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Ensemble Perception of Emotion: Incidental Effects of Social Identity

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Abstract

Research in vision science suggests that people possess a perceptual mechanism – ensemble perception - which enables them to rapidly identify the characteristics of groups (e.g., emotion, sex-ratio, race-ratio). This work examined whether ensemble perceptions of groups are driven by the characteristics of group members whose behavior is most likely to impact the perceiver. Specifically, we predicted that more self-relevant group members would be weighted more heavily in ensemble perceptions than less self-relevant group members. Study 1 (*n* = 83) found that young adult participants' ensemble perceptions of emotion were biased in favor of more self-relevant (younger adult) group members' emotional expressions, compared to less self-relevant (older adult) group members' emotional expressions, and that these ensemble perceptions informed judgments of belonging in the group. Study 2 recruited older (*n* = 94) and younger (*n* = 97) adult participants and again found a general pattern of bias in favor of more self-relevant (younger adult) group members' emotional expressions in ensemble perceptions of emotion and that these ensemble perceptions informed evaluations of belonging in the group. Finally, Study 3 (*n* = 193) and Study 4 (*n* = 152) directly manipulated the relevance of older and younger adult group members and found that the extent of bias in ensemble perceptions of emotion depended on whether younger or older adults were made more self-relevant. Results suggest that incidental cues of social identity can bias ensemble perceptions of emotion and influence downstream judgments of belonging.

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ABSTRACT

Research in vision science suggests that people possess a perceptual mechanism – ensemble perception - which enables them to rapidly identify the characteristics of groups (e.g., emotion, sex-ratio, race-ratio). This work examined whether ensemble perceptions of groups are driven by the characteristics of group members whose behavior is most likely to impact the perceiver. Specifically, we predicted that more self-relevant group members would be weighted more heavily in ensemble perceptions than less self-relevant group members. Study 1 (n = 83) found that young adult participants' ensemble perceptions of emotion were biased in favor of more self-relevant (younger adult) group members' emotional expressions, compared to less self-relevant (older adult) group members' emotional expressions, and that these ensemble perceptions informed judgments of belonging in the group. Study 2 recruited older (n = 94) and younger (n = 97) adult participants and again found a general pattern of bias in favor of more self-relevant (younger adult) group members' emotional expressions in ensemble perceptions of emotion and that these ensemble perceptions informed evaluations of belonging in the group. Finally, Study 3 (n = 193) and Study 4 (n = 152) directly manipulated the relevance of older and younger adult group members and found that the extent of bias in ensemble perceptions of emotion depended on whether younger or older adults were made more self-relevant. Results suggest that incidental cues of social identity can bias ensemble perceptions of emotion and influence downstream judgments of belonging.

Keywords: ensemble perception, emotion, facial expression, belonging

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Chapter One

Human evolution, from the earliest hunter-gatherer bands to today's more complex social structures, has been marked by our participation in social groups. Indeed, many scientists have argued that the human necessity for living in groups compels people to learn about—and adapt to—the characteristics of social groups (Phillips et al., 2014). For example, rapidly identifying a small group as benevolent vs. hostile is likely to have important and immediate consequences for the individual—such as whether they enter or exit the group and how the group might treat them. Accordingly, it has been argued that rapid perceptions of group emotion (anger, joy) function, in part, to support perceiver well-being. Indeed, recent research in vision science suggests a perceptual mechanism—*ensemble perception*—that enables people to identify the characteristics of a group more rapidly than they can analyze each member of the group (Haberman & Whitney, 2007, 2009, 2012). In particular, it is now clear that ensemble perception operates on visible groups of people, enabling perceivers to rapidly identify group emotion (Haberman & Whitney, 2007, 2009) after a brief glance and before perceivers can closely analyze every *individual* in the group.

Ensemble perceptions of emotion may serve a social function, such as helping people anticipate the behavior of groups (Alt et al., 2019; Goodale et al., 2018; Sanchez-Burks & Huy, 2009; Whitney et al., 2014). However, ensemble perception is not specific to social characteristics or human groups, and was initially investigated for low-level

visual characteristics, such as texture, size, orientation, and color (Ariely, 2001; Cavanagh, 2001; Dakin & Watt, 1997; Webster et al., 2014). Accordingly, some have argued that the functions of ensemble perceptions are not specific to social groups (Chang & Gauthier, 2022). On the other hand, individual differences research suggests that a single, domain-general account of ensemble perception is unlikely to be accurate. For example, across 9 studies, participants' low-level ensemble perceptions were correlated, as were their high-level (e.g., facial emotion) ensemble perceptions, but low-level ensemble perceptions were not associated with high-level ensemble perceptions (Haberman et al., 2015). Thus, it is possible that ensemble perceptions of facial emotion (and other *social* cues) enable perceivers' to effectively navigate social life.

Extant evidence for the social function of ensemble perception is limited to the consequences of such perceptions. For example, ensemble perceptions of social groups inform perceivers about the extent to which that group offers affiliative opportunities (Alt et al., 2019; Goodale et al., 2018). However, the consequences of a psychological phenomenon (here, ensemble perception) do not necessarily reveal the function of that phenomenon. For example, eyesight enables people to see the characteristics of other people but that does not necessarily mean that the function of eyesight is social. Instead, we argue that if ensemble perception of emotion is driven (in part) by its function for navigating social groups, its *operating characteristics* should be sensitive to the social affordances of group members.

We examined this idea in the context of group members' social identities. Indeed, a great deal of evidence suggests that perceivers rapidly identify *individual's* gender, age, and race identities, and that such social categorization drives impression formation and

various intergroup biases (Brewer, 1988; Macrae & Bodenhausen, 2000; Fiske & Neuberg, 1990). We predicted that group members' social identities would spontaneously bias ensemble perceptions of facial emotion in a manner consistent with theorizing about social identity perception (e.g., Neel & Lasseter, 2019).

What is Ensemble Perception?

People constantly encounter more information in their visual worlds than they can actively attend to, encode, and remember. To compensate for these inherent processing limitations, humans possess mechanisms to extract meaningful information quickly and efficiently about the gist of their visual environment (Alvarez, 2011; Ariely, 2001; Chong & Treisman, 2003). By integrating similar bits of visual information and segmenting dissimilar bits of information, people are able to rapidly see features and objects. These processes of integration and segmentation operate as well on groups of objects (Haberman & Whitney, 2012; Elias & Sweeny, 2020; Wagemans et al., 2012). Specifically, the visual system appears to select stimuli in the environment that share perceptual properties and can consequently treat groups of stimuli as a perceptual "unit". That is, rather than sequentially analyzing each individual item within a group, people appear to compute *summary statistics* describing the emergent properties of the stimulus group (Alvarez, 2011; Phillips et al., 2014). For example, perceivers can identify the average facial emotion in a visible group after seeing that group for as little as 50ms (Haberman & Whitney, 2009).

Given the historical and contemporary necessity of effectively interacting with— and in— groups, several scientists have argued that ensemble perception may be critical for adaptive social functioning (Phillips et al., 2014; Sanchez-Burks & Huy, 2009;

Sweeny et al., 2013; Whitney et al., 2014). Rapidly extracting the emotion of a group may be particularly important for making inferences about the threats (e.g., facial anger) or opportunities for affiliation (e.g., facial joy) provided by a group (Alt et al., 2019; Goodale et al., 2018; Thornton et al., 2019). Thus, the degree to which people think a group provides affiliative opportunities may depend on ensemble perceptions of emotion—implicating a social-functional role for ensemble perception that we examine here.

Does Form Reflect Function in Ensemble Perception?

To the degree that a process—such as ensemble perception of emotion—is thought to be driven by a given "function", the operating characteristics of that process should reflect the function, so that form equals function. Ensemble perceptions of emotion, for example, may function to help people navigate the social world, in particular. If so, then the mechanisms responsible for producing ensemble perceptions should be sensitive to task-irrelevant factors that *are* relevant to perceivers' social lives. Thus, the operating characteristics of ensemble perception would reflect their presumable function (navigating group contexts). In the current studies, and as detailed further below, we examine whether the weighting of some group members over others in ensemble perception depends on the social identities of those group members.

The operating characteristics of face-based ensemble perceptions remain a matter of some debate. Early accounts suggested that ensemble perception is similar to "gist" perception, in that people form emergent perceptions of a group from a *coarse* visual analysis of the group as a whole (Ariely, 2001; Chong & Treisman, 2003; Parkes et al., 2001). Contemporary evidence is mixed, however, regarding whether ensemble

perception unfolds as a function of distributed attention across an entire stimulus set (Baek & Chong, 2020) or whether perceivers sample from a subset of items within a stimulus set to generate summary statistics for the whole group (Allik et al., 2013; Goldenberg et al., 2021; Maule & Franklin, 2016). The latter account (*selective summarization*) suggests that ensemble percepts may be differentially influenced by the most salient members of a group (Kanaya et al., 2018; Maule & Franklin, 2016). That is, rather than equally weighting the contributions of every individual within a group, perceivers may *sample* from a subset of individuals to form their ensemble percepts.

We reasoned that this "weighting" (or "sampling") of group members could be systematically biased to maximize utility to the social perceiver. This approach to identifying the function of social-cognitive processes has been applied broadly to the perception of individuals (Kenrick, 1994; McArthur & Baron, 1983; Zebrowitz & Montepare, 2013). Empirical findings based on this approach suggest that social perceptions prioritize those individuals who seem most likely to influence the perceiver's goals or outcomes (i.e., "relevant" individuals). For example, processes in attention, encoding, and retrieval appear to be biased to favor individuals most capable of helping or harming the self (powerful individuals; Dalmaso et al., 2014; Foulsham et al., 2010; Maner et al., 2008; Ratcliff et al., 2011; Weisbuch et al., 2017). Moreover, social targets believed to be highly relevant to one's wellbeing (e.g., threatening individuals) may elicit greater attention than those believed to be less relevant (Brown-Iannuzzi et al., 2014; Neuberg & Fiske, 1987; Trawalter et al., 2008). In general, then, perceivers prioritize visual processing of individuals who seem (subjectively) most likely to impact their well-being for better or for worse (i.e., they prioritize the most "relevant" individuals).

This "relevance" explanation was nicely elaborated by Neel and colleagues in a wide-ranging review of disparate social perception phenomena (Lassetter, Hehman, & Neel, 2021; Neel & Lassetter, 2019). From their perspective, appraisals of relevance result from an interaction among perceiver goals, situational cues, and target characteristics. Individuals capable of facilitating one's goals, hindering their goals, or both should be perceived as "relevant" and garner greater attention than those believe to neither facilitate nor hinder their goal pursuit. Accordingly, more (vs. less) relevant individuals should have a greater impact on perceivers' evaluations of social threat and opportunity. Although relevance appraisals may typically unfold as a function of this dynamic interaction, some cues may be associated with relevance across a majority of perceivers and a variety of social settings. For example, individuals perceived as being low in social status, power, or competence, such as older adults, may generally be regarded as irrelevant toward most chronic and situational goals (Neel & Lassetter, 2019), and may therefore have limited impact on perceivers.

