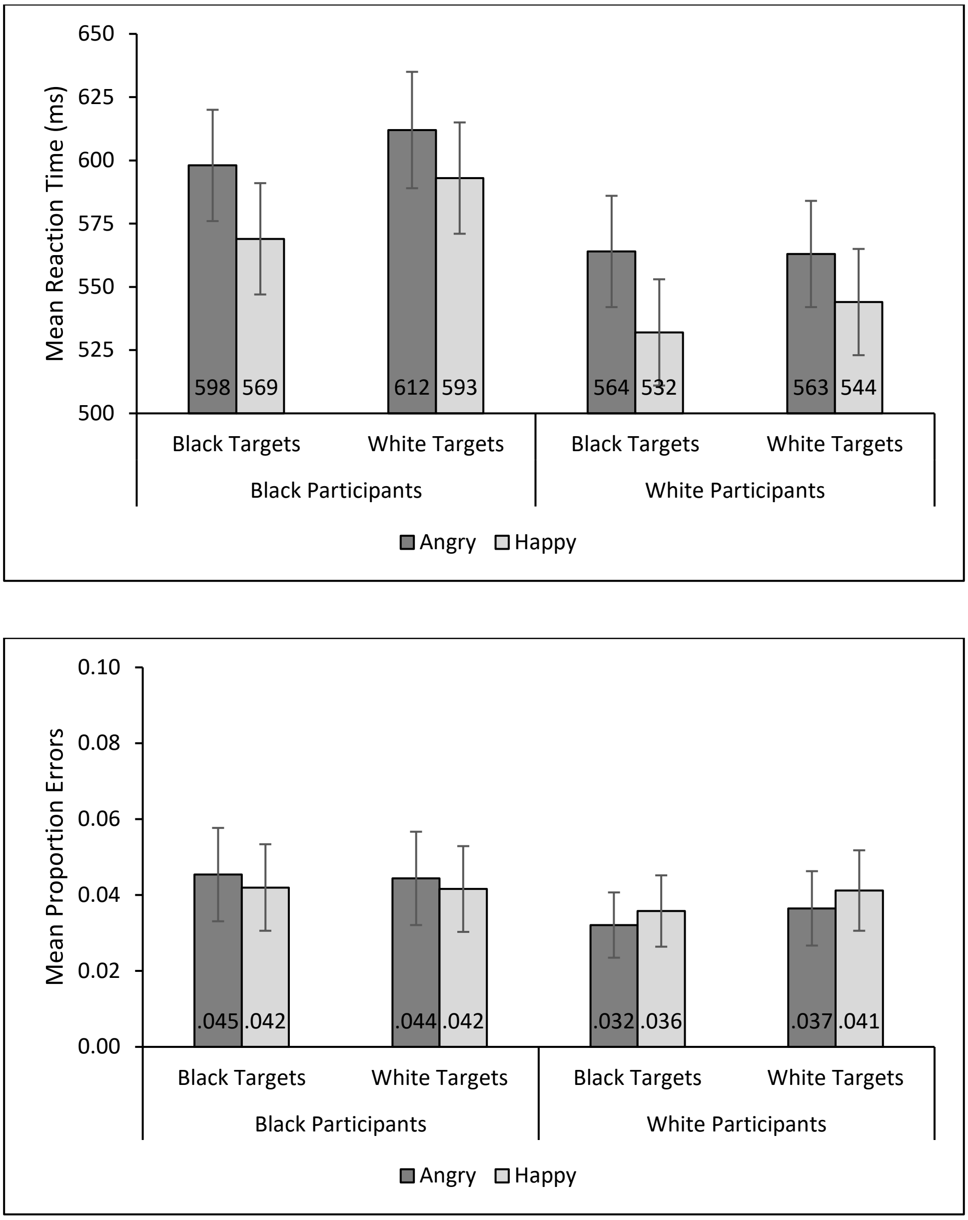


Figure 6b. Experiment 3b Mean reaction time (top panel) and mean proportion errors (bottom panel) by Perceiver Race, Target Race and Target Emotion. Error bars represent 95% confidence intervals.

Discussion – Experiment 3a and Experiment 3b

Experiment 3a and experiment 3b support the possibility that social category modulation of emotion categorization is the result of a dynamic contextually sensitive process. Unlike in the previous four experiments, there was no evidence of interactions between Perceiver Category, Target Category, and Target Emotion. Instead, there was an overall happy face advantage in reaction times (but not in errors). If social category modulation of emotion categorization is the result of a dynamic contextually driven intergroup process, it raises the intriguing possibility that the same face might exert different influence on emotion categorization dependent on whether it is believed to belong to an in-group member or an out-group member. We explore this possibility in Experiment 4.

Experiment 4

The aim of Experiment 4 was to establish whether social category modulation of emotion perception is influenced by contextual beliefs about whether in-group/out-group race targets also belonged to an in-group/out-group nationality. Replicating the findings from Experiments 1 and 2, we hypothesized there would be a Perceiver Sex X Target Sex X Target Emotion interaction. However, we also hypothesized there would be an interaction between Target Nationality, Target Race, and Target Emotion. Specifically, replicating the findings from Experiment 1 and Experiment 2, we predicted that White perceivers who were told that White targets were an in-group nationality and Black targets were an out-group nationality would show a happy face advantage for White targets but not Black targets. However, unlike in Experiment 1 and Experiment 2, we expected that White perceivers who were told that White targets were an out-group nationality and Black targets were in-group nationality would show a happy face advantage for both White targets and Black targets. Further, if intergroup processes are a mechanism driving social category modulation of emotion categorization, we would also expect the size of the happy face advantage would be determined by the relative category overlap between perceivers and targets. Specifically, we predicted that the happy face advantage for White targets would be significantly larger when perceivers were told White targets belonged to an in-group nationality relative to when they believed they belonged to an out-group nationality.

Method – Experiment 4

Experiment 4 was preregistered. See: https://osf.io/zbmun.

Participants and exclusion criteria

The final sample for inclusion in the analysis was therefore 397 participants, comprising 202 White women and 195 White men (age range = 18 – 31; age *M* = 25 years). We aimed to have a final sample of around 384 participants, with approximately equal numbers of White women, and White men. As in Experiment 2b and Experiment 3, we over-recruited our initial sample by around 10% to allow us to exclude outlier participants based on their performance relative to the entire sample, whilst still leaving sufficient power to test our hypotheses. To this end, we initially recruited 424 young adult US domiciled participants (212 White females and 212 White males), via the online recruitment platform *Prolific Academic* (www.prolific.ac), who completed the experiment remotely via the online testing platform *Gorilla* (www.gorilla.sc), and were compensated around UK£2.50/US$3 for their time. We used pre-screen criteria available in *Prolific Academic* to recruit only participants who self-identified as “Located in the USA”, “Female” or “Male”, and “White/Caucasian”. We excluded participants if they exhibited excessively high error rates or excessively slow reaction times (both > 3 S.D. above the median); this resulted in the exclusion of 27 participants.

Design

The experiment had a 2(Target Nationality: American/Black - Russian/White vs. American/White - Nigerian/Black) X2(Perceiver Sex: female perceivers vs. male perceivers) X 2(Target Sex: female targets vs. male targets) X 2(Target Race: Black targets vs. White targets) X 2(Target Emotion: angry targets vs. happy targets) mixed factorial design, with Target Nationality and Perceiver Sex as between-subjects factors. Half of the participants were assigned to the American/Black - Russian/White condition; following exclusions there were 103 females and 95 males in this condition. The other half of the participants were assigned to the American/White - Nigerian/Black condition; following exclusions there were 99 females and 100 males in this condition.

Materials and Procedure

The materials and procedure were identical to those used in Experiment 2, except for the addition of revised recruitment information and pre-experiment instructions (see below). The revised recruitment information and instructions informed participants that they would be making face emotion categorization decisions about people from their own country or people from another country.

Recruitment information: Participants were recruited using the following information: *"Categorizing the emotional faces of people from different countries: In this study we are interested in whether there are differences in facial expressions of emotions between different countries. You will see images of unfamiliar faces of people your your own country and another country and your task will be to categorize their emotional expressions as quickly and as accurately as you can."*

Experiment instructions: Participants in each of the two Target Nationality conditions received subtly different instructions. Participants in the American/Black - Russia/White condition were told the following before the face categorization trials: *"In this project we are interested in whether there are cultural differences in emotional expressions dependent on NATIONALITY. We would like you to categorize whether faces are angry or happy, as quickly and as accurately as possible. Half of the faces you will see will belong to people who are <u>American</u> and half of the faces will belong to people who are <u>Russian</u>. The American faces will all be <u>Black</u>, whereas the Russian faces will all be <u>White</u>. Your task is to categorize the emotion expressions on the faces as quickly and as accurately as you can."* Participants were then shown images of the national flags above example faces from the associated face category (e.g., a USA flag above four example Black faces). Participants in the American/White - Nigerian/Black condition received identical instructions, except "*<u>Russian"</u>* was replaced with "*Nigerian*", "*<u>Black</u>*" was replaced with "*White*" and "*<u>White</u>*" was replaced with "*Black*".