This approach is built, in part, on ecological theories of perception (Gibson, 1979; McArthur & Baron, 1983) which emphasize that responses to stimuli depend on what those stimuli "offer" the perceiver, for better or worse (*affordances*). That is, perceivers develop (or inherit) perceptual sensitivity to ecological configurations that have direct implications for their well-being. As Neel and Lassetter (2019) note, affordances may depend on perceivers' *attunements*—individual or species-level sensitivity to certain configurations. Zebrowitz and Montepare (2013) explain:

> Attunements may be innate…Attunements also may be educated in a process of perceptual development that varies with perceivers' behavioral capabilities (men but not boys may be attuned to a woman's sexual availability), social goals

> (secular men but not priests may be attuned to a woman's sexual availability), or perceptual experiences (a lover but not a stranger may be attuned to a woman's sexual availability).

As illustrated by this quote, ecological approaches emphasize *chronic* attunements likely to be shared by a wide range of human perceivers. For example, perceivers exhibit strong consensus for many *meaningful* face judgments, including spontaneously expressed emotions, physical traits, such as attractiveness and facial maturity, and personality traits, including personality traits associated with power (Albright et al., 1997; Cunningham et al., 1995; Kenny et al., 1994; Matsumoto et al., 2009; Rule et al., 2010; Rule et al., 2013; Zebrowitz, Montepare, & Lee, 1993). Tests of ecological approaches focus on subtle changes to stimulus configurations, such as the configuration of facial anger, and what judgments of those facial configurations "afford". Indeed, in several studies (Hess et al., 2000; Knutson, 1996; Montepare & Dobish, 2003) subtle cues to facial joy caused perceivers to attribute trait warmth (or affiliative intent) to a person, suggesting perceptions of facial joy may afford affiliation to a perceiver.

Following these paradigms, the studies reported here manipulate the configuration of a social group (rather than an individual). The "configuration" was manipulated by pairing different facial emotions with different social identities within each visible group. If ensemble perceptions are biased toward the facial emotions of the most relevant social identities in a group, the implication is that the processes underlying ensemble perception are shaped by perceptions of social identity—consistent with the view that ensemble perception of facial emotion serves a social function. Studies 1 & 2 examine this account with respect to social identities broadly associated with greater relevance. Finally, Studies 3 & 4 provide direct evidence for the role of social identity relevance in ensemble

perceptions of emotion: in Study 3, we manipulated self-relevance via a learning paradigm in what might be the first manipulation of self-relevance in studies of social perception. In Study 4, we manipulated the social context in which ensemble perceptions occurred to increase the relevance of group members generally perceived as having lower relevance. In total, we surmised that ensemble perceptions of emotion would be *biased* by group characteristics that are not relevant to perceivers' task performance but are relevant to perceivers' ability to navigate social groups. In this way, we aimed to examine if the presumed social function of ensemble perception was reflected in the operating characteristics of ensemble perception.

Ensemble Perception: Emotion and Social Identity

We focused here on the biasing role of social identities in ensemble perception. We reasoned that visible cues to social identity drive perceivers' attention to individuals most likely to be (self) relevant. From a functional perspective, it is no wonder that people preferentially attend to, encode, and remember highly relevant individuals—cognitive processes should be biased toward those individuals most likely to influence one's well-being. Accordingly, ensemble perceptions may unintentionally focus on (or "sample") the characteristics of group members with social identities that hold the most relevance to the perceiver, thus biasing ensemble percepts toward those individuals. Further, these biased ensemble perceptions should inform self-relevant judgments of each visible group, such as the degree to which the group affords an opportunity for affiliation. For theoretical purposes detailed below, we tested our hypotheses in the context of ensemble perceptions of emotion.

Where prior work has focused on the extent to which perceivers draw *accurate* ensemble perceptions of race and gender in a small group (Phillips et al., 2018; Yang & Dunham, 2019), the current work focuses on how group members' social identities can bias ensemble perceptions on a *different* dimension—facial emotion. Facial emotions rapidly inform perceivers about social characteristics of adaptive importance (Marsh et al., 2005; Shariff & Tracy, 2011). For example, judgments about whether a person is a good candidate for affiliation depend on whether that person's face seems happy versus angry (Hess et al., 2000; Knutson, 1996; Montepare & Dobish, 2003). This relationship may be especially strong in small group contexts, where processes that forecast inclusion or exclusion are especially relevant.

Critically, there is also evidence that perceivers are sensitive to the interaction between social identity cues and facial emotion cues (Hugenberg, 2005; van der Schalk et al., 2011; Weisbuch & Ambady, 2008). This evidence regards perceptions of individuals whereas ensemble perceptions of groups requires "leveling up" the unit of analysis to a broader entity, where the components of that entity are individual faces. In this context, the perceptual interaction between facial cues to emotion and social identity may emerge at that broader level of analysis—by virtue of which group *components* (individual faces) are emphasized in ensemble percepts of emotion. We hypothesized that ensemble perceptions of emotion would be biased toward the facial expressions of group members whose emotions are most likely to influence perceiver's well-being, an outcome which depends on rapidly perceiving facial emotion *and* social identity. In summary, by examining how social identity cues bias ensemble perceptions of emotion, we can

examine how incidental processing of social identity cues bias ensemble perceptions of the average mental state (emotion) in a group.

We have argued that ensemble perceptions of emotion are weighted towards group members whose emotions are most likely to be self-relevant. Specifically, the emotions of some people (versus others) are likely to be more important to the well-being of a perceiver. Social identities may be more or less relevant for perceivers for several reasons, two of which we examine here.

The most intuitive reason that a specific social identity may be relevant is whether or not the perceiver shares an identity with the people they perceive. Ingroup bias may emerge, as it does in perceptions of individuals (Anastasi & Rhodes, 2006; Cross et al., 1971; Harrison & Hole, 2009; Kuefner et al., 2008; Meissner & Brigham, 2001; Rodin, 1987; Rule et al., 2007; Slone et al., 2000), such that ensemble perceptions are weighted toward the emotions of people who share a social identity with a perceiver. Yet it is equally plausible that certain social identities are more likely to influence all perceivers in a given culture or context. Often, intergroup effects in social perception depend more on the capabilities and social status of the persons perceived than on the match between perceiver and target social identity. For example, reflexive gaze-cuing (in which visual attention is automatically directed in the direction of a face's eye gaze) appears to depend on whether the social identity has higher or lower social status than one's own (Dalmaso et al., 2012, 2014; Weisbuch et al., 2017). Similar effects can be observed in other perceptual phenomena, such that social identities who are more capable of helping or harming the self are prioritized.

Self-relevance and age. In theory, ensemble perceptions could be biased by any visible social identity. In the current study, we focused on age (young versus old adult) as the social identity dimension. Age, along with race and gender, is one of the three social identity dimensions that (a) is associated with facial cues and that (b) broadly shapes social cognition. People (in most, not all, societies) tend to believe that younger adults have higher social status and power, are more competent, and have a greater capability to hurt or harm (i.e., are more "relevant") than older adults (Cuddy et al., 2005; Cuddy & Fiske, 2002; Heckhausen, Dixon, & Baltes, 1989; North & Fiske, 2015). In other words, older adults may generally be perceived as having low social value and be disregarded by perceivers (Neel & Lassetter, 2019; Rodin, 1987). There were several other reasons we focused on age identities in the current work. First, educational practices, mass media, and social media have increasingly highlighted the inequities faced by people with marginalized race- and gender-identities, so that participants may feel especially strong (internal or external) pressure to deliberately control their judgments of groups depicting marginalized race and gender identities. In contrast, participants are willing to report negative biases against older age identities, explicitly reporting their bias in ratings of liking and attraction (Ebner, 2008; He et al., 2021). Moreover, both younger and older adults may hold similar stereotypic beliefs and implicit bias toward older adults (Nosek, Banaji, & Greenwald, 2002). Thus, effects observed with age identities seemed more likely than race or gender identities to represent *general* processing operations associated with relevance appraisal. Finally, the association between age and relevance is largely pancultural, applying even to collectivist regions (Cuddy et al., 2005; North & Fiske,

2015)[1]. Thus, the relationship between age and relevance represents a reliable dimension for examining how social identity relevance impacts ensemble perception.

We acknowledge that we cannot *assume* age biases would generalize to other social identities. Instead, we "predict from" (Mook, 1982) a broad theory of social identity effects in ensemble perception to predict what "should" happen if the theory is accurate. We thus test our theory of social identity effects in ensemble perception in the context of age identities. Evidence in support of our theory (even if limited at present to age identities) should increase confidence in the theory.

Invisibility and threat. We expected group members' social identities to have an unintentional influence on perceivers' ensemble perceptions of emotion. However, our hypotheses were complicated by evidence that ensemble perceptions of emotion tend to be biased toward angry faces, a phenomenon referred to as *anger bias* (Mihalache et al., 2021). According to Neel and Lassetter's recent theory of social perception, social identities that are frequently relevant to perceivers should be prioritized in attention, memory, and judgment, but in threatening contexts cues to threat (like facial anger) may take precedence, thus reducing or eliminating these identity-driven effects on perception (Neel & Lassetter, 2019). Drawing from this account, we expected that social identity-based relevance would bias ensemble perceptions of group emotion but that this bias may be reduced or eliminated when the group was angry (on average, across group members). We tested this prediction by presenting study participants with three different types of groups: angry, happy, or ambivalent (i.e., both angry and happy). We reasoned that when

[1] For example, North & Fiske's (2015) meta-analysis found derogation of older adults *was* observed in East Asia.

perceiving happy groups, perceivers' ensemble perceptions would be biased towards the emotions of group members with more self-relevant social identities. In contrast, no such moderation may be observed in ensemble perceptions of angry crowds. Hypotheses for the ambivalent condition were more exploratory but it seemed possible that a muted pattern of social-identity moderation may occur when there are both threatening (angry) and affiliative (happy) faces.

Overview of Studies

One key consideration in this work regards participants' ability to identify emotion on individual faces. For example, older adult faces include wrinkles which can reduce recognition of any facial emotion (Hess et al., 2012). Before conducting the studies reported below, we thoroughly tested individual faces to equate the perceived emotions on young vs. older faces—thus, individual "young adult" faces were matched to individual "older adult" faces with respect to "objective" emotion and with respect to perceived emotion. Through these procedures, we aimed to minimize the contributions of age-based emotion biases/stereotypes in *person* perception and thus isolate *people* perception processes. In total, we hypothesized that ensemble perceptions would be biased by the self-relevance of group members' social identities, and that such ensemble perceptions would inform meaningful downstream judgments, such as evaluations of the affiliative opportunities presented by a group. We also examined (a) whether such effects are most pronounced in the *absence* of angry facial expressions and (b) whether such effects owe to the relevance of group members' social identities and/or shared social identity with group member.

Transparency and openness

For Studies 1-4 reported below, we follow *Journal Article Reporting Standards* (JARS; Kazak, 2018). We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study. All data and research materials are available upon request. Studies 1-3 were not pre-registered. Study 4 was pre-registered on AsPredicted.org.

Chapter Two: Study 1

In Study 1, young adult participants were asked to perceive visible groups that included both 4 younger adults (<35 years of age) and 4 older adults (>65 years of age) for 1000ms per group. Each participant perceived three types of groups. *Angry groups* included extremely angry faces and neutral faces. *Happy groups* included extremely happy faces and neutral faces. *Ambivalent groups* included moderately angry faces and moderately happy faces. After seeing a group briefly, participants estimated its average facial emotion on a scale from extremely angry to extremely happy. Importantly, in each visible group the young adult faces displayed systematically different emotions than the older adult faces, enabling us to calculate the degree to which participants ensemble perceptions were biased in favor of the younger faces (as hypothesized).

We predicted that ensemble perceptions would be biased toward emotions expressed in young (vs. older) adult faces. For example, a *group* of four happy faces and four neutral faces should be perceived as happier when the happy faces are young (and the neutral faces are older) than when the happy faces are older (and the neutral faces are young). Such a main effect may be moderated by an interaction with the facial emotion actually displayed by the group. Given evidence that contextual threats can eliminate the attentional advantage given to high-status face identities (Neel & Lassetter, 2019), the hypothesized effects of face age on ensemble perception may not emerge for perceptions of angry groups.

We test these predictions in Study 1, as well as several predictions regarding person-group "fit". That is, immediately after completing the ensemble perception of emotion task, participants completed the same task but made a different judgment: the degree to which they thought they would belong or "fit in" with the group. We expected participants to evaluate groups as more affiliative when the young adult faces displayed more positive (less negative) emotion than the older adult faces, as compared to when the older adult faces displayed more positive (less negative) emotion. Additionally, we expected participants with more pronounced age bias in their ensemble perceptions of emotion to have a corresponding bias in their affiliation evaluations (given that facial joy is regarded as an affiliative signal; Hess et al., 2000; Knutson, 1996; Montepare & Dobish, 2003).

We also collected individual difference measures in an effort to compare our theory and hypotheses to a simple ingroup bias, in which young adult participants preferentially attend to young adult faces *because* those faces share their age-identity.

Method

Participants and Setting

This study was run during the winter of 2021 at a private university in the American West. Data were collected during the final 6 weeks of the academic term, and sample size was determined by the number of sign-ups during the 6-week period. In total, we recruited 85 young adult participants. Two participants were excluded due to reported visual impairments hindering their ability to complete the ensemble perception task, resulting in a final sample size of 83 participants (65% women; 74% White, 12% multiracial, 9% Asian/Pacific Islander, 4% Hispanic/Latinx). The mean age of

participants was 19 (range: 18 – 26, *SD* = 1.62). A sensitivity power analysis using G*Power (Faul et al., 2007) based on an alpha level 0.05 and power of 80% revealed that this sample ($N = 83$) was sufficient to detect an effect size of $f = 0.24$ ($\eta_p^2 = 0.05$).

Materials

It was critical to ensure that perceptions of emotion on *individual faces* were not biased by the face's age. We therefore aimed to equate younger and older faces on both the objective emotion portrayed in the face (stimulus-driven emotion) and the subjective emotion perceived on each face (evaluated in a pretest). As detailed below, we used pretest ratings to create groups in which the emotional difference between the younger faces and older faces was held constant across trials. Ultimately, these procedures enabled us to create visible groups that were closely controlled with respect to facial emotion.

Phase 1: Generation of individual face stimuli

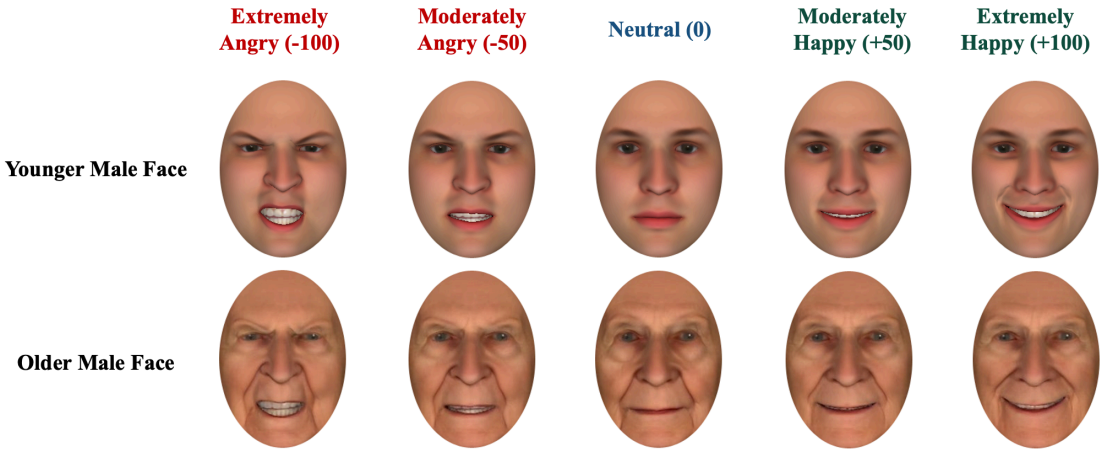
In Phase 1, we equated young and old faces on *objective* facial emotion. We created all faces using FaceGen (Blanz & Vetter, 1999; Singular Inversions; 2005). FaceGen is a generative statistical face modeler which uses parameters obtained from three-dimensional face scans to generate and manipulate realistic 3D human faces that can vary along numerous dimensions (e.g., age, race, gender). Thus, we used FaceGen's age parameters to generate 20 unique (10 male, 10 female) face identities for each age-group. Younger face models were created by setting age to 25, whereas older face models were created by setting the age to 65. On visual inspection, however, the age discrepancy between the younger and older adult faces was not as robust as desired. To address this issue, all older adult faces were manipulated to appear older using the FaceApp software

package (https://www.faceapp.com). These procedures yielded a total of 40 face models (20 older, 20 younger). All face models were White and cropped to remove the top of the head, ears, and chin.

Next, we created 5 emotional expressions (extremely angry, moderately angry, neutral, moderately happy, extremely happy) for each unique face model using FACSgen objective emotion parameters (Krumhuber et al., 2012; Roesch et al., 2011). FACSgen is a tool, developed at the Swiss Center of Affective Sciences, that supports the manipulation of emotional expressions of 3D faces using parameters from the Facial Action Coding System (Ekman & Friesen, 1978). All face models were generated in FaceGen and displayed a neutral emotional expression. These neutral expressions were then manipulated in FACSgen to vary in the extent to which they contained cues of anger or joy. Specifically, the extreme and moderate anger expressions were created (for each model) by moving the "anger" slider in FACSgen to 100% and 50%, respectively (in Figure 1, -100 and -50). Other sliders (e.g., happiness) were not used in creating angry expressions. The extreme and moderate happy expressions were created (for each model) by moving the "happy" slider in FACSgen to 100% and 50%, respectively (in Figure 1, +100 and +50). Other slides (e.g., anger) were not used in generating happy emotional expressions. Neutral expressions were not manipulated in any way using FACSgen. These procedures yielded 5 different emotion images for each of the 40 face models (N = 200 images).

Figure 1

Sample Emotion Expressions Generated in FACSgen



Note. Examples of each emotional expression (extremely angry, moderately angry, neutral, moderately happy, extremely happy) for one younger adult (top) and one older adult (bottom) face identity.

Phase 2: Pretest for facial emotion

As noted by other scientists (e.g., Johnson et al., 2012) face-manipulation software enables scientists to equate the stimulus-driven ("bottom-up") characteristics of different faces but in so doing, fails to equate individual faces for the *perceived* characteristics of different faces. For example, even when younger adult and older adult faces are equated on "objective" emotion characteristics, perceivers may see more of a given emotion on a younger adult's face than an older adult's face (or vice-versa). For the current work, it was critical to equate the perceived characteristics of *individual* faces so that any biases observed in ensemble perception could not be reduced to biases in perceptions of individual faces. To do so, we designed a pretest in which participants evaluated the emotion of each of the facial images we created.

Ninety-eight participants evaluated the emotion of each facial image on a 1 (extremely angry) to 9 (extremely happy) scale. Each participant evaluated 40 facial

images, one-by-one, so that each image was evaluated by between 17 and 21 participants. For each facial image, we then computed the average *perceived* emotion across raters. We then confirmed that individual young adult and individual older adult faces were reliably equated on perceived emotion for all five levels of emotion (see Appendix A). These ratings, together with the objective parameters, were used to generate well-controlled face groups.

Phase 3: Generation of face groups

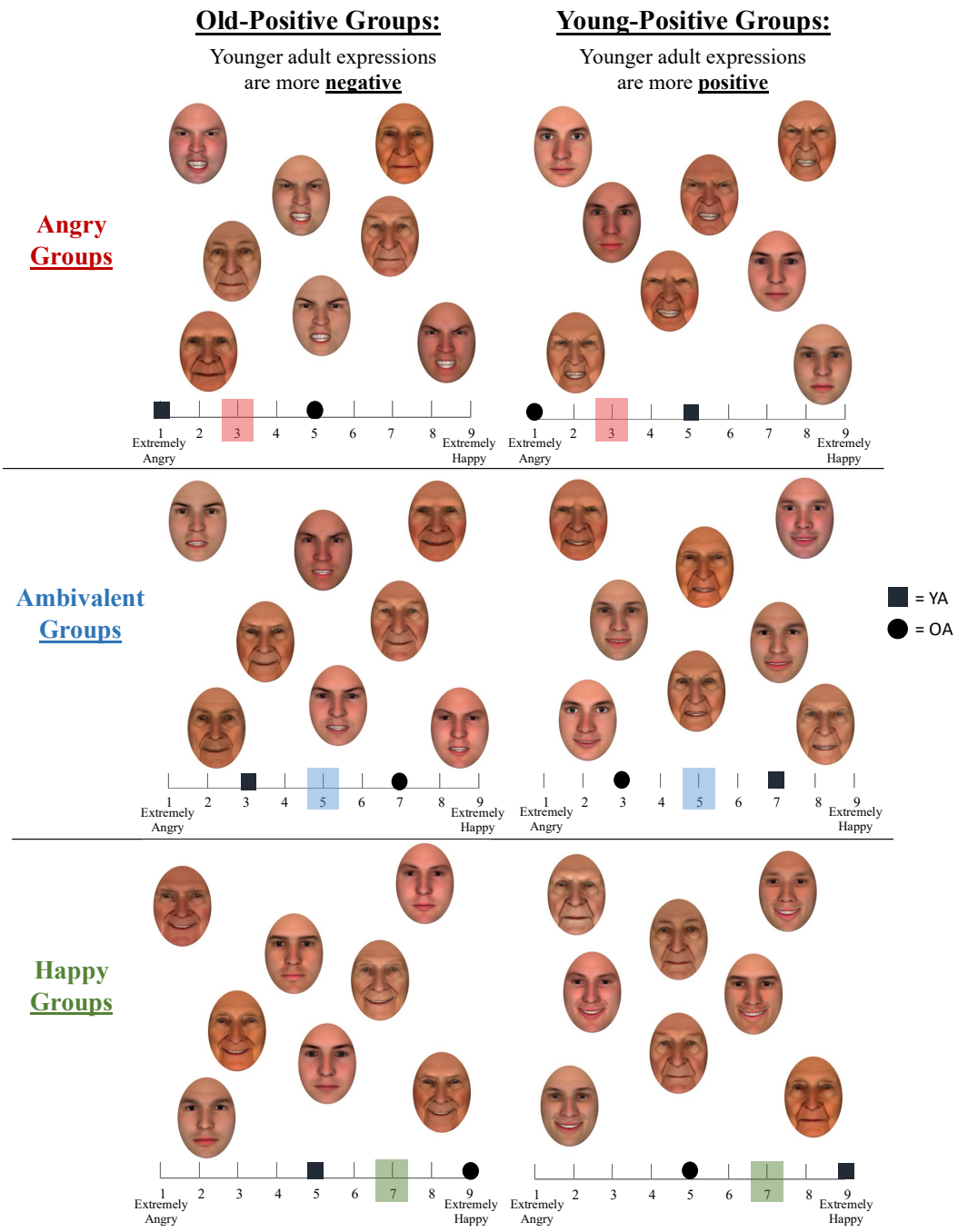
Pretest ratings were used to select individual faces for each visible group. We created 20 face groups for each cell in a 3 (overall group emotion: angry, ambivalent, happy) x 2 (age-bias: young-positive, old-positive) design. The *young-positive* condition included trials in which young adult faces were happier (or less angry) than older adult faces; the *old-positive* condition included trials in which older adult faces were happier (or less angry) than young adult faces. Regardless of condition, each face group included 8 individual faces (4 younger adult, 4 older adult). We thus manipulated the average emotion in the entire group (angry vs ambivalent vs happy) and whether the younger adult faces displayed more positive *or* more negative emotion than the older adult faces. All face groups were single gender, with an equal number of face groups consisting of men and of women.