Results – Experiment 4

There was a total of 50,816 valid trials across the 397 participants. We initially removed 1456 outlying trials (see Expt. 1a for method). Participants accurately categorized emotional expression on 95% of remaining trials; we excluded from the reaction time analysis trials on which errors were made (2726 trials excluded). Thus, the final datasets comprised 49,360 responses for error analysis and 46,633 correct response times for RT analysis. To ensure consistency across experiments, we report the data from RT and Errors models that included the specified fixed effects plus random by-participant slopes for Target Emotion and no by-item random slopes; both the RT and Errors models converged. Comparison of the fit of these models with the fit from the full models indicated the fits were not significantly different. The full output for both above models can be found in Supplementary Table 13 (RT data) and Supplementary Table 14 (Error data).

Interaction of Perceiver Sex, Target Sex, and Target Emotion

The RT model indicated the presence of the predicted Perceiver Sex X Target Sex X Target Emotion interaction (β = 25, $t = 6.32$, $p < .001$; see Figure 4a, top panel). We further examined this interaction by running separate Target Sex X Target Emotion tests for each Perceiver Sex. For female perceivers, there was evidence of a Target Sex X Target Emotion interaction (β = 27, $t = 3.76$, $p < .001$; pairwise comparisons indicated female perceivers showed a significant happy face advantage for female targets (*M* diff = 35 ms, [95% CI = 23, 47], $t = 6.60$, $p < .001$) but not male targets (*M* diff = 8 ms, [95% CI = -4, 20], $t = 1.52$, $p = .255$). Whereas for male perceivers, there was no evidence of a Target Sex X Target Emotion interaction (β = 2, $t = .20$, $p = .84$) but there was evidence of an overall happy face advantage, as indicated by a significant main effect of Target Emotion (β = 27, $t = 5.79$, $p < .001$).

The Errors model also indicated the presence of the predicted Perceiver Sex X Target Sex X Target Emotion interaction (β = .40, $t = 2.34$; see Figure 4a, bottom panel). We further examined this interaction by running separate Target Sex X Target Emotion tests for each Perceiver Sex. For female perceivers, there was evidence of a Target Sex X Target Emotion interaction (β = .50, $t = 2.77$, $p < .006$; pairwise comparisons indicated that female perceivers showed Female perceivers showed a significant happy face advantage for female targets (OR = 1.53, [95% CI = 1.12, 2.08], $t = 3.07$, $p = .004$), but showed no significant difference in either direction for male targets (OR = .93, [95% CI = .69, 1.25], $t = .55$, $p = 1.00$). Whereas for male perceivers there was no evidence of a Target Sex X Target Emotion interaction (β = .13, $t = .61$, $p = .56$), nor did they show evidence of a significant main effect of Target Emotion (β = .22, $t = 1.69$, $p = .092$).

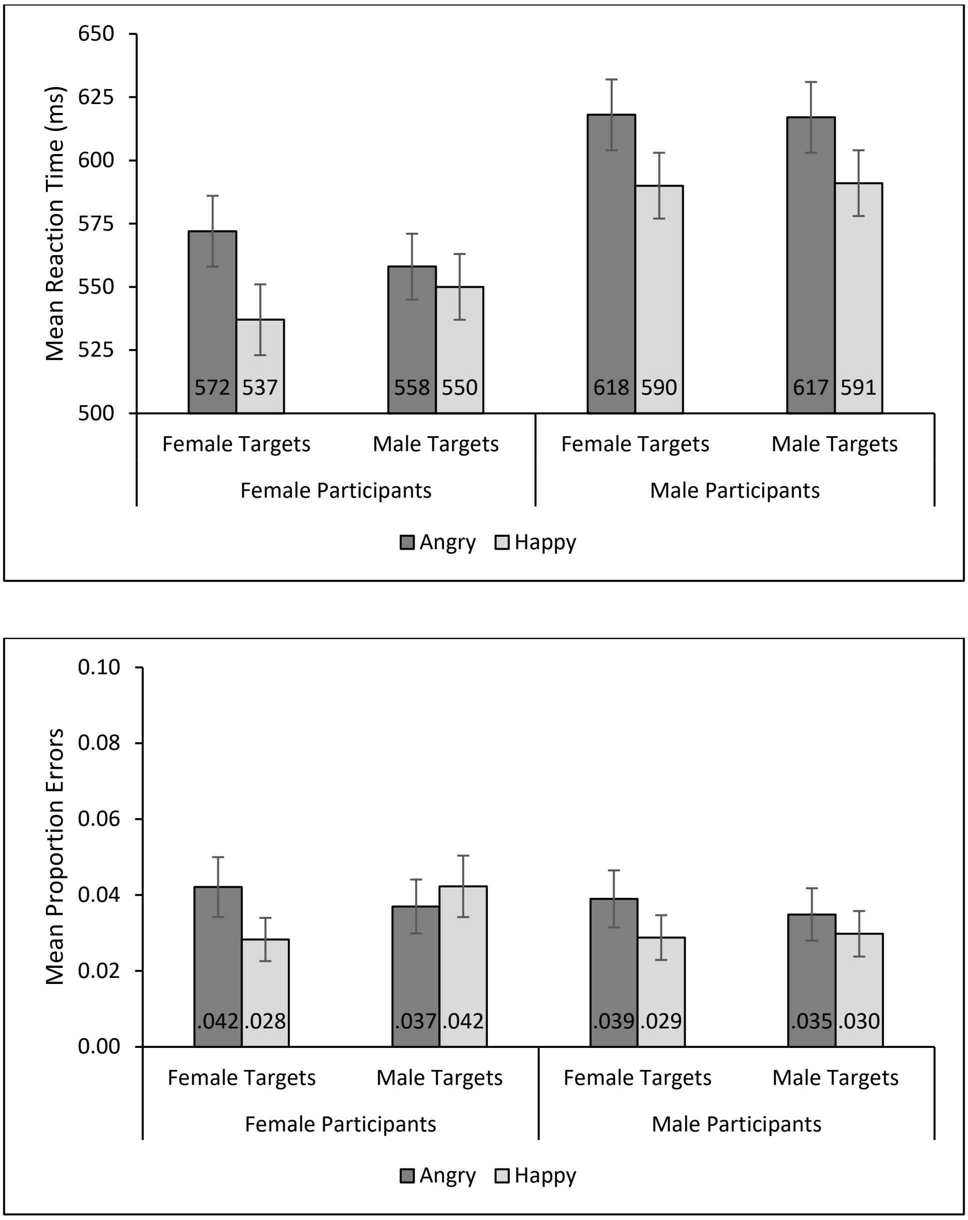


Figure 7a. Experiment 4 Mean reaction time (top panel) and mean proportion errors (bottom panel) by Perceiver sex, Target Sex, and Target Emotion. Error bars represent 95% confidence intervals.

Interaction of Target Nationality, Target Race, and Target Emotion

The RT model indicated evidence of the predicted Nationality Condition X Target Race X Target Emotion interaction (β = 19, *t* = 4.62, *p* < .001; see Figure 4b, top panel). We examined this interaction with Target Race X Target Emotion tests for each Target Nationality. For perceivers in the American/White condition there was a Target Race X Target Emotion interaction (β = 19, *t* = 4.62, *p* < .001); pairwise comparisons indicated that perceivers in the American/White condition showed a significant happy face advantage for White targets (*M* diff = 48 ms, [95% CI = 33, 63], *t* = 7.23, *p* < .001) but not Black targets (*M* diff = 7 ms, [95% CI = -8, 22], *t* = 1.00, *p* = .635). For perceivers in the American/Black condition there was also a Target Race X Target Emotion interaction (β = 19, *t* = 2.78, *p* < .007); as predicted, perceivers in the American/Black condition showed a significant happy face advantage for both White targets (*M* diff = 32 ms, [95% CI = 21, 44], *t* = 6.20, *p* < .001) and Black targets (*M* diff = 14 ms, [95% CI = 2, 25], *t* = 2.59, *p* = .019). Crucially, the size of the happy face advantage for White targets was significantly larger in the American/White condition than in the American/Black condition (*M* diff = 12 ms, [95% CI = 4, 20], *t* = 3.02, *p* = .003); there was no difference in the size of the bias for Black targets between perceivers in the American/Black condition and the American/White condition (*M* diff = 7 ms, [95% CI = -1, 15], *t* = 1.67, *p* = .10.

The Errors model also indicated evidence of the predicted Nationality Condition X Target Race X Target Emotion interaction (β = .68**,** *t* = 4.01; see Figure 4b, bottom panel). To examine the predicted effects, we began by running separate Target Race X Target Emotion tests for each Target Nationality. For perceivers in the American/White condition there was evidence of a Target Race X Target Emotion interaction (β = 1.33, *t* = 7.09, *p* < .001); pairwise comparisons revealed that perceivers in the American/White condition showed a significant happy face advantage for White targets (OR = 2.28, [95% CI = 1.65, 3.14], *t* = 5.75, *p* < .001), but showed a significant angry face advantage for Black targets (OR = .60, [95% CI = .43, .84], *t* = 3.42, *p* < .001). For perceivers in the American/Black condition there was also evidence of a Target Race X Target Emotion interaction (β = .59, *t* = 3.28, *p* = .001); perceivers in the American/Black condition showed a significant happy face advantage for White targets (OR = 1.62, [95% CI = 1.19, 2.20], *t* = 1.19, *p* < .001) but no advantage in either direction for Black targets (OR = .90, [95% CI = .65, 1.23], t = .78, p = .87). As predicted, the size of the happy face advantage for White targets was significantly larger in the American/White condition than in the American/Black condition (OR = 1.40, [95% CI = 1.07, 1.83], t = 2.43, p = .015); there was also a significant difference in the effect of target emotion for Black targets, with a larger bias towards an angry face advantage in the American/Black condition than in the American/White condition (OR = .72, [95% CI = .55, .94], t = 2.38, p = .017.