Face groups were generated so that the *difference* in facial emotion between the younger and older adults was held constant across groups, for both objective and subjective facial emotion. We first aimed to equate young-positive and old-positive groups on objective emotion. For example, there were two types of "happy" group conditions. The old-positive condition included 4 older adult faces with +100 objective

facial emotion and 4 younger faces with “0” objective facial emotion. The young-positive condition included 4 younger faces with +100 objective facial emotion and 4 older adult faces with “0” objective facial emotion. Thus, the old-young emotion difference in these two types of happy groups was always 100 steps. The same 100 step difference was employed for ambivalent groups and angry groups. Thus, in the old-positive groups, the older adults expressed more positive/less negative emotion than the younger adults, and in the young-positive groups, the young adults expressed more positive/less negative emotion than the older adults (see Figure 2 below).

Figure 2

Sample Young-Positive and Old-Positive Groups for Each Group Emotion



Note. Sample groups for each 3 (overall group emotion: angry, ambivalent, happy) x 2 (age-bias: young-positive, old-positive) group type. YA refers to young adults and OA refers to older adults.

We then used the pretest data, in which all faces were evaluated on a 1 (extremely angry) to 9 (extremely happy) scale, to select faces for each visible group. As with objective parameters, we aimed to ensure that the subjective difference between older and younger facial emotions was held constant. In the young-positive conditions, the four young adult faces had an average subjective emotion rating that was approximately 2.35 scale points higher than the four older adult faces. In the old-positive conditions, the four older adult faces had an average subjective emotion rating that was approximately 2.35 scale points higher than the four younger adult faces (see Table 1). To generate cell means in Table 1, we computed—for each face group—the average pretest rating of the four young adult faces and the average pretest rating of the four older adult faces. We then aggregated these ratings within experimental condition (e.g., young-positive/angry), so standard deviations refer to variability across face groups.

Table 1

Pretest Subjective Emotion Ratings for Each Group Type

	Angry Groups	Ambivalent Groups	Happy Groups
Young-positive			
YA mean emotion rating	5.16 (.27)	6.62 (.23)	7.52 (.35)
OA mean emotion rating	2.81 (.27)	4.30 (.20)	5.20 (.38)
YA-OA Difference	**2.35**	**2.32**	**2.32**
Old-positive			
YA mean emotion rating	2.78 (.31)	4.04 (.28)	5.09 (.32)
OA mean emotion rating	5.23 (.41)	6.39 (.28)	7.39 (.28)
YA-OA Difference	**-2.45**	**-2.35**	**-2.30**

Note. Table of the pretested subjective ratings for younger (YA) and older (OA) adults for each group condition (i.e., age-bias x overall group emotion). In both the young-positive and old-positive condition, younger and older adult faces had an average pretested subjective emotion rating that differed by ~2.35 scale points.

Finally, and as described in Appendix A, we then confirmed that (a) angry groups (regardless of bias) displayed *subjectively* more negative affect than ambivalent groups

which in turn displayed subjectively more negative affect than happy groups; and (b) that controlling for individual face emotion ratings did not significantly influence the pattern of results reported in Studies 1-3.

Stimulus generation and pretesting thus provided several design features important to testing hypotheses. First, the average emotion expressed in a group was equivalent for old-positive groups and young-positive groups. Second, the emotions expressed on *individual* young-faces were matched to emotion expressed on individual older faces. Put differently, facial emotions were equally recognizable whether appearing on individual younger adult faces or individual older adult faces. Thus, if participants form ensemble perceptions that are more emotionally positive for young-positive than old-positive groups, this effect must be due to participants preferentially *weighting* the emotions of young group members relative to older group members (rather than simply being more sensitive to *individual* young vs. older faces).

Individual Difference Measures

Given the age of our sample (i.e., young adults), it is possible that biases in ensemble perceptions of emotion, and subsequent belongingness ratings, may partially reflect an *ingroup bias*. We thus included multiple exploratory measures to examine this possibility. We reasoned that if ingroup bias drives biased ensemble perceptions, then factors which increase ingroup bias should also increase bias in ensemble perception. Indeed, ingroup biases are rooted, in part, in (a) overlap between cognitive representations of self and group (Aron et al., 1992, 2013; Galinsky & Moskowitz, 2000), (b) needs for ingroup-belonging (Gómez et al., 2011; Greitemeyer, 2012; Hunter et al., 2017; Leary et al., 2013), and an absence of contact with the outgroup (Pettigrew &

Tropp, 2006). We used individual difference measures to examine each of these constructs. First, we assessed the degree to which participants included younger and older adults in their representations of themselves (Aron et al., 1992). Specifically, participants were asked to select from a set of increasingly overlapping circles from 1 (no overlap) to 7 (most overlap) that best represented how close they felt to older/younger adults in their life. Second, we assessed participants' self-reported belonging using the 10-item Need to Belong Scale (Leary et al., 2013). Participants responded on a 5-point Likert-type scale (1 = Not at all; 5 = Extremely) on items such as "I want other people to accept me" and "If other people don't seem to accept me, I don't let it bother me" (reverse-scored; $\alpha = .69$). Finally, to assess intergroup contact, participants were asked to indicate the frequency (0 = "Almost never"; 6 = "More than once a week") and quality (1 = "Very unfavorable"; 5 = "Very favorable") of contact with individuals over the age of 65 (Schwartz & Simmons, 2001).

Procedure

Participants were first directed to a Qualtrics survey to complete informed consent. Next, participants were instructed that they would complete a group perception task[2] using Inquisit 6. Participants were informed that they would first see a group of faces and then be asked to indicate the average emotion of the entire group on a scale ranging from 1 (extremely angry) to 9 (extremely happy). Groups were presented for 1000ms, immediately followed by the emotion rating scale until a key response was

[2] In Study 1, participants completed a social exclusion manipulation prior to the group perception task. Specifically, participants were randomly assigned to write about a time in which they had previously been included or excluded. The social exclusion manipulation was part of a separate project and in exploratory analyses we observed no main effects or interactions involving this variable ($ps > .05$) and we do not discuss it further.

recorded. Each group condition was randomly presented 20 times for a total of 120 trials. Following the group emotion ratings, participants again saw the same 120 groups presented in a random order and were asked to rate the extent to they would fit in with, or belong in, the entire group on a 1 (not at all) to 9 (extremely well) scale. Participants then completed the exploratory individual difference measures, along with demographic items. Participants then completed demographics and were debriefed and thanked for their participation. All experimental procedures and materials were reviewed and approved by the Institutional Review Board (IRB) at the researcher's university.

Results

Participants did not report difficulties following the procedure or completing the ensemble perception tasks. As described in detail below, we hypothesized and found evidence that young adult participants' ensemble perceptions were biased in favor of group members with more self-relevant social identities.

Emotion Ratings

Mean emotion ratings of each group type served as the dependent measure of interest. We excluded responses that seemed unlikely to reflect a genuine response so excluded responses rendered in less than 300ms or greater than 30s (15.2% of all trials; including these responses did not change the patterns of significance reported below).

We predicted that young adult participants would preferentially weight the emotional expressions of young adults relative to older adults in their ensemble perceptions of emotion. To test this, we conducted a 2 (age-bias: young-positive, old-positive) x 3 (overall group emotion: angry, ambivalent, happy) repeated-measures ANOVA on ratings of group emotion. There was a main effect of overall group emotion,

$F(2, 162) = 558.38$, $p < .001$, $\eta_p^2 = .87$. Angry groups ($M = 3.72$, $SD = 0.76$) were perceived as angrier than ambivalent groups ($M = 5.46$, $SD = 0.55$), $t(81) = -22.20$, $p < .001$, $d = -2.45$, 95% CI [-1.90, -1.59] and happy groups ($M = 6.22$, $SD = 0.48$), $t(81) = -26.86$ $p < .001$, $d = -2.97$, 95% CI [-2.68, -2.31]. Happy groups were perceived as happier, or less angry, than ambivalent groups, $t(81) = 14.21$, $p < .001$, $d = 1.57$, 95% CI [0.65, 0.86]. These main effects suggest that our manipulation of overall emotion was effective.

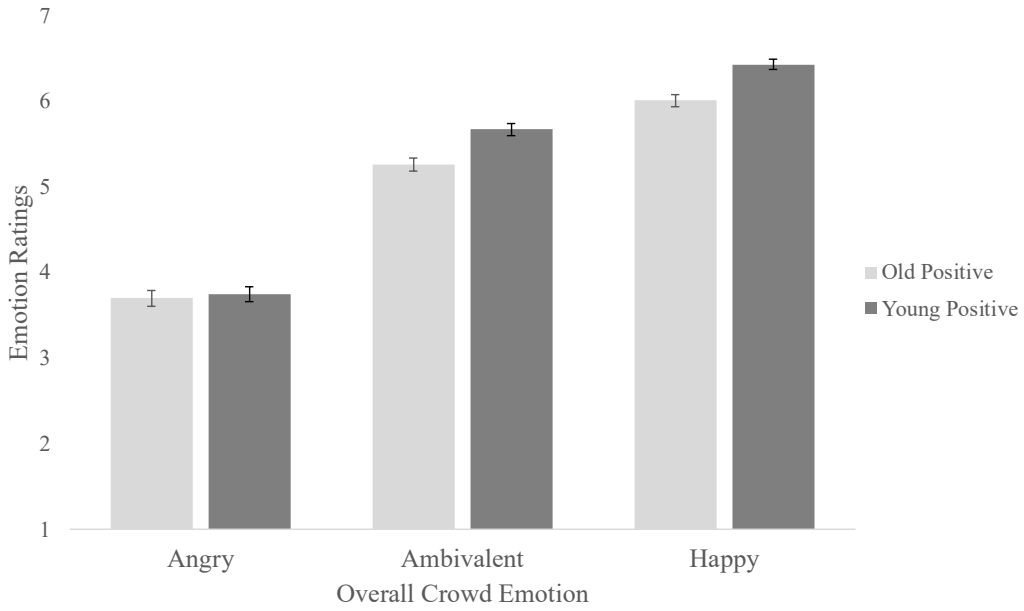
More importantly, and as predicted, we observed a main effect of age-bias, such that participants perceived more positive emotion in young-positive groups ($M = 5.30$, $SD = 0.49$) than in old-positive groups ($M = 4.99$, $SD = 0.55$), $F(1, 81) = 27.08$, $p < .001$, $\eta_p^2 = .25$. As a reminder, this effect was observed despite the fact that young-positive and old-positive groups were matched with respect to overall group emotion. Thus, we observed support for our main hypothesis.

Main effects, however, were qualified by a significant age-bias by overall group emotion interaction, $F(2, 162) = 10.16$, $p < .001$, $\eta_p^2 = .11$ (see Figure 3). This interaction is consistent with the view that ensemble perception effects driven by social identity relevance may be undermined by threatening contexts (cf. Neel & Lassetter, 2019). Participants perceived more positive emotion in young-positive happy groups ($M = 6.43$, $SD = 0.58$) than in old-positive happy groups ($M = 6.01$, $SD = 0.61$), $t(81) = 5.38$, $p < .001$, $d = 0.59$, 95% CI [0.26, 0.57]. Participants also perceived more positive emotion in young-positive ambivalent groups ($M = 5.67$, $SD = 0.63$) than in old-positive ambivalent groups ($M = 5.26$, $SD = 0.72$), $t(81) = 4.68$, $p < .001$, $d = 0.52$, 95% CI [0.23, 0.58]. However, participants did *not* perceive more positive emotion in young-positive angry

groups (M = 3.75, SD = 0.81) than in old-positive angry groups (M = 3.70, SD = 0.82), $t(81) = 0.73$, $p = .47$, $d = 0.08$, 95% CI [-0.08, 0.18]. Thus, our hypotheses were supported for happy and ambivalent groups—ensemble perceptions of emotion were biased to favor more self-relevant (young) social identities. The absence of such effects in angry groups is consistent with the view that "anger bias" may undermine incidental effects of social identity on ensemble perceptions of emotion.

Figure 3

Mean Emotion Ratings for Each Group Type



Note. Average emotion ratings for age-bias (old-positive vs young-positive) x overall group emotion (angry, ambivalent, happy) for Study 1. Error bars represent □ 1 SEM.

Belongingness Ratings

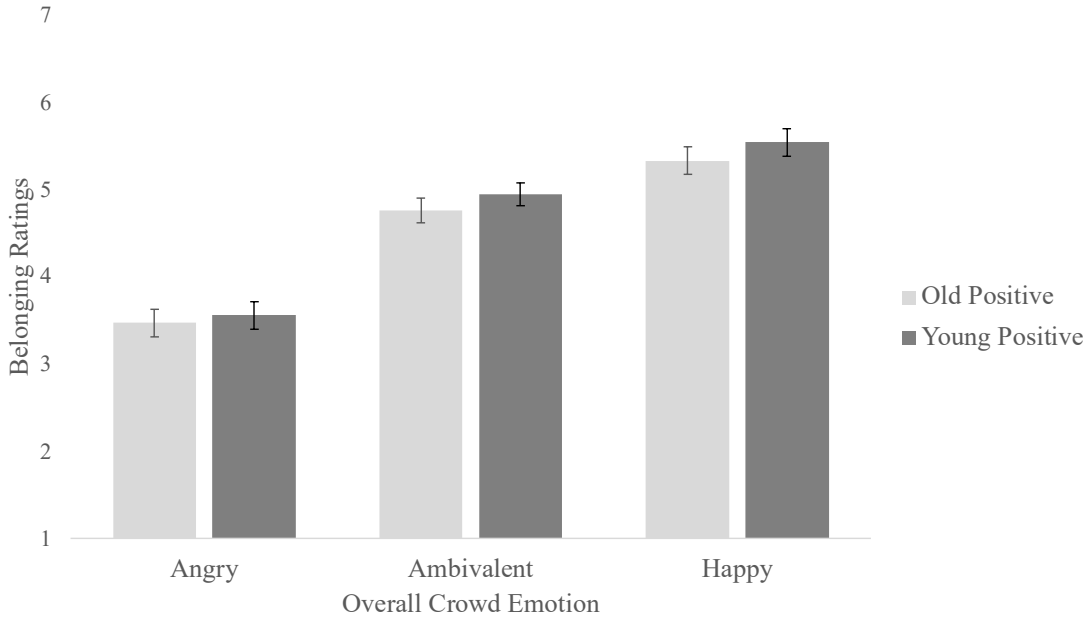
We also predicted that young adult participants would report greater belonging in young-positive groups than old-positive groups. To test this, we conducted a 2 (age-bias: young-positive, old-positive) x 3 (overall group emotion: angry, ambivalent, happy)

repeated-measures ANOVA on belongingness ratings. A main effect of overall group emotion emerged, $F(2, 160) = 106.05$, $p < .001$, $\eta_p^2 = .57$. Participants reported significantly more belonging with happy groups ($M = 5.44$, $SD = 1.40$) compared to ambivalent groups ($M = 4.86$, $SD = 1.15$), $t(81) = 5.80$, $p < .001$, $d = 0.64$, 95% CI [0.38, 0.78] and angry groups ($M = 3.52$, $SD = 1.41$), $t(81) = 10.54$, $p < .001$, $d = 1.16$, 95% CI [1.55, 2.28]. Participants also reported more belonging with ambivalent groups compared to angry groups, $t(81) = 12.02$, $p < .001$, $d = 1.33$, 95% CI [1.11, 1.55]. The statistically-large effect of overall group emotion supports an assumption in our design: that facial happiness in groups signals affiliative opportunity and that facial anger in groups signals threat or exclusion (the opposite of affiliation; DeWall et al., 2009; Fridlund & Russell, 2006; Knutson, 1996; Parkinson, 2005).

More importantly, and as predicted, there was a main effect of age-bias on belongingness ratings, $F(1, 80) = 5.21$, $p = .03$, $\eta_p^2 = .06$, such that participants reported greater belonging in young-positive groups ($M = 4.69$, $SD = 1.12$) than in old-positive groups ($M = 4.53$, $SD = 1.21$). There was no significant interaction between age-bias and overall group emotion on belongingness ratings, $F(2, 160) = 0.85$, $p = .429$, $\eta_p^2 = .01$ (see Figure 4). Thus, regardless of overall group emotion, young adult participants reported significantly greater belonging in groups in which more self-relevant (young) group members expressed more positive (less negative) emotion.

Figure 4

Mean Belongingness Ratings for Each Group Type



Note. Average belongingness ratings for age-bias (old-bias vs young-bias) x overall group emotion (angry, ambivalent, happy) for Study 1. Error bars represent ± 1 SEM.

Biased Ensemble Perception and Belongingness Ratings

Finally, we aimed to examine whether biased ensemble perceptions of emotion were predictive of biased belonging ratings. For each overall group emotion, we created a *biased ensemble perception* score by subtracting emotion ratings for old-positive groups from young-positive groups, and did this separately for happy, ambivalent, and angry groups. We also created a *biased belonging* score by subtracting belonging ratings for old-positive groups from young-positive groups, and did this separately for happy, ambivalent, and angry groups. Finally, we computed the correlation between the biased ensemble perception scores and the biased belonging scores. Ensemble perception bias significantly predicted belonging bias for both ambivalent (B = .41, p < .001, 95% CI [0.17, 0.65]) and happy groups (B = .26, p = .04, 95% CI [0.01, 0.50]). However, for

angry groups, ensemble perception bias did not significantly predict belonging bias (B = -.02, p = .90, 95% CI [-0.36, 0.32]). Thus, greater overweighting of younger expressions significantly predicted the extent to which participants reported greater belonging in young-positive groups than in old-positive groups (unless the group was angry on the whole).

Individual Differences in Ingroup Bias

Because participants were young adults, ensemble perception biases that favor young adults may simply reflect an ingroup bias. Distinguishing between social identity *relevance bias* and *ingroup bias* is a challenge with the Study 1 design, but if ingroup bias drives the above effects, factors which increase ingroup bias should also increase the observed effects on ensemble perception. Thus, we next examined whether self-group overlap, chronic need to belong, and intergroup contact were correlated with biased ensemble perception of emotion and biased belonging scores. All correlations were non-significant (ps > .20). These analyses indicate that factors related to ingroup bias were unrelated to social-identity bias in ensemble perceptions of emotion, suggesting that such bias is unlikely to derive from a simple ingroup bias. We examined this idea further in Study 2.

Discussion

In Study 1, participants' ensemble perceptions of emotion were biased toward the expressions of group members with more self-relevant social identities. Specifically, participants ensemble perceptions of emotions more closely matched the emotions *displayed* by young group members than the emotions displayed by older group members. For example, participants perceived more happiness in a group when the young

adult faces displayed happiness and old adults displayed neutrality (young-positive condition) than when the old adult faces displayed happiness and young adult faces displayed neutrality (old-positive condition). We observed these effects for visible groups that included happy facial expressions ("happy" and "ambivalent" groups) but not otherwise ("angry" groups). We assume that the absence of such effects reflect superseding effects of threat (cf. Neel & Lassetter, 2019).

Importantly, participants reported greater belonging in young-positive groups than old-positive groups. Correlations between biased ensemble perceptions and biased belonging judgments suggest that biased ensemble perceptions informed participants' judgments of belonging in each group. Put differently, the impact of social identity relevance on the operating characteristics of ensemble perception informed evaluations of "fit" or belonging with a group, as predicted by the functional approach.

Individual difference measures failed to moderate the results of Study 1. These measures were intended to address the idea that the hypothesized effects of social identity *relevance* are simply ingroup-bias effects. Individual differences in ingroup identity (self-age group overlap; age-based contact) and ingroup-belongingness needs did not inform the effects observed in Study 1. To more directly examine the alternative hypothesis in Study 2, we collected data from both young adults (as in Study 1) and older adults.

Chapter Three: Study 2

We aimed to replicate the findings from Study 1 by recruiting an equal number of younger and older adult participants. If the biases in ensemble perception observed in Study 1 were driven by the global self-relevance of group members' social identities, as we predicted, then both young *and* older adult participants should overweight the emotional expressions of young group members. However, if the effects observed in Study 1 are driven solely by shared social identities, then this bias should only emerge for younger adult participants. Finally, it was possible that two independent effects would emerge—one for social-identity relevance and one for shared social identity. Thus, Study 2 was a more robust test of relevance-driven bias in ensemble perception and allowed for an examination of the role of shared social identity.