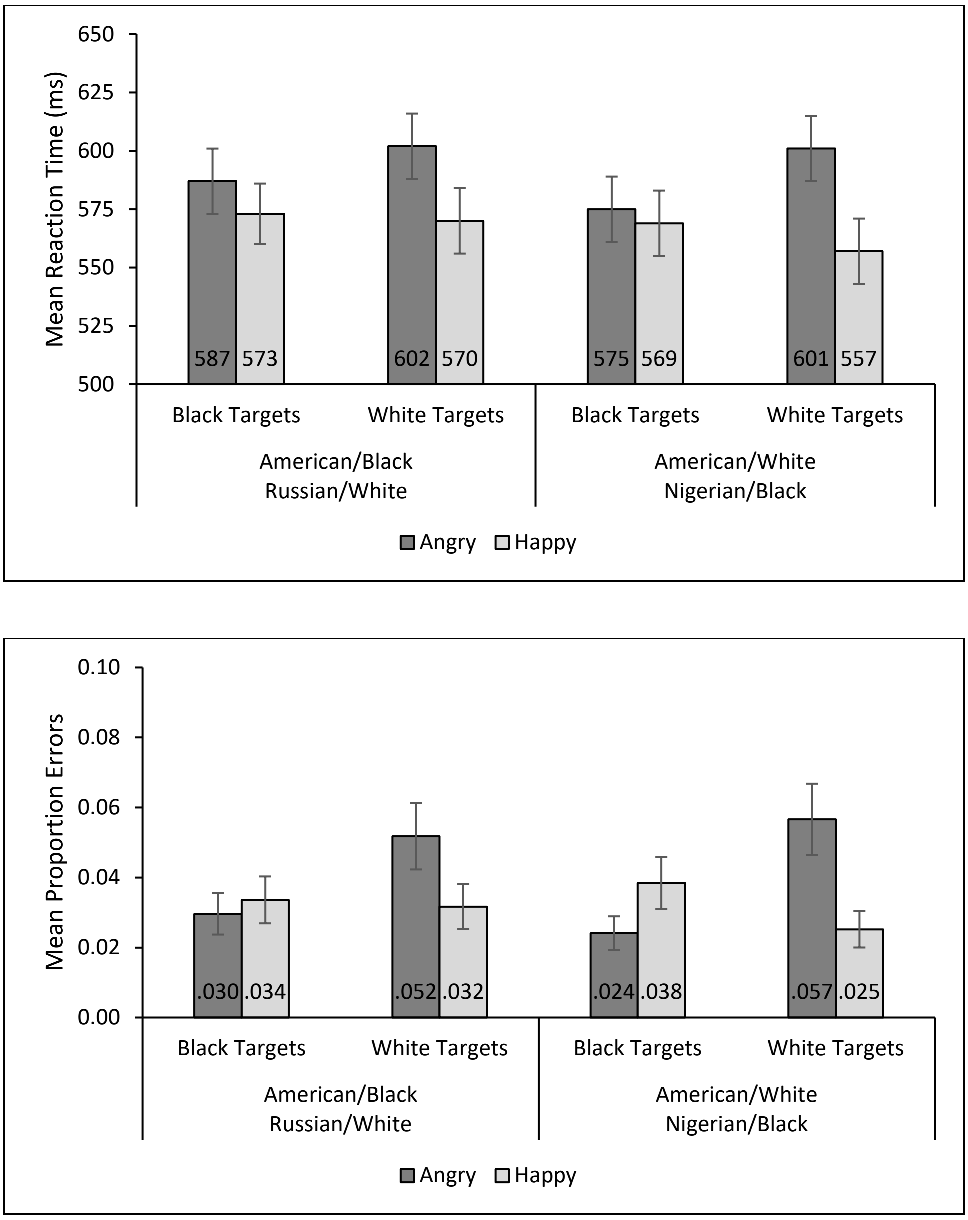


Figure 7b. Experiment 4 Mean reaction time (top panel) and mean proportion errors (bottom panel) by Target Nationality, Target Race, and Target Emotion. Error bars represent 95% confidence intervals.

Discussion – Experiment 4

The findings from Experiment 4 provide further support that social category modulation of emotion categorization is the result of a dynamic contextually driven intergroup process, such that same face might exert different influence on emotion categorization dependent on whether it is believed to belong to an in-group member or an out-group member. As hypothesized, but unlike in Experiment 1 and Experiment 2, White perceivers showed a happy face advantage for both White targets and Black targets but only if they had been told that White targets were an out-group nationality and Black targets were in-group nationality. Similarly, as hypothesized, the happy face advantage for White targets was significantly larger when perceivers were told White targets belonged to an in-group nationality relative to when they believed they belonged to an out-group nationality.

General discussion

Theoretical understanding of how social categories influence emotion categorization has been constrained by imbalances in the social category membership of perceivers and targets typically used in experiments. The current findings address these issues. First, we found robust and reliable support for the idea that emotion categorization is influenced by interactions between the social categories of perceivers and targets. Second, we found evidence that the social category influence exerted on emotion categorization by is sensitive to different social contexts. Taken together, the current findings suggest that social category modulation of emotion categorization is influenced by a dynamic contextually driven intergroup process.

Accounts based solely on either structural overlap or stereotype congruence are insufficient to explain the interactions we saw between perceiver and target social categories. If social category modulation of the happy/angry face advantages were driven by structural overlap in physical face features associated with specific emotions and specific social categories, we would have expected the effect to be equivalent for all perceivers (Becker et al., 2007; Zebrowitz et al., 2010). Similarly, if social category modulation of the happy/angry face advantages were driven by stereotype congruence, we would have expected the effect to be equivalent for all perceivers (Bijlstra et al., 2010). That emotion categorization was influenced by interactions between perceiver and target categories seems to preclude both structural overlap and stereotype congruence as unitary explanations of social category modulation of emotion categorization.

The overall pattern of our results is compatible with an evaluative congruence explanation of social category modulation of emotion categorization (Craig et al., 2017; Hugenberg, 2005; Hugenberg & Sczesny, 2006). The interactions we saw between perceiver category and target category suggest intergroup processes could be a source of evaluative congruence driving a happy face advantage for in-group targets. However, across all seven experiments, we also saw a more generalized happy face advantage for White targets and female targets, which occurred irrespective of perceiver category. More positive evaluations of White targets and female targets could be driven by cultural exposure in everyday life. Evidence from naturalistic observations (Chapell, 1997; McDuff et al., 2017) and lab-based studies suggest women smile more often than men (LaFrance et al., 2003). Images of smiling White women are used more often to illustrate news articles (Kwak & An, 2016; Rodgers et al., 2007) and advertising campaigns (e.g., An & Kwak, 2019). If people more frequently encounter smiling unfamiliar faces that are White and/or female, it could lead to perceptual, cognitive, or evaluative efficiencies that drive a generalized happy face advantage for these categories.

The current findings are harmonious with the dynamic interactive theory of person construal (Freeman & Ambady, 2011), which suggests that person perception is influenced by dynamic interactions between low-level perceptual information, social categories, stereotypes, and higher-level social cognitive states. Dynamic interactive theory suggests that on first viewing a face, multiple possible social categorizations are activated in parallel through the bottom-up extraction of low-level face features, but that over time top-down attentional control selects a single dominant categorization whilst inhibiting other possible categorizations. The likelihood and ease with which a single categorization comes to dominate is influenced by interactions between bottom-up perceptual cues, current context, and top-down stored representations. We suggest that having spontaneously extracted bottom-up perceptual cues of emotional expressions, gender, and race, the ability of our perceivers to categorize happy and angry emotions is then mediated by the activation of social categories and the subsequent top-down influence of intergroup bias.

The current findings have important implications for how previous findings on social category modulation of emotion categorization should be interpreted. Where previous research has found a happy face advantage for female targets but not male targets, it might be because most perceivers in the sample were female (Aguado, et al., 2009; Bijlstra, et al., 2010; Craig, et al., 2017a; Craig & Lipp, 2018b, Expt. 1a & Expt. 2; Craig & Lipp, 2017b; Craig, et al., 2017b; Lipp et al., 2015a; Lipp, et al., 2015b). Indeed, there is evidence to suggest a happy face advantage for both female and male targets in several studies with more balanced gender ratios (Craig & Lipp, 2018b; Hugenberg & Sczesny, 2006; Lindeberg et al., 2019a; Lipp et al., 2015a). Similarly, where previous research found a happy face advantage for White targets but not Black targets, or indeed an angry advantage for

Black male targets, it might be because most perceivers in the sample were White or White females respectively (Bijlstra et al., 2010; Craig & Lipp, 2018b; Craig et al., 2012; Hugenberg & Bodenhausen, 2004; Hugenberg, 2005; Lipp et al., 2015b). Based on the current data, it seems likely that samples of perceivers that were either race balanced or predominantly Black would be more likely to find a happy face advantage for Black targets.

Conclusion

The current findings suggest emotion categorization is influenced by dynamic contextually sensitive intergroup interactions. In so doing, it underlines the importance of carefully considering potential interactions between the social categories of perceivers and targets both when designing and interpreting research on social judgement. Such considerations not only constrain the generality of findings but can also influence their theoretical interpretation (Simons et al., 2017).

Table 2. Table of limitations and suggestions for future research

Description of limitation	Suggestion for future research
Participants in these experiments were younger adults from the UK and the USA, whose race was White or Black; this is not a representative sample of the general population.	Future research should examine whether people from different racial identities, particularly people of mixed racial identity, and people from cultural environments with greater or lesser racial diversity might exhibit different patterns of response.
While we used a far larger number of face identities and more social categories than is typical of research in this area, we still only used targets from four social categories and did not control many aspects of the target stimuli to ensure equivalence across target categories.	Future research should use more diverse social categories and more diverse stimuli within these categories (e.g., naturalistic ambient images). It should also control for perceived category prototypicality, emotional prototypicality, attractiveness, and age, which could influence responses if confounded with category membership.
While we found consistent evidence of social category modulation of happy face categorization across the seven experiments, social category modulation of angry face categorization was more mixed; we only found an angry face advantage in errors in Expt. 1b, 2b, and 4.	The current findings are in keeping with previous research in this area, such that the happy face advantage appears more robust across experiments than does the angry face advantage (see Table 1). Given the variability in the angry face advantage we see across experiments, despite using identical stimuli, it is possible that the presence or absence of an angry face advantage might be driven by participant individual differences. Future research should attempt to determine whether individual differences in gender/race attitudes or beliefs might impact the likelihood of finding an angry face advantage.

As is typical in the literature, we only used happy and angry facial expressions.	Given evidence that different emotional expressions can produce different patterns of emotion response (e.g., Bijlstra et al., 2010), future research should examine whether similar patterns of response occur when happy and angry faces are paired with either neutral faces or other negative emotions (e.g., fear, disgust, sadness).
The current research appears to provide support for the dynamic interactive theory of person construal. However, caution should be applied when drawing this post hoc conclusion, as this was not the aim of the current research.	Future research should endeavor to directly establish whether predictions derived from dynamic interactive theory might further elucidate social category modulation of emotion categorization. This should be done both experimentally and through theoretical synthesis of previously published evidence.

References

Aguado, L., García-Gutierrez, A., & Serrano-Pedraza, I. (2009). Symmetrical interaction of sex and expression in face classification tasks. *Perception & Psychophysics, 71*(1), 9-25.

An, J., & Kwak, H. (2019). Gender and racial diversity in commercial brands' advertising images on social media. Paper presented at the *International Conference on Social Informatics,* 79-94.

Anwyl-Irvine, A., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. (2018). Gorillas in our midst: Gorilla. sc. *Behavior Research Methods,*

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2014). Fitting linear mixed-effects models using lme4. *arXiv Preprint arXiv:1406.5823,*

Beaupré, M. G., & Hess, U. (2006). An ingroup advantage for confidence in emotion recognition judgments: The moderating effect of familiarity with the expressions of outgroup members. *Personality and Social Psychology Bulletin, 32*(1), 16-26.

Becker, D. V., Kenrick, D. T., Neuberg, S. L., Blackwell, K. C., & Smith, D. M. (2007). The confounded nature of angry men and happy women. *Journal of Personality and Social Psychology, 92*(2), 179.

Bijlstra, G., Holland, R. W., & Wigboldus, D. H. J. (2010). The social face of emotion recognition: Evaluations versus stereotypes. *Journal of Experimental Social Psychology, 46*(4), 657-663.

Billings, L. S., Harrison, D. W., & Alden, J. D. (1993). Age differences among women in the functional asymmetry for bias in facial affect perception. *Bulletin of the Psychonomic Society, 31*(4), 317-320.

Brauer, M., & Curtin, J. J. (2018). Linear mixed-effects models and the analysis of nonindependent data: A unified framework to analyze categorical and continuous independent variables that vary within-subjects and/or within-items. *Psychological Methods, 23*(3), 389.

Brewer, M. B. (1988). A dual process model of impression formation. In R. S. J. Wyer, & T. K. Srull (Eds.), *Advances in social cognition* (pp. 1-36). Erlbaum. 10.1037/0022-3514.56.1.5

Chapell, M. S. (1997). Frequency of public smiling across the life span. *Perceptual and Motor Skills, 85*(3_suppl), 1326.

Craig, B. M., Koch, S., & Lipp, O. V. (2017a). The influence of social category cues on the happy categorisation advantage depends on expression valence. *Cognition and Emotion, 31*(7), 1493-1501.

Craig, B. M., & Lipp, O. V. (2017). The influence of facial sex cues on emotional expression categorization is not fixed. *Emotion, 17*(1), 28.

Craig, B. M., & Lipp, O. V. (2018a). The influence of multiple social categories on emotion perception. *Journal of Experimental Social Psychology, 75*, 27-35.

Craig, B. M., Mallan, K. M., & Lipp, O. V. (2012). The effect of poser race on the happy categorization advantage depends on stimulus type, set size, and presentation duration. *Emotion, 12*(6), 1303.

Craig, B. M., Zhang, J., & Lipp, O. V. (2017b). Facial race and sex cues have a comparable influence on emotion recognition in Chinese and Australian participants. *Attention, Perception, & Psychophysics, 79*(7), 2212-2223.

Craig, B. M., & Lipp, O. V. (2018b). Facial age cues and emotional expression interact asymmetrically: age cues moderate emotion categorisation. *Cognition and Emotion, 32*(2), 350-362.

Crisp, R. J., Hewstone, M., & Rubin, M. (2001). Does multiple categorization reduce intergroup bias? *Personality and Social Psychology Bulletin, 27*(1), 76-89.

Degner, J., & Wentura, D. (2010). Automatic prejudice in childhood and early adolescence. *Journal of Personality and Social Psychology, 98*(3), 356.

Devine, P. G. (1989). Stereotypes and prejudice: Their automatic and controlled components. *Journal of Personality and Social Psychology, 56*, 5-18. 10.1037/0022-3514.56.1.5

Dovidio, J. F., & Gaertner, S. L. (2010). Intergroup bias.

Eagly, A. H., Mladinic, A., & Otto, S. (1991). Are women evaluated more favorably than men?: An analysis of attitudes, beliefs, and emotions. *Psychology of Women Quarterly, 15*(2), 203-216.

Elfenbein, H. A., & Ambady, N. (2003a). Universals and cultural differences in recognizing emotions. *Current Directions in Psychological Science, 12*(5), 159-164.

Elfenbein, H. A., & Ambady, N. (2003b). When familiarity breeds accuracy: cultural exposure and facial emotion recognition. *Journal of Personality and Social Psychology, 85*(2), 276.

Ellison, J. W., & Massaro, D. W. (1997). Featural evaluation, integration, and judgment of facial affect. *Journal of Experimental Psychology: Human Perception and Performance, 23*(1), 213.

Feyereisen, P., Malet, C., & Martin, Y. (1986). Is the faster processing of expressions of happiness modality-specific? *Aspects of face processing* (pp. 349-355). Springer.

Fiske, S. T., & Neuberg, S. L. (1990). A continuum model of impression formation from category based to individuating processes: Influences of information and motivation on attention and interpretation. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (pp. 1-74). Academic Press.

Freeman, J. B., & Ambady, N. (2011). A dynamic interactive theory of person construal. *Psychological Review, 118*(2), 247.

Friesen, J. P., Kawakami, K., Vingilis-Jaremko, L., Caprara, R., Sidhu, D. M., Williams, A., Hugenberg, K., Rodríguez-Bailón, R., Cañadas, E., & Niedenthal, P. (2019). Perceiving happiness in an intergroup context: The role of race and attention to the eyes in differentiating between true and false smiles. *Journal of Personality and Social Psychology, 116*(3), 375.

Gaertner, S. L., Dovidio, J. F., Anastasio, P. A., Bachman, B. A., & Rust, M. C. (1993). The common ingroup identity model: Recategorization and the reduction of intergroup bias. *European Review of Social Psychology, 4*(1), 1-26.

Hewstone, M., Rubin, M., & Willis, H. (2002). Intergroup bias. *Annual Review of Psychology, 53*(1), 575-604.

Hugdahl, K., Iversen, P. M., & Johnsen, B. H. (1993). Laterality for facial expressions: does the sex of the subject interact with the sex of the stimulus face? *Cortex, 29*(2), 325-331.

Hugenberg, K. (2005). Social categorization and the perception of facial affect: target race moderates the response latency advantage for happy faces. *Emotion, 5*(3), 267.

Hugenberg, K., & Bodenhausen, G. V. (2004). Ambiguity in social categorization: The role of prejudice and facial affect in race categorization. *Psychological Science, 15*(5), 342-345.

Hugenberg, K., & Sczesny, S. (2006). On wonderful women and seeing smiles: Social categorization moderates the happy face response latency advantage. *Social Cognition, 24*(5), 516-539.

Kawakami, K., Friesen, J. P., & Fang, X. (2022). Perceiving ingroup and outgroup faces within and across nations. *British Journal of Psychology,*

Kazak, A. E. (2018). Journal article reporting standards.