Method

Participants and Setting

We aimed to recruit approximately 100 younger and 100 older adults for Study 2. In total, we recruited 199 participants through Prolific Academic in the Fall of 2021. Prolific allows researchers to prescreen participants using various demographic factors and participants are blind to prescreen criteria. Using Prolific's prescreen, we recruited participants between the ages of 18 and 30 (i.e., young adults) and 60 years of age or older (i.e., older adults) for Study 2. Participant age was also assessed via self-report at the end of the study and was used to verify the accuracy of participant age obtained in the

prescreen. To increase the number of older adults eligible for the study, we recruited participants from both the United States and United Kingdom. We excluded 5 participants due to self-reported visual impairments that hindered their ability to complete the group perception task and 3 participants due to technical issues with the group perception task (e.g., multiple key presses failed to register). This resulted in a final sample size of 191 participants (74.9% White; 71.7% women), with 97 young adults (M_{age} = 21.91, SD_{age} = 3.33) and 94 older adults (M_{age} = 64.89, SD_{age} = 4.99). The gender imbalance observed in this study was primarily driven by the younger adult sample, in which 84.5% identified as women (see Charalambides, 2021). A sensitivity power analysis using G*Power (Faul et al., 2007) based on an alpha level 0.05 and power of 80% revealed that this sample (N = 191) was sufficient to detect an effect size of f = 0.16 ($\eta_p^2 \approx 0.03$).

Materials and Procedure

Materials and procedures were largely identical to those used in Study 1. However, we made two key changes to the individual difference measures in Study 2. First, since our sample included both younger and older adult participants, we updated the intergroup contact measure to include frequency and quality of contact with *both* younger and older adults (as opposed to only older adults in Study 1; Schwartz & Simmons, 2001). Second, despite close controls for our age-based facial emotion expressions, it is possible that participants' *concepts* of happiness or anger are age-biased and thus generally attribute negative states to older adults (which would amplify the Study 1 effects). To address this possibility, we examined if individual differences in age-emotion stereotypes moderate the results of Study 2. Thus, we replaced the need to

belong (individual difference) measure used in Study 1 with a measure of age-gender stereotypes about expressions of anger and happiness (Fabes & Martin, 1991). Specifically, participants were asked to indicate the extent to which older adults, younger adults, men, and women, expressed, on average, anger and happiness using a 1 (almost never) to 7 (very often) scale. In general, participants did not have difficulties following the procedure or completing the ensemble perception tasks. All experimental procedures and materials were reviewed and approved by the Institutional Review Board (IRB) at the researcher's university.

Results

As described in detail below, we hypothesized and found evidence that both young and older adult participants' ensemble perceptions were biased in favor of group members with more self-relevant social identities.

Emotion Ratings

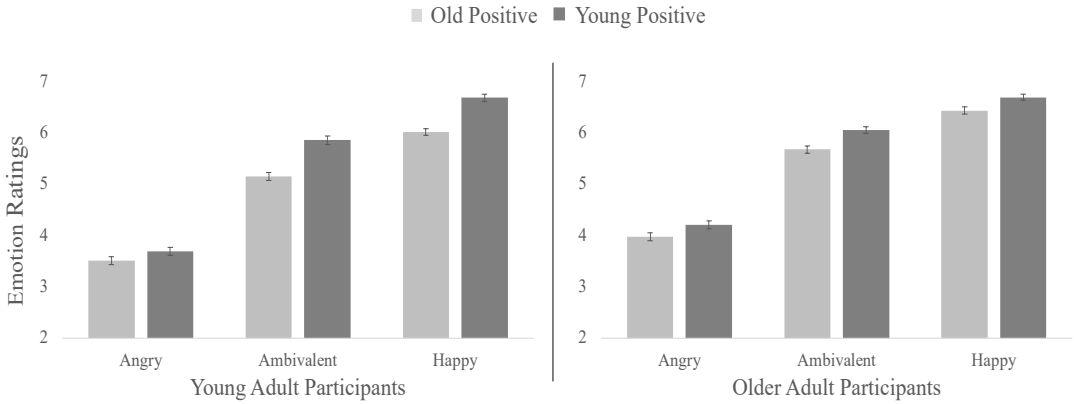
Mean emotion ratings of each group type served as the dependent measure of interest. As in Study 1, trials in which response times were under 300 ms or over 30 seconds were excluded from analyses (8.4% of all trials). Consistent with Study 1, we predicted that young adult participants would preferentially weight the emotional expressions of young adult group members relative to older adult group members. In addition, if these effects are driven by self-relevance, then older adult participants should also overweight the emotional expressions of young adult group members relative to older adult group members. To test this, we conducted a 2 (age-bias: young-positive, old-positive) x 2 (participant age-group: young adult, older adult) x 3 (overall group emotion: angry, ambivalent, happy) mixed model ANOVA on ratings of group emotion. As in

Study 1, there was a main effect of overall group emotion, $F(2, 374) = 1438.01$, $p < .001$, $\eta_p^2 = .89$. Angry groups ($M = 3.85$, $SD = 0.76$) were perceived as angrier than ambivalent groups ($M = 5.70$, $SD = 0.68$), $t(188) = -42.44$, $p < .001$, $d = -3.09$, 95% CI [-1.93, -1.76] and happy groups ($M = 6.47$, $SD = 0.59$), $t(188) = -41.66$, $p < .001$, $d = -3.03$, 95% CI [-2.74, -2.49]. Happy groups were perceived as happier (less angry) than ambivalent groups, $t(188) = 18.23$, $p < .001$, $d = 1.33$, 95% CI [0.69, 0.86].

More importantly, and replicating Study 1, we observed a main effect of age-bias, such that participants perceived more positive emotion in young-positive groups ($M = 5.55$, $SD = 0.55$) than in old-positive groups ($M = 5.14$, $SD = 0.62$), $F(1, 187) = 190.72$, $p < .001$, $\eta_p^2 = .51$. Thus, we observed support for our main hypothesis. In addition, there were significant 2-way interactions between age-bias condition and overall group emotion, $F(2, 374) = 16.15$, $p < .001$, $\eta_p^2 = .08$, and participant age-group, $F(1, 187) = 14.36$, $p < .001$, $\eta_p^2 = .07$. Critically, these interactions were qualified by a significant 3-way interaction, $F(2, 374) = 8.92$, $p < .001$, $\eta_p^2 = .05$ (see Figure 5). To probe this 3-way interaction, we next report emotion ratings for young adult participants and older adult participants separately.

Figure 5

Younger and Older Adult Mean Emotion Ratings for Each Group Type



Note. Average emotion ratings for young adult participants (left) and older adult participants (right) as a function of within-age group emotion (older happier vs younger happier) x overall group emotion (angry, ambivalent, happy) for Study 2. Error bars represent □ 1 SEM.

Young Adult Participants. We conducted a 2 (age-bias: young-positive, old-positive) x 3 (overall group emotion: angry, ambivalent, happy) repeated-measures ANOVA on young adult participants' ensemble perceptions of emotion. There was a main effect of overall group emotion $F(2, 190) = 794.05$, $p < .001$, $\eta_p^2 = .89$. For young adult participants, angry groups ($M = 3.61$, $SD = 0.73$) were perceived as angrier than ambivalent groups ($M = 5.52$, $SD = 0.70$), $t(95) = -31.24$, $p < .001$, $d = -3.19$, 95% CI [-2.03, -1.78] and happy groups ($M = 6.37$, $SD = 0.61$), $t(95) = -31.65$, $p < .001$, $d = -3.23$, 95% CI [-2.93, -2.58]. Happy groups were perceived as happier than ambivalent groups, $t(95) = 13.90$, $p < .001$, $d = 1.42$, 95% CI [0.73, 0.97]. More importantly, there was a main effect of age-bias, such that young adult participants perceived more positive emotion in young-positive groups ($M = 5.43$, $SD = 0.57$) than in old-positive groups ($M = 4.90$, $SD = 0.61$), $F(1, 95) = 151.72$, $p < .001$, $\eta_p^2 = .62$. This is a replication of the Study 1 effects (where all participants were young adults).

This effect was qualified by a significant age-bias by group emotion interaction, $F(2, 190) = 23.23$, $p < .001$, $\eta_p^2 = .20$. Young adult participants perceived more positive emotion in young-positive happy groups ($M = 6.70$, $SD = 0.67$) than old-positive happy groups ($M = 6.03$, $SD = 0.68$), $t(95) = 11.19$, $p < .001$, $d = 1.14$, 95% CI [0.55, 0.79]. Young adult participants also perceived more positive emotion in young-positive ambivalent groups ($M = 5.87$, $SD = 0.78$) than in old-positive ambivalent groups ($M = 5.16$, $SD = 0.80$), $t(95) = 9.72$, $p < .001$, $d = 0.99$, 95% CI [0.57, 0.86]. In addition, young adult participants perceived more positive emotion in young-positive angry groups ($M = 3.70$, $SD = 0.79$) than in old-positive angry groups ($M = 3.52$, $SD = 0.80$), $t(95) = 2.89$, $p = .005$, $d = 0.30$, 95% CI [0.06, 0.31]. However, and as in Study 1, the effects of age-bias were reduced in angry groups, thus accounting for the statistical interaction, relative to happy and ambivalent groups (though the effect was *not eliminated* in Study 2). Thus, our hypotheses were supported for young adult participants. That is, young adult participants appear to have preferentially weighted the emotional expressions of young adult group members in their ensemble perceptions of emotions for all group emotions, though they did so to a greater extent for ambivalent and happy groups relative to angry groups.

Older Adult Participants. The key extension of Study 2 is that we included older adult participants to examine if they—like young adults—would produce ensemble perceptions of emotion that favor young (vs. older) group members. We conducted a 2 (age-bias: young-positive, old-positive) x 3 (overall group emotion: angry, ambivalent, happy) repeated-measures ANOVA on older adult participants' ensemble perceptions of emotion. There was a main effect of overall group emotion $F(2, 184) = 648.71$, $p < .001$, $\eta_p^2 = .88$. For older adult participants, angry groups ($M = 4.10$, $SD = 0.71$) were

perceived as angrier than ambivalent groups (M = 5.88, SD = 0.61), $t(92)$ = -28.94, p < .001, d = -3.00, 95% CI [-1.90, -1.66], and happy groups (M = 6.58, SD = 0.55), $t(92)$ = -27.86, p < .001, d = -2.89, 95% CI [-2.65, -2.30]. Happy groups were perceived as happier than ambivalent groups, $t(92)$ = 11.98, p < .001, d = 1.24, 95% CI [0.58, 0.82]. More importantly, we observed a main effect of age-bias condition, such that older adult participants perceived more positive emotion in young-positive groups (M = 5.67, SD = 0.51) than in old-positive groups (M = 5.37, SD = 0.54), $F(1, 92)$ = 51.40, p < .001, η_p^2 = .36. Unlike for younger adults, there was no significant age-bias by group emotion interaction, $F(2, 184)$ = 1.28, p = .28, η_p^2 = .01. Thus, older adult participants appear to have preferentially weighted the emotional expressions of younger group members relative to older group members in their ensemble perceptions of emotion similarly for all group emotions.

In general, then, both younger and older adults exhibited a young age-bias in their ensemble perceptions of emotion and—unlike in Study 1—for all three types of groups (happy, ambivalent, angry). The three-way interaction among age-bias condition, group emotion, and participant age-group can be understood in terms of age-bias effect for angry groups: for young adult participants *only*, this effect was diminished relative to the age-bias effect for happy and ambivalent groups.

Comparison of Younger vs Older Adult Emotion Ratings. As reported above, both younger and older adult participants overweighted the emotional expressions of younger relative to older adults in a group. However, the presence of such an effect does not preclude additional effects of shared social identity in ensemble perception. Thus, we next examined whether young (vs. older) adult participants exhibited a *stronger* ensemble

perception bias favoring the facial emotions of younger (vs. older) adult group members. To do so, for each participant, we calculated the mean difference between ensemble perceptions of emotion in the young-positive condition versus the old-positive condition. Positive scores on this metric indicate that ensemble perceptions of emotion were more consistent with the expressions of young than older adults, whereas negative scores indicate the opposite. We then examined whether these *biased ensemble perception* scores differed by participant age-group (separately for happy, ambivalent, and angry groups).

For happy groups, *biased* ensemble perception scores were significantly more positive for young adult participants (M = 0.67, SD = 0.59) than for older adult participants (M = 0.27, SD = 0.59), $t(187) = 4.74$, $p < .001$, d = 0.69, 95% CI [0.24, 0.57]. For ambivalent groups, biased ensemble perception scores were significantly more positive for young adult participants (M = 0.71, SD = 0.72) than older adult participants (M = 0.37, SD = 0.60), $t(187) = 3.49$, $p < .001$, d = 0.51, 95% CI [0.15, 0.53]. However, for angry groups, young adult participants (M = 0.18, SD = 0.61) and older adult participants (M = 0.25, SD = 0.66) exhibited similar biased ensemble perception scores, $t(187) = -0.73$, p = .46, d = -0.11, 95% CI [-0.25, 0.11]. Notably, for each of the three group emotion categories, age-bias scores were significantly greater than 0 for *both* younger adult and older adult participants, indicating the existence of a bias favoring younger faces in ensemble perceptions of emotion (ts > 2.89, ps < .05). Thus, although both younger and older adult participants preferentially weighted the emotional expressions of younger relative to older adult group members, young adult participants did this to a significantly greater extent than did older adult participants when the average

group emotion was ambivalent or happy. These results are consistent with the idea that ensemble perceptions are biased by *shared* social identity as well as social identity *relevance*.

Belongingness Ratings

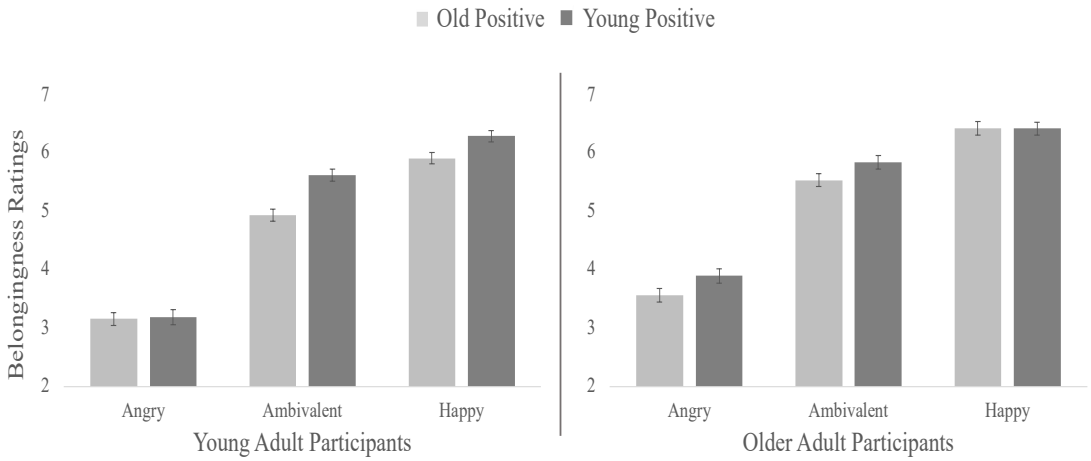
Next, we examined belongingness ratings. We predicted that young adult participants would report greater belonging in young-positive groups than old-positive groups. In addition, if such effects are driven by group members' social identity relevance, then older adults should also report greater belonging in young-positive groups than old-positive groups. Thus, we ran a 2 (age-bias: young-positive, old-positive) x 2 (participant age-group: young adult, older adult) x 3 (overall group emotion: angry, ambivalent, happy) mixed model ANOVA on belongingness ratings. There was a main effect of overall group emotion, $F(2, 374) = 702.07$, $p < .001$, $\eta_p^2 = .79$. Participants reported significantly less belonging with angry groups ($M = 3.46$, $SD = 1.16$) than ambivalent groups ($M = 5.49$, $SD = 0.99$), $t(188) = -26.36$, $p < .001$, $d = -1.92$, 95% CI [-2.18, -1.88], and happy groups ($M = 6.26$, $SD = 0.98$), $t(188) = 28.96$, $p < .001$, $d = -2.11$, 95% CI [-3.01, -2.66]. Participants reported greater belonging with happy groups than ambivalent groups, $t(188) = 15.23$, $p < .001$, $d = 1.11$, 95% CI [0.68, 0.88].

More importantly, and replicating Study 1, there was also a main effect of age-bias on belongingness ratings, $F(1, 187) = 77.70$, $p < .001$, $\eta_p^2 = .29$, such that participants reported greater belonging with young-positive groups ($M = 5.21$, $SD = 0.87$), than old-positive groups ($M = 4.92$, $SD = 0.89$). In addition, there were significant 2-way interactions between age-bias condition and overall group emotion $F(2, 374) = 11.02$, $p < .001$, $\eta_p^2 = .06$ and participant age-group $F(1, 187) = 5.18$, $p = .02$, $\eta_p^2 = .027$.

Critically, these interactions were qualified by a significant 3-way interaction, $F(2, 374) = 13.13$, $p < .001$, $\eta_p^2 = .07$ (see Figure 6). To probe this 3-way interaction, we next report belonging ratings for younger and older adult participants separately.

Figure 6

Younger and Older Adult Mean Belongingness Ratings for Each Group Type



Note. Belongingness ratings for young adult participants (left) and older adult participants (right) as a function of within-age group emotion (older happier vs younger happier) x overall group emotion (angry, ambivalent, happy) for Study 2. Error bars represent □ 1 SEM.

Young Adult Participants. We conducted a 2 (age-bias: young-positive, old-positive) x 3 (overall group emotion: angry, ambivalent, happy) repeated-measures ANOVA on young adult participants' belongingness ratings. There was a main effect of overall group emotion $F(2, 190) = 358.65$, $p < .001$, $\eta_p^2 = .79$. Young adult participants reported significantly less belonging with angry groups ($M = 3.18$, $SD = 1.14$) than ambivalent groups ($M = 5.29$, $SD = .88$), $t(95) = -19.43$, $p < .001$, $d = -1.98$, 95% CI [-2.32, -1.89], and happy groups ($M = 6.11$, $SD = 0.90$), $t(95) = -20.71$, $p < .001$, $d = -2.11$, 95% CI [-3.21, -2.65]. Participants reported greater belonging with happy groups than ambivalent groups, $t(95) = 10.29$, $p < .001$, $d = 1.05$, 95% CI [0.67, 0.99]. More

importantly, there was a main effect of age-bias, such that young adult participants reported greater belonging in young-positive groups (M = 5.04, SD = 0.77) than old-positive groups (M = 4.68, SD = 0.79), $F(1, 95) = 59.57$, $p < .001$, $\eta_p^2 = .39$.

These effects were qualified by a significant age-bias by overall group emotion interaction, $F(2, 190) = 17.87$, $p < .001$, $\eta_p^2 = .16$. Young adult participants reported greater belonging in young-positive happy groups (M = 6.30, SD = 0.95) than in old-positive happy groups (M = 5.92, SD = 0.99), $t(95) = 5.03$, $p < .001$, d = 0.51, 95% CI [0.23, 0.52]. Young adult participants also reported greater belonging in young-positive ambivalent groups (M = 5.63, SD = 1.00) than in old-positive ambivalent groups (M = 4.94, SD = 0.97), $t(95) = 7.43$, $p < .001$, d = 0.76, 95% CI [0.50, 0.87]. However, young adult participants did not report greater belonging in young-positive angry groups (M = 3.20, SD = 1.25) than in old-positive angry groups (M = 3.16, SD = 1.22), $t(95) = 0.57$, p = .57, d = 0.06, 95% CI [-0.09, 0.17]. Thus, young adult participants reported significantly greater belonging in groups in which more self-relevant (young adult) faces were more emotionally positive than less self-relevant (older adult) faces but not for angry groups.

Older Adult Participants. Next, we aimed to examine if older adult participants would report greater belonging in young-positive compared to old-positive groups. Thus, we conducted a 2 (age-bias: young-positive, old-positive) x 3 (overall group emotion: angry, ambivalent, happy) repeated-measures ANOVA on older adult participants' belongingness ratings. There was a main effect of overall group emotion, $F(2, 184) = 345.57$, $p < .001$, $\eta_p^2 = .79$. Older adult participants reported significantly less belonging with angry groups (M = 3.74, SD = 1.11) than ambivalent groups (M = 5.69, SD = 1.06),

$t(92) = -17.84$, $p < .001$, $d = -1.85$, 95% CI [-2.17, -1.74], and happy groups ($M = 6.43$, $SD = 1.04$), $t(92) = -20.33$, $p < .001$, $d = -2.11$, 95% CI [-2.96, -2.43]. Older adult participants reported greater belonging with happy groups than ambivalent groups, $t(92) = 11.59$, $p < .001$, $d = 1.20$, 95% CI [0.61, 0.86]. More importantly, there was a main effect of age-bias, such that older adult participants reported greater belonging in young-positive groups ($M = 5.39$, $SD = 0.93$) than in old-positive groups ($M = 5.18$, $SD = 0.91$), $F(1, 92) = 22.17$, $p < .001$, $\eta_p^2 = .19$.

These effects were qualified by a significant age-bias by overall group emotion interaction, $F(2, 184) = 6.21$, $p = .002$, $\eta_p^2 = .06$. Older adult participants did not report greater belonging in young-positive happy groups ($M = 6.43$, $SD = 1.09$) than in old-positive happy groups ($M = 6.43$, $SD = 1.12$), $t(92) = -.03$, $p = .98$, $d = -0.003$, 95% CI [-0.15, 0.15]. Older adult participants did report greater belonging in young-positive ambivalent groups ($M = 5.85$, $SD = 1.16$) than in old-positive ambivalent groups ($M = 5.54$, $SD = 1.08$), $t(92) = 4.03$, $p < .001$, $d = 0.42$, 95% CI [0.16, 0.46]. Older adult participants also reported greater belonging in young-positive angry groups ($M = 3.90$, $SD = 1.17$) than in old-positive angry groups ($M = 3.57$, $SD = 1.18$), $t(92) = 4.31$, $p < .001$, $d = 0.45$, 95% CI [0.18, 0.49]. Thus, older adult participants reported significantly greater belonging in ambivalent and angry (but not happy) groups in which more self-relevant (young) groups members expressed more positive emotion (see Discussion).