Kwak, H., & An, J. (2016). Revealing the hidden patterns of news photos: Analysis of millions of news photos through gdelt and deep learning-based vision apis. Paper presented at the *Tenth International AAAI Conference on Web and Social Media,*

LaFrance, M., Hecht, M. A., & Paluck, E. L. (2003). The contingent smile: a meta-analysis of sex differences in smiling. *Psychological Bulletin, 129*(2), 305.

Lehr, D. J., Bergum, B. O., & Standing, T. E. (1966). Response latency as a function of stimulus affect and presentation order. *Perceptual and Motor Skills, 23*(3_suppl), 1111-1116.

Leppänen, J.,M., & Hietanen, J. K. (2003). Affect and face perception: odors modulate the recognition advantage of happy faces. *Emotion, 3*(4), 315.

Leppänen, J.,M., & Hietanen, J. K. (2004). Positive facial expressions are recognized faster than negative facial expressions, but why? *Psychological Research, 69*(1-2), 22-29.

Lindeberg, S., Craig, B. M., & Lipp, O. V. (2019). You look pretty happy: Attractiveness moderates emotion perception. *Emotion, 19*(6), 1070.

Lipp, O. V., Craig, B. M., & Dat, M. C. (2015a). A happy face advantage with male caucasian faces: It depends on the company you keep. *Social Psychological and Personality Science, 6*(1), 109-115.

Lipp, O. V., Karnadewi, F., Craig, B. M., & Cronin, S. L. (2015b). Stimulus set size modulates the sexâ€“emotion interaction in face categorization. *Attention, Perception, & Psychophysics, 77*(4), 1285-1294.

Ma, D. S., Correll, J., & Wittenbrink, B. (2015). The Chicago face database: A free stimulus set of faces and norming data. *Behavior Research Methods, 47*(4), 1122-1135.

Martin, D. (2022, *Evidence that multiple mechanisms drive social category modulation of emotion categorization. OSF Data repository.* osf.io/jh4zp

Martin, D., & Macrae, C. N. (2007). A face with a cue: Exploring the inevitability of person categorization. *European Journal of Social Psychology, 37*(5), 806-816.

Martin, D., Slessor, G., Allen, R., Phillips, L. H., & Darling, S. (2012). Processing orientation and emotion recognition. *Emotion, 12*(1), 39.

Martin, D., Swainson, R., Slessor, G., Hutchison, J., Marosi, D., & Cunningham, S. J. (2015). The simultaneous extraction of multiple social categories from unfamiliar faces. *Journal of Experimental Social Psychology, 60*, 51-58.

McDuff, D., Kodra, E., Kaliouby, R. e., & LaFrance, M. (2017). A large-scale analysis of sex differences in facial expressions. *PloS One, 12*(4), e0173942.

Meissner, C. A., & Brigham, J. C. (2001). Thirty years of investigating the own-race bias in memory for faces: A meta-analytic review. *Psychology, Public Policy, and Law, 7*(1), 3.

Nosek, B. A., Banaji, M. R., & Greenwald, A. G. (2002). Harvesting implicit group attitudes and beliefs from a demonstration web site. *Group Dynamics: Theory, Research, and Practice, 6*(1), 101.

Rodgers, S., Kenix, L. J., & Thorson, E. (2007). Stereotypical portrayals of emotionality in news photos. *Mass Communication & Society, 10*(1), 119-138.

Schug, J., Alt, N. P., & Klauer, K. C. (2015). Gendered race prototypes: Evidence for the non-prototypicality of Asian men and Black women. *Journal of Experimental Social Psychology, 56*, 121-125.

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2016). False-positive psychology: undisclosed flexibility in data collection and analysis allows presenting anything as significant.

Simons, D. J., Shoda, Y., & Lindsay, D. S. (2017). Constraints on generality (COG): A proposed addition to all empirical papers. *Perspectives on Psychological Science, 12*(6), 1123-1128.

Stalans, L., & Wedding, D. (1985). Superiority of the left hemisphere in the recognition of emotional faces. *International Journal of Neuroscience, 25*(3-4), 219-223.

Stenberg, G., Wiking, S., & Dahl, M. (1998). Judging words at face value: Interference in a word processing task reveals automatic processing of affective facial expressions. *Cognition & Emotion, 12*(6), 755-782.

Szumilas, M. (2010). Explaining odds ratios. *Journal of the Canadian Academy of Child and Adolescent Psychiatry = Journal De L'Academie Canadienne De Psychiatrie De L'Enfant Et De L'Adolescent, 19*(3), 227-229. ccap19_3p227 [pii]

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.

Tajfel, H., & Turner, J. C. (1979). An integrative theory of intergroup conflict. In W. G. Austin, & S. Worchel (Eds.), *The Social Psychology of Intergroup Relations* (pp. 33). Brooks-Cole.

Team, R. C. (2021). No title. *R: A Language and Environment for Statistical Computing.R Foundation for Statistical Computing, Vienna, Austria.2012,* Turner, J. C., & Reynolds, K. J. (1987). A self-categorization theory. *Rediscovering the Social Group: A Self-Categorization Theory,*

Vingilis-Jaremko, L., Kawakami, K., & Friesen, J. P. (2020). Other-Groups Bias Effects: Recognizing Majority and Minority Outgroup Faces. *Social Psychological and Personality Science, 11*(7), 908-916.

Zebrowitz, L. A., Kikuchi, M., & Fellous, J. (2010). Facial resemblance to emotions: group differences, impression effects, and race stereotypes. *Journal of Personality and Social Psychology, 98*(2), 175.

Supplementary Table 1. Expt. 1a output for the converged RT model:

lmer (RT ~ 1 + Perceiver Sex * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |Participants) + (1|item))

Effect	Variance	Estimate	*SE*	*df*	*t*	*p*
Fixed Effects						
(Intercept)		511.07	7.13	102.15	71.72	<.001***
PSex		-41.44	13.95	93.98	-2.97	.004*
TSex		.18	3.62	115.55	.05	.960
TEmotion		-21.67	4.31	135.96	-5.03	<.001***
TRace		6.44	3.62	115.58	1.78	.078
PSex*TSex		-4.51	4.22	10939.32	-1.07	.285
PSex*TEmotion		-6.44	6.30	94.39	-1.02	.309
TSex*TEmotion		1.28	7.24	115.56	1.42	.158
PSex*TRace		1.66	4.22	10942.28	.39	.695
TSex*TRace		17.65	7.24	115.55	2.44	.016*
TEmotion*TRace		-22.64	7.24	115.59	-3.13	.002**
PSex*TSex*TEmotion		-17.87	8.45	10937.46	-2.12	.034*
PSex*TSex*TRace		-3.74	8.45	10938.57	-.44	.658
PSex*TEmotion*TRace		2.01	8.45	10938.70	.24	.812
TSex*TEmotion*TRace		12.30	14.48	115.55	.85	.398
PSex*TSex*TEmotion*TRace		-24.18	16.89	10937.78	-1.43	.152
Random Effects						
Item (Intercept)	276					
Subject (Intercept)	4560					
TEmotion	523					
Residual	12514					

Supplementary Table 2. Expt. 1a output for the converged Error model:

glmer (Errors ~ 1 + Perceiver Sex * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |Participant) + (1|item))

Effect	Variance	Estimate	*SE*	*t*	*p*
Fixed Effects					
(Intercept)		-3.01	.09	-31.72	<.001***
PSex		-.19	.17	-1.10	.271
TSex		.22	.10	2.07	.039*
TEmotion		-.16	.12	-1.34	.180
TRace		.21	.10	2.03	.042*
PSex*TSex		.04	.15	.28	.779
PSex*TEmotion		-.32	.18	-1.84	.066
TSex*TEmotion		.35	.21	1.68	.093
PSex*TRace		.03	.15	.20	.841
TSex*TRace		.07	.21	.36	.722
TEmotion*TRace		-.74	.21	-3.55	<.001***
PSex*TSex*TEmotion		-.90	.31	-2.92	.003**
PSex*TSex*TRace		.24	.31	.77	.443
PSex*TEmotion*TRace		.67	.31	2.18	.030*
TSex*TEmotion*TRace		.02	.42	.05	.963
PSex*TSex*TEmotion*TRace		-.13	.61	-.22	.827
Random Effects					
Item (Intercept)	.16				
Subject (Intercept)	.52				
TEmotion	.14				

Supplementary Table 3. Expt. 1b output for the converged RT model:

lmer (RT ~ 1 + Perceiver Sex * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |Participants) + (1|item))

Effect	Variance	Estimate	*SE*	*df*	*t*	*p*
Fixed Effects						
(Intercept)		561.71	8.49	100.54	66.20	<.001***
PSex		12.39	16.68	93.94	.74	.459
TSex		2.00	3.73	115.11	.54	.593
TEmotion		-18.80	4.51	145.52	-4.17	<.001***
TRace		8.45	3.73	115.11	2.26	.026*
PSex*TSex		-3.66	4.01	11122.72	-.91	.361
PSex*TEmotion		7.46	6.47	93.92	1.15	.252
TSex*TEmotion		15.44	7.47	115.11	2.07	.041*
PSex*TRace		1.30	4.01	11123.50	.32	.746
TSex*TRace		15.87	7.47	115.11	2.13	.036*
TEmotion*TRace		-23.31	7.47	115.12	-3.12	.002**
PSex*TSex*TEmotion		-17.80	8.03	11122.25	-2.22	.027*
PSex*TSex*TRace		3.83	8.03	11121.99	.48	.634
PSex*TEmotion*TRace		-12.02	8.03	11121.58	-1.50	.134
TSex*TEmotion*TRace		25.55	14.93	115.11	1.71	.090
PSex*TSex*TEmotion*TRace		.89	16.06	11122.61	.06	.956
Random Effects						
Item (Intercept)	317					
Subject (Intercept)	6578					
TEmotion	618					
Residual	11504					

Supplementary Table 4. Expt. 1b output for the converged Error model:

glmer (Errors ~ 1 + Perceiver Sex * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |Participant) + (1|item))

Effect	Variance	Estimate	*SE*	*t*	*p*
Fixed Effects					
(Intercept)		-3.26	.09	-37.83	<.001***
PSex		-.03	.14	-.19	.853
TSex		-.02	.12	-.16	.874
TEmotion		-.11	.13	-.84	.400
TRace		.14	.12	1.18	.237
PSex*TSex		-.46	.18	-2.59	.010*
PSex*TEmotion		-.08	.19	-.42	.673
TSex*TEmotion		.37	.23	1.58	.115
PSex*TRace		-.13	.18	-.74	.457
TSex*TRace		.01	.23	.04	.972
TEmotion*TRace		-.96	.23	-4.13	<.001***
PSex*TSex*TEmotion		-.94	.35	-2.66	.008**
PSex*TSex*TRace		.24	.35	.68	.496
PSex*TEmotion*TRace		-.72	.35	-2.05	.041*
TSex*TEmotion*TRace		-.24	.46	-.51	.611
PSex*TSex*TEmotion*TRace		.43	.71	.61	.540
Random Effects					
Item (Intercept)	.17				
Subject (Intercept)	.29				
TEmotion	.08				

Supplementary Table 5. Expt. 2a output for the converged RT model:

lmer (RT ~ 1 + Perceiver Sex * Perceiver Race * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |Participant) + (1|item))

Effect	Variance	Estimate	*SE*	*df*	*t*	*p*
Fixed Effects						
(Intercept)		563.02	6.44	209.35	87.36	<.001***
PSex		9.28	12.52	187.89	.74	.459
PRace		-5.20	12.52	187.89	-.42	.678
TSex		1.74	3.40	115.80	.51	.609
TEmotion		-27.36	3.95	178.58	-6.92	<.001***
TRace		8.61	3.40	115.81	2.51	.013*
PSex*PRace		23.01	25.04	187.89	.92	.359
PSex*TSex		-4.43	2.93	22064.82	-1.52	.130
PRace*TSex		-.18	2.93	22062.52	-.06	.950
PSex*TEmotion		-7.51	4.98	186.81	-1.51	.133
PRace*TEmotion		12.13	4.98	186.78	2.43	.016*
TSex*TEmotion		8.78	6.81	115.81	1.29	.200
PSex*TRace		1.67	2.93	22064.74	.55	.568
PRace*TRace		-.54	2.93	22062.49	-.19	.855
TSex*TRace		12.61	6.81	115.80	1.85	.067
TEmotion*TRace		-14.15	6.81	115.81	-2.08	.040*
PSex*PRace*TSex		2.36	5.86	22062.29	.40	.687
PSex*PRace*TEmotion		3.45	9.95	186.77	.35	.729
PSex*TSex*TEmotion		-21.83	5.86	22061.95	-3.72	<.001***
PRace*TSex*TEmotion		8.86	5.86	22059.61	1.51	.131
PSex*PRace*TRace		-.85	5.86	22062.04	-.14	.884
PSex*TSex*TRace		3.38	5.86	22063.83	.57	.564
PRace*TSex*TRace		6.40	5.86	22061.63	1.09	.275
PSex*TEmotion*TRace		-3.98	5.86	22063.84	-.69	.497
PRace*TEmotion*TRace		-15.83	5.86	22061.66	-2.70	.007**
TSex*TEmotion*TRace		19.74	13.62	115.81	1.45	.150
PSex*PRace*TSex*TEmotion		-9.34	11.71	22059.38	-.79	.425
PSex*PRace*TSex*TRace		24.58	11.71	22061.31	2.10	.036*
PSex*PRace*TEmotion*TRace		-23.75	11.71	22061.15	-2.03	.043*
PSex*TSex*TEmotion*TRace		14.86	11.71	22062.83	1.27	.205
PRace*TSex*TEmotion*TRace		13.78	11.71	22060.56	1.18	.239
PSex*PRace*TSex*TEmotion*TRace		-29.15	23.43	22060.26	-1.25	.213
Random Effects						
Item (Intercept)	302					
Subject (Intercept)	7418					
TEmotion	776					
Residual	12076					

Supplementary Table 6. Expt. 2a output for the converged Error model:

glmer (Errors ~ 1 + Perceiver Sex * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |Participant) + (1|item))

Effect	Variance	Estimate	*SE*	*t*	*p*
Fixed Effects					
(Intercept)		-3.20	.07	-44.19	<.001***
PSex		.02	.12	.17	.862
PRace		-.07	.12	-.57	.568
TSex		.08	.09	.90	.369
TEmotion		-.30	.11	-2.71	.007**
TRace		.10	.09	1.15	.252
PSex*PRace		-.30	.24	-1.23	.220
PSex*TSex		-.06	.12	-.54	.589
PRace*TSex		-.06	.12	-.55	.579
PSex*TEmotion		-.22	.16	-1.39	.165
PRace*TEmotion		.05	.16	.30	.763
TSex*TEmotion		.42	.18	2.30	.022*
PSex*TRace		-.04	.12	-.33	.745
PRace*TRace		-.08	.12	-.73	.465
TSex*TRace		.09	.18	.49	.624
TEmotion*TRace		-.74	.18	-4.08	<.001***
PSex*PRace*TSex		-.54	.23	-2.33	.020*
PSex*PRace*TEmotion		.14	.31	.45	.652
PSex*TSex*TEmotion		-.76	.23	-3.27	.001**
PRace*TSex*TEmotion		-.19	.23	-.81	.417
PSex*PRace*TRace		-.03	.23	-.11	.911
PSex*TSex*TRace		-.39	.23	-1.69	.091
PRace*TSex*TRace		-.40	.23	-1.74	.081
PSex*TEmotion*TRace		-.54	.23	-2.32	.021*
PRace*TEmotion*TRace		-.50	.23	-2.14	.032*
TSex*TEmotion*TRace		.06	.36	.18	.861
PSex*PRace*TSex*TEmotion		-.08	.46	-.16	.870
PSex*PRace*TSex*TRace		.09	.46	.20	.843
PSex*PRace*TEmotion*TRace		.40	.46	.87	.384
PSex*TSex*TEmotion*TRace		-.12	.46	-.27	.789
PRace*TSex*TEmotion*TRace		-.61	.46	-1.32	.186
PSex*PRace*TSex*TEmotion*TRace		.15	.92	.17	.867
Random Effects					
Item (Intercept)	.15				
Subject (Intercept)	.50				
TEmotion	.43				

Supplementary Table 7. Expt. 2b output for the converged RT model:

lmer (RT ~ 1 + Perceiver Sex * Perceiver Race * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |Participant) + (1|item))

Effect	Variance	Estimate	*SE*	*df*	*t*	*p*
Fixed Effects						
(Intercept)		570.30	4.86	453.29	117.35	<.001***
PSex		16.54	9.25	388.58	1.79	.074
PRace		-6.51	9.25	388.58	-.70	.482
TSex		2.09	3.16	117.83	.66	.510
TEmotion		-24.74	3.43	159.82	-7.21	<.001***
TRace		9.16	3.16	117.83	2.90	.004**
PSex*PRace		18.75	18.50	388.58	1.01	.311
PSex*TSex		-1.42	2.07	44700.11	-.69	.492
PRace*TSex		1.70	2.07	44699.02	.82	.411
PSex*TEmotion		-9.48	3.38	385.64	-2.80	.005**
PRace*TEmotion		7.23	3.38	385.61	2.14	.033*
TSex*TEmotion		13.35	6.32	117.83	2.11	.037*
PSex*TRace		.45	2.07	44702.02	.22	.826
PRace*TRace		3.01	2.07	44701.06	1.46	.145
TSex*TRace		14.51	6.32	117.82	2.30	.023*
TEmotion*TRace		-15.11	6.32	117.83	-2.39	.018*
PSex*PRace*TSex		7.32	4.14	44699.34	1.77	.077
PSex*PRace*TEmotion		3.70	6.77	385.62	.55	.585
PSex*TSex*TEmotion		-24.75	4.14	44693.08	-5.98	<.001***
PRace*TSex*TEmotion		.50	4.14	44692.13	.12	.903
PSex*PRace*TRace		-1.63	4.14	44701.24	-.39	.694
PSex*TSex*TRace		3.92	4.14	44694.61	.95	.343
PRace*TSex*TRace		2.61	4.14	44693.66	.63	.528
PSex*TEmotion*TRace		-6.38	4.14	44693.33	-1.54	.123
PRace*TEmotion*TRace		-18.64	4.14	44692.37	-4.51	<.001***
TSex*TEmotion*TRace		14.98	12.64	117.82	1.19	.238
PSex*PRace*TSex*TEmotion		-6.43	8.27	44692.37	-.78	.437
PSex*PRace*TSex*TRace		15.14	8.27	44693.99	1.83	.067
PSex*PRace*TEmotion*TRace		-4.47	8.27	44692.55	-.54	.589
PSex*TSex*TEmotion*TRace		1.91	8.27	44693.83	.23	.818
PRace*TSex*TEmotion*TRace		8.04	8.27	44692.73	.97	.331
PSex*PRace*TSex*TEmotion*TRace		-17.94	16.54	44693.09	-1.08	.278
Random Effects						
Item (Intercept)	285					
Participant (Intercept)	8299					
TEmotion	702					
Residual	12162					

Supplementary Table 8. Expt. 2b output for the converged Error model:

glmer (Errors ~ 1 + Perceiver Sex * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |Participant) + (1|item))

Effect	Variance	Estimate	*SE*	*t*	*p*
Fixed Effects					
(Intercept)		-2.96	.07	-41.83	<.001***
PSex		-.25	.13	-2.00	.046
PRace		-.22	.13	-1.71	.087
TSex		.07	.07	.98	.329
TEmotion		-.05	.09	-.50	.614
TRace		.16	.07	2.15	.032*
PSex*PRace		.14	.25	.56	.579
PSex*TSex		.07	.10	.63	.530
PRace*TSex		-.03	.10	-.31	.759
PSex*TEmotion		.02	.13	.17	.862
PRace*TEmotion		.17	.13	1.29	.198
TSex*TEmotion		.42	.15	2.79	.005**
PSex*TRace		.07	.10	.65	.519
PRace*TRace		.01	.10	.06	.955
TSex*TRace		.11	.15	.71	.476
TEmotion*TRace		-.73	.15	-4.88	<.001***
PSex*PRace*TSex		.17	.21	.83	.408
PSex*PRace*TEmotion		.16	.26	.61	.544
PSex*TSex*TEmotion		-.84	.21	-4.02	<.001***
PRace*TSex*TEmotion		-.42	.21	-2.02	.043*
PSex*PRace*TRace		.13	.21	.64	.526
PSex*TSex*TRace		.16	.21	.79	.432
PRace*TSex*TRace		-.07	.21	-.33	.739
PSex*TEmotion*TRace		-.42	.21	-2.02	.044*
PRace*TEmotion*TRace		-.83	.21	-3.96	<.001***
TSex*TEmotion*TRace		-.06	.30	-.19	.852
PSex*PRace*TSex*TEmotion		.10	.42	.24	.814
PSex*PRace*TSex*TRace		.33	.42	.78	.436
PSex*PRace*TEmotion*TRace		-.42	.42	-.99	.320
PSex*TSex*TEmotion*TRace		.71	.42	1.71	.088
PRace*TSex*TEmotion*TRace		.13	.42	.31	.754
PSex*PRace*TSex*TEmotion*TRace		-.04	.83	-.05	.958
Random Effects					
Item (Intercept)	.09				
Participant (Intercept)	.64				
TEmotion	.23				

Supplementary Table 9. Expt. 3a output for the converged RT model:

lmer (RT ~ 1 + Perceiver Sex * Perceiver Race * Target Sex * Target Race * Target Emotion + (1 + Target Emotion|Participant) + (1|item))

Effect	Variance	Estimate	*SE*	*df*	*t*	*p*
Fixed Effects						
(Intercept)		578.72	6.50	225.23	89.08	<.001***
PSex		-15.79	12.49	195.71	-1.26	.208
PRace		-33.23	12.49	195.71	-2.66	.008**
TSex		9.53	3.89	114.02	2.45	.016*
TEmotion		-23.25	4.18	164.46	-5.56	<.001***
TRace		2.39	3.80	127.49	.63	.531
PSex*PRace		28.62	24.99	195.71	1.15	.253
PSex*TSex		3.88	3.10	22862.00	1.25	.211
PRace*TSex		.69	3.11	22864.50	.22	.825
PSex*TEmotion		.53	4.62	194.68	.12	.908
PRace*TEmotion		9.08	4.62	194.71	1.96	.051
TSex*TEmotion		3.94	7.58	128.82	.52	.604
PSex*TRace		-2.48	3.11	22886.73	-.80	.424
PRace*TRace		5.75	3.11	22889.03	1.85	.064
TSex*TRace		23.92	7.59	127.47	3.15	.002**
TEmotion*TRace		7.57	7.57	129.58	1.00	.319
PSex*PRace*TSex		-3.53	6.21	22862.56	-.57	.569
PSex*PRace*TEmotion		-4.48	9.24	194.69	-.49	.628
PSex*TSex*TEmotion		3.90	6.21	22882.66	.63	.530
PRace*TSex*TEmotion		-6.31	6.21	22885.38	-1.02	.310
PSex*PRace*TRace		-22.74	6.21	22887.57	-3.66	<.001***
PSex*TSex*TRace		10.58	6.21	22880.06	1.70	.089
PRace*TSex*TRace		-32.08	6.21	22882.33	-5.17	<.001***
PSex*TEmotion*TRace		.22	6.21	22893.46	.04	.972
PRace*TEmotion*TRace		6.52	6.21	22895.91	1.05	.294
TSex*TEmotion*TRace		18.29	15.14	129.88	1.21	.229
PSex*PRace*TSex*TEmotion		23.06	12.42	22882.95	1.86	.063
PSex*PRace*TSex*TRace		-3.83	12.42	22880.74	-.31	.758
PSex*PRace*TEmotion*TRace		-13.54	12.42	22894.35	-1.09	.276
PSex*TSex*TEmotion*TRace		14.33	12.42	22879.70	1.15	.249
PRace*TSex*TEmotion*TRace		.97	12.42	22882.30	.08	.938
PSex*PRace*TSex*TEmotion*TRace		-27.14	24.84	22880.44	-1.09	.275
Random Effects						
Item (Intercept)	407					
Participant (Intercept)	7683					
TEmotion	584					
Residual	14060					

Supplementary Table 10. Expt. 3a output for the converged Error model:

glmer (Errors ~ 1 + Perceiver Sex * Perceiver Race * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |Participants) + (1|item))

Effect	Variance	Estimate	*SE*	*t*	*p*
Fixed Effects					
(Intercept)		-3.24	.08	-42.85	<.001***
PSex		.31	.13	2.40	.017 *
PRace		-.15	.13	-1.16	.244
TSex		.13	.09	1.46	.145
TEmotion		-.16	.11	-1.55	.121
TRace		.04	.09	.47	.636
PSex*PRace		.02	.26	.08	.938
PSex*TSex		-.07	.11	-.65	.516
PRace*TSex		.05	.11	.42	.675
PSex*TEmotion		-.08	.14	-.58	.560
PRace*TEmotion		.09	.14	.66	.511
TSex*TEmotion		.13	.18	.73	.465
PSex*TRace		-.12	.11	-1.05	.293
PRace*TRace		.13	.11	1.17	.243
TSex*TRace		.32	.18	1.76	.078
TEmotion*TRace		.23	.18	1.29	.199
PSex*PRace*TSex		.31	.23	1.37	.171
PSex*PRace*TEmotion		.41	.28	1.48	.139
PSex*TSex*TEmotion		-.07	.23	-.30	.763
PRace*TSex*TEmotion		.34	.23	1.50	.133
PSex*PRace*TRace		-.10	.23	-.43	.665
PSex*TSex*TRace		.15	.23	.67	.501
PRace*TSex*TRace		.05	.23	.22	.825
PSex*TEmotion*TRace		-.15	.23	-.67	.502
PRace*TEmotion*TRace		-.23	.23	-1.00	.317
TSex*TEmotion*TRace		.43	.36	1.19	.235
PSex*PRace*TSex*TEmotion		.05	.46	.12	.904
PSex*PRace*TSex*TRace		-.48	.46	-1.06	.288
PSex*PRace*TEmotion*TRace		.11	.46	.25	.804
PSex*TSex*TEmotion*TRace		.03	.46	.06	.953
PRace*TSex*TEmotion*TRace		.62	.46	1.37	.171
PSex*PRace*TSex*TEmotion*TRace		.29	.91	.32	.753
Random Effects					
Item (Intercept)	.16				
Participant (Intercept)	.61				
TEmotion	.24				

Supplementary Table 11. Expt. 3b output for the converged RT model:

lmer (RT ~ 1 + Perceiver Sex * Perceiver Race * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |Participant) + (1|item))

Effect	Variance	Estimate	*SE*	*df*	*t*	*p*
Fixed Effects						
(Intercept)		571.92	7.51	201	76.13	<.001***
PSex		4.02	14.73	186	2.72	.007**
PRace		-42.15	14.73	186	-2.86	.005**
TSex		4.00	4.49	235	.89	.374
TRace		12.26	4.17	214	2.94	.004**
TEmotion		-24.81	4.00	197	-6.20	<.001***
PSex*PRace		-38.04	29.47	186	-1.29	.198
PSex*TSex		-2.27	6.79	179	-.33	.739
PRace*TSex		8.74	6.79	179	1.29	.200
PSex*TRace		3.97	5.91	183	.67	.502
PRace*TRace		-13.35	5.91	183	-2.26	.025*
TSex*TRace		25.40	6.55	117	3.88	<.001***
PSex*TEmotion		1.95	5.43	176	.36	.720
PRace*TEmotion		-.72	5.43	176	-.13	.894
TSex*TEmotion		1.47	6.55	117	.22	.823
TEmotion*TRace		11.26	6.55	116	1.72	.088
PSex*PRace*TSex		-.81	13.59	179	-.06	.953
PSex*PRace*TRace		3.08	11.82	183	.26	.795
PSex*TSex*TRace		-9.58	5.80	21126	-1.65	.099
PRace*TSex*TRace		-17.89	5.80	21127	-3.09	.002**
PSex*PRace*TEmotion		17.16	1.87	176	1.58	.116
PSex*TSex*TEmotion		-4.35	5.80	21138	-.75	.453
PRace*TSex*TEmotion		-11.42	5.80	21140	-1.97	.049*
PSex*TEmotion*TRace		-6.75	5.80	21142	-1.16	.244
PRace*TEmotion*TRace		1.35	5.80	21144	.23	.816
TSex*TEmotion*TRace		17.95	13.11	116	1.37	.174
PSex*PRace*TSex*TRace		22.26	11.59	21126	1.92	.055
PSex*PRace*TSex*TEmotion		5.52	11.59	21139	.48	.634
PSex*PRace*TEmotion*TRace		-6.40	11.59	21143	-.55	.581
PSex*TSex*TEmotion*TRace		-26.90	11.58	21106	-2.32	.020*
PRace*TSex*TEmotion*TRace		8.77	11.58	21108	.76	.449
PSex*PRace*TSex*TEmotion*TRace		31.01	23.16	21107	1.34	.181
Random Effects						
Item (Intercept)	276					
Subject (Intercept)	10233					
TSex	1785					
TRace	1252					
TEmotion	996					
Residual	11381					

Supplementary Table 12. Expt. 3b output for the converged Error model:

glmer (Errors ~ 1 + Perceiver Sex * Perceiver Race * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |Participant) + (1|item))

Effect	Variance	Estimate	*SE*	*t*	*p*
Fixed Effects					
(Intercept)		-3.19	.09	-33.69	<.001***
PSex		.12	.17	.71	.479
PRace		-.19	.17	-1.08	.280
TSex		.12	.10	1.16	.246
TRace		.02	.11	.19	.846
TEmotion		.06	.10	.60	.551
PSex*PRace		.06	.34	.17	.864
PSex*TSex		-.29	.13	-2.20	.028*
PRace*TSex		-.14	.13	-1.08	.281
PSex*TRace		-.14	.15	-.92	.360
PRace*TRace		.19	.15	1.26	.207
TSex*TRace		.19	.18	1.06	.290
PSex*TEmotion		-.01	.12	-.10	.923
PRace*TEmotion		.16	.12	1.25	.211
TSex*TEmotion		.31	.18	1.72	.085
TEmotion*TRace		.02	.18	.09	.931
PSex*PRace*TSex		-.10	.26	-.40	.692
PSex*PRace*TRace		-.35	.31	-1.13	.258
PSex*TSex*TRace		-.45	.22	-2.05	.041*
PRace*TSex*TRace		.32	.22	1.42	.155
PSex*PRace*TEmotion		-.15	.25	-.58	.559
PSex*TSex*TEmotion		.14	.22	.65	.515
PRace*TSex*TEmotion		.06	.22	.27	.787
PSex*TEmotion*TRace		-.52	.22	-2.36	.019*
PRace*TEmotion*TRace		.00	.22	.00	.998
TSex*TEmotion*TRace		.31	.36	.85	.394
PSex*PRace*TSex*TRace		1.04	.44	2.36	.018*
PSex*PRace*TSex*TEmotion		.77	.44	1.76	.078
PSex*PRace*TEmotion*TRace		-.39	.44	-.88	.381
PSex*TSex*TEmotion*TRace		.53	.44	1.21	.228
PRace*TSex*TEmotion*TRace		.42	.44	.95	.344
PSex*PRace*TSex*TEmotion*TRace		-.25	.88	-.28	.779
Random Effects					
Item (Intercept)	.16				
Subject (Intercept)	1.17				
TSex	.19				
TRace	.12				
TEmotion	.43				

Supplementary Table 13. Expt. 4 output for the converged RT model:

lmer (RT ~ 1 + Target Nationality * Perceiver Sex * Target Sex * Target Race * Target Emotion + (1 + Target Emotion |participant) + (1|item))

Effect	Variance	Estimate	*SE*	*df*	*t*	*p*
Fixed Effects						
(Intercept)		579.28	4.60	469	125.92	<.001***
TNationality		-7.46	8.63	390	-.87	.388
PSex		49.98	8.63	390	5.79	<.001***
TSex		.12	3.34	118	.04	.972
TRace		6.75	3.34	118	2.02	.046
TEmotion		-24.25	3.63	161	-6.68	<.001***
TNationality*PSex		-36.35	17.26	390	-2.11	.036
TNationality*TSex		4.77	2.01	45707	2.38	.017*
PSex*TSex		-.07	2.01	45707	-.03	.973
TNationality*TRace		1.47	2.01	45710	.73	.463
PSex*TRace		-2.76	2.01	45711	-1.37	.170
TSex*TRace		16.14	6.69	118	2.41	.017*
TNationality*TEmotion		-2.33	3.47	380	-.67	.502
PSex*TEmotion		-5.04	3.47	380	-1.45	.148
TSex*TEmotion		14.39	6.69	118	2.15	.033*
TRace*TEmotion		-28.65	6.69	118	-4.29	<.001***
TNationality*PSex*TSex		.81	4.01	45707	.20	.841
TNationality*PSex*TRace		-.35	4.01	45711	-.09	.931
TNationality*TSex*TRace		-7.49	4.01	45702	-1.87	.062
PSex*TSex*TRace		-.65	4.01	45703	-.16	.870
TNationality*PSex*TEmotion		2.34	6.95	380	.34	.737
TNationality*TSex*TEmotion		.95	4.01	45706	.24	.813
PSex*TSex*TEmotion		-25.37	4.01	45707	-6.32	<.001***
TNationality*TRace*TEmotion		-18.54	4.01	45703	-4.62	<.001***
PSex*TRace*TEmotion		-1.96	4.01	45704	-2.73	.006**
TSex*TRace*TEmotion		18.82	13.38	118	1.41	.162
TNationality*PSex*TSex*TRace		12.35	8.03	45702	1.54	.124
TNationality*PSex*TSex*TEmotion		-.21	8.03	45706	-.03	.979
TNationality*PSex*TRace*TEmotion		7.63	8.03	45704	.95	.342
TNationality*TSex*TRace*TEmotion		1.25	8.03	45705	.16	.876
PSex*TSex*TRace*TEmotion		-12.26	8.03	45706	-1.53	.127
TNationality*PSex*TSex*TRace*TEmotion		-37.48	16.05	45706	-2.34	.020*
Random Effects						
Item (Intercept)	326					
Subject (Intercept)	7270					
TEmotion	792					
Residual	11694					

Supplementary Table 14. Expt. 4 output for the converged Error model:

glmer (Errors ~ 1 + Target Nationality * Perceiver Sex* Target Sex * Target Race * Target Emotion +

(1 + Target Emotion |participant) + (1|item))

Effect	Variance	Estimate	*SE*	*t*	*p*
Fixed Effects					
(Intercept)		-3.32	.06	-52.58	<.001***
TNationality		-.05	.11	-.50	.615
PSex		-.12	.11	-1.15	.252
TSex		.05	.08	.66	.508
TEmotion		-.19	.09	-2.15	.032*
TRace		.24	.08	3.15	.002**
TNationality*PSex		.12	.21	.58	.560
TNationality*TSex		.16	.08	1.84	.066
PSex*TSex		-.18	.08	-2.13	.033*
TNationality*TEmotion		.01	.10	.10	.923
PSex*TEmotion		-.10	.10	-.98	.325
TSex*TEmotion		.35	.15	2.30	.022*
TNationality*TRace		-.04	.08	-.43	.667
PSex*TRace		-.10	.08	-1.14	.256
TSex*TRace		.22	.15	1.44	.149
TEmotion*TRace		-.98	.15	-6.39	<.001***
TNationality*PSex*TSex		-.15	.17	-.88	.378
TNationality*PSex*TEmotion		.13	.21	.62	.534
TNationality*TSex*TEmotion		.33	.17	1.93	.053
PSex*TSex*TEmotion		-.40	.17	-2.34	.019*
TNationality*PSex*TRace		.01	.17	.03	.974
TNationality*TSex*TRace		-.20	.17	-1.18	.239
PSex*TSex*TRace		.36	.17	2.11	.035*
TNationality*TEmotion*TRace		-.68	.17	-4.01	<.001***
PSex*TEmotion*TRace		-.41	.17	-2.44	.015*
TSex*TEmotion*TRace		.20	.31	.65	.518
TNationality*PSex*TSex*TEmotion		.08	.34	.24	.814
TNationality*PSex*TSex*TRace		.14	.34	.43	.671
TNationality*PSex*TEmotion*TRace		.31	.34	.93	.354
TNationality*TSex*TEmotion*TRace		-.22	.34	-.66	.509
PSex*TSex*TEmotion*TRace		.09	.34	.27	.791
TNationality*PSex*TSex*TEmotion*TRace		.06	.67	.09	.928
Random Effects					
Item (Intercept)	.13				
Subject (Intercept)	.81				
TEmotion	.27				