Comparison of Younger and Older Adult Participants Belonging Ratings. As described above, younger adults reported greater belonging with young-positive happy groups compared to old-positive happy groups, but older adults did not. In addition, older adults reported greater belonging with young-positive angry groups compared to old-

positive angry groups, but younger adults did not. However, both younger and older adult participants reported greater belonging with young-positive ambivalent groups relative to old-positive ambivalent groups. Thus, we next examined whether young adult participants reported *greater* bias in self-reported belonging with young-positive ambivalent groups than did older adult participants. To do so, for each participant, we calculated the mean difference between self-reported belonging in the young-positive condition versus the old-positive condition. Positive scores on this metric indicate that belongingness ratings were higher when younger group members displayed more positive emotion, whereas negative scores indicate that belongingness ratings were higher when older group members displayed more positive emotion. We then examined whether this *biased belonging* score differed by participant age-group for ambivalent groups and found that biased belonging scores were significantly more positive for younger adult participants (M = 0.68, SD = 0.90) than older adult participants (M = 0.31, SD = 0.74), $t(187) = 3.09$, $p = .002$, $d = 0.45$, 95% CI [0.14, 0.61]. Thus, although both young and older adult participants reported greater belonging in young-positive ambivalent groups, young adult participants did so to a significantly greater extent than did older adult participants (see Discussion)

Effect of Emotion Ratings on Belongingness Ratings

We aimed to examine whether biased ensemble perceptions of emotion explained why younger and older adult perceivers reported greater belonging with young-positive than old-positive groups. As with Study 1, we computed a score to index the direct effect of age-bias on belongingness. For each overall group emotion (happy, ambivalent, angry), we created a *biased ensemble perception* score by subtracting emotion ratings for

old-positive groups from young-positive groups for younger and older adult participants. For each overall group emotion, we also created a *biased belonging* score by subtracting belonging ratings for old-positive groups from young-positive groups for young and older adult participants separately. Finally, we computed the correlation between the biased ensemble perception scores and the biased belonging scores.

Young Adult Participants. For young adult participants, biased ensemble perception scores significantly predicted biased belonging scores for angry (B = .25, p = .019, 95% CI [0.04, 0.46]), happy (B = .50, p < .001, 95% CI [0.26, 0.73]), and ambivalent groups (B = .37, p = .003, 95% CI [0.13, 0.62]). Thus, greater overweighting of young adult emotional expressions significantly predicted the extent to which young adult participants reported greater belonging in young-positive groups than in old-positive groups for all group emotions.

Older Adult Participants. For older adult participants, biased ensemble perception scores significantly predicted biased belonging scores for angry (B = .37, p = .002, 95% CI [0.14, 0.60]) and happy (B = .27, p = .036, 95% CI [0.02, 0.53]) groups and neared significance for ambivalent groups (B = .25, p = .051, 95% CI [-0.001, 0.50]). Thus, greater overweighting of younger emotional expressions significantly predicted the extent to which older adult participants reported greater belonging in young-positive groups than in old-positive groups for angry and happy groups and was marginally significant for ambivalent groups.

Individual Differences in Ingroup Bias

As reported above, Study 2 allowed us to compare the extent to which younger *and* older adults exhibited young-bias in their ensemble perceptions. In this way, Study 2

provided a better test than Study 1 in terms of whether ensemble perceptions were primarily biased by social identity relevance (young-bias) or shared social identity (ingroup-bias). These results are reported above. However, we again reasoned that if biases in ensemble perception were driven by ingroup bias, then factors which increase ingroup bias should also increase the observed effects on ensemble perception. Thus, we examined whether self-group overlap and intergroup contact were associated with biased ensemble perception scores. For younger adult participants, all correlations were non-significant (ps > .09). For older adult participants, correlations were largely non-significant (ps > .08) with the exception of inclusion of younger individuals in the self (r = -.20, p = .05). That is, for older adult participants, increased inclusion of younger adults in their sense of self was associated with reduced weighting of younger group members relative to older group members in their ensemble perceptions. These analyses indicate that for younger adult participants, individual difference measures related to ingroup bias were unrelated to social-identity bias in ensemble perceptions of emotion. For older adult participants, measures associated with ingroup bias were generally unrelated to social-identity bias in ensemble perceptions of emotion. However, greater inclusion of younger adults in their sense of self significantly predicted reduced young-bias in their ensemble perception of emotion, consistent with an ingroup bias that may obtain in addition to social identity relevance effects.

Individual Differences in Age-Emotion Stereotypes

It is also possible that participants' concepts of happiness or anger are age-biased and this might influence the reported bias in ensemble perception of emotion. For example, participants may more readily associate younger adults with happiness and

older adult with anger, and these age-emotion stereotypes may drive attention toward stereotype congruent expressions. Thus, we next examined whether individual differences in age-emotion stereotypes were associated with biased ensemble perception scores. Before testing this hypothesis, we first examined the degree to which participants reported age-emotion stereotypes on average. Participants reported that young adults (M = 4.84, SD = 1.21) and older adults (M = 4.59, SD = 1.46) express anger to a similar degree, $t(190) = 1.86$, $p = .065$, $d = 0.13$, 95% CI [0.02, 0.52]. However, participants reported that younger adults (M = 5.24, SD = 1.16) express more happiness than older adults (M = 4.90, SD = 1.13), $t(190) = 3.07$, $p = .002$, $d = 0.22$, 95% CI [0.12, 0.56]. We next examined these stereotypes for younger and older adults separately. Young adult participants reported that younger adults (M = 4.72, SD = 1.26) and older adults (M = 4.97, SD = 1.52) express anger to a similar degree, $t(96) = -1.20$, $p = .233$, $d = -0.12$, 95% CI [-0.66, 0.16]. However, young adult participants reported that younger adults (M = 5.31, SD = 1.11) tend to express more happiness than older adults (M = 4.90, SD = 1.22), $t(96) = 2.45$, $p = .016$, $d = 0.25$, 95% CI [0.08, 0.75]. Older adults reported that younger adults (M = 4.97, SD = 1.14) express more anger than older adults (M = 4.20, SD = 1.28), $t(93) = 4.82$, $p < .001$, $d = 0.50$, 95% CI [0.45, 1.08]. In addition, older adults reported that younger adults (M = 5.17, SD = 1.20) express more happiness than older adults (M = 4.90, SD = 1.04), $t(93) = 1.85$, $p = .067$, $d = 0.19$, 95% CI [-0.02, 0.56]. Contrary to this alternative explanation, age-emotion stereotypes were not associated with biased ensemble perception scores for younger (ps > .36) or older (ps > .08) adult participants. These analyses indicate that individual difference measures assessing age-emotion stereotypes were unrelated to social-identity bias in ensemble perceptions of emotion.

Discussion

In Study 2, both younger and older adult participants' ensemble perceptions of emotion overweighted the expressions of group members with more self-relevant social identities. Specifically, younger adults preferentially weighted the emotion of young adult group members for all group emotions, although such effects were diminished in judgments of angry groups (as in Study 1). Older adults also preferentially weighted the emotion of young adult group members in their ensemble perceptions of emotion. However, unlike for young adult participants, there was no moderation of age-bias effects by group emotion. In general, both younger and older adult participants' ensemble perceptions of emotion were biased toward younger adult group members, regardless of whether the overall group emotion was angry, ambivalent, or happy.

Analyses on belongingness ratings were generally consistent with our hypotheses but there were several exceptions. As in Study 1, young adult participants reported greater belonging in young-positive happy and ambivalent groups, but not angry groups. Moreover, young adult participants' belongingness ratings were highly correlated with their ensemble perceptions of emotion, and for all three group emotions. These replicable findings suggest that for happy and ambivalent groups, at least, age-bias in ensemble perceptions of emotion translate to feelings of belonging in emotional groups. As detailed in the General Discussion, we suspect (but cannot confirm) that the absence of age-bias in belongingness ratings of angry groups is due to an "anger bias" that captures attention and drives ensemble perception.

Older adult participants exhibited a slightly different pattern of belongingness ratings. They reported greater belonging in young-positive ambivalent and *angry* groups,

but not happy groups. This unanticipated pattern is a challenge to explain with our theoretical framework and cannot be easily accommodated by an anger bias explanation. This effect was especially confounding in light of theory-consistent evidence that older adult participants' ensemble perceptions of emotion were biased in favor of young adults' facial emotion for happy, ambivalent, *and* angry groups, and that these biased ensemble perceptions were predictive of belongingness ratings for all 3 types of emotional groups. In general, then, we observed mixed evidence for our hypotheses regarding older adults' belongingness ratings and speculate on how different group emotions (happy versus angry) might differentially impact the belongingness ratings of younger versus older adults (see General Discussion).

Finally, we observed evidence for an ingroup age-bias in ensemble perception: the effect of young-positive (vs. old-positive) group emotions was stronger for young adult than older adult participants. Thus, we observed evidence for a biasing effect of both social identity relevance and shared social identity in ensemble perceptions of emotion and judgments of belonging for young adult participants.

Chapter Four: Study 3

In Studies 1-2, participants produced ensemble perceptions of emotion in which emotions of younger adults were weighted more heavily than those of older adults. We have argued that these effects accrue because perceivers evaluate the emotions of young adults as more self-relevant than those of older adults. Put differently, the emotions of young adults are more predictive of self-relevant outcomes than are the emotions of older adults and are therefore prioritized in group perception. In Study 3, we directly tested this account of age-biased ensemble perception via a reward/punishment learning paradigm. Considerable evidence suggests that stimuli previously associated with rewards or punishment (including social feedback) are prioritized in attention, especially attention for stimuli presented in crowds (for review, see Anderson, 2015). In general, such learning seems to accrue by altering the "value signal" of a stimulus, which subsequently guides attention.

These learning paradigms provide an excellent means for altering the self-relevance of age-based emotion expressions. For the current project, we reasoned that *relevance* reflects the degree to which a given person's emotion has the (perceived) potential to impact the outcomes of the perceiver. Specifically, happy expressions tend to predict affiliation (a positive outcome) whereas angry expressions tend to predict threat (a negative outcome). Our theory is that young adult (vs. older adult) happy and angry expressions are evaluated as more likely to yield positive and negative outcomes for the

self, respectively, thus making the emotions of young adults more relevant than those of older adults. Reward learning paradigms enable us to manipulate this relationship by altering the predictive value of young and older adult emotions.

Phase 1 of Study 3 represents the learning phase, and the key extension of Studies 1-2. On each trial in the learning paradigm, participants evaluated whether there were over or under 100 dots in an array. Each array had 100 dots, and we manipulated feedback on a per trial basis. Feedback was delivered through two mechanisms: (1) a facial emotion and (2) an indication of whether a trial was relevant to their cash reimbursement. Each participant saw a happy face on *any* trial they got "correct" or an angry face on any trial they got "incorrect". The key manipulation in this study, however, was whether those facial expressions were relevant to the participant's monetary outcomes. Immediately following the facial expression, participants learned whether they would gain/receive money for that trial or not. In the *old-relevant condition*, every trial with a monetary gain (happy expressions) or loss (angry expressions) was paired with an older adult's emotion expression. Conversely, every trial without a monetary gain or loss was paired with a *younger* adult's emotion expression. Thus, in this condition, participants learn that older adults' emotion expressions are more relevant than younger adults (presumably counteracting the pattern in their daily lives). The *young-relevant condition* presented the opposite pattern of contingencies, so that younger adult's emotion expressions were more relevant than older adults. Following the learning phase, participants completed the same ensemble perception task completed in Studies 1-2.

We have theorized that ensemble perceptions of emotion are biased in favor of group members with the greatest perceived social relevance. Critically, we have argued

that young adults are broadly perceived as more socially relevant than older adults. This perception of younger adults as more socially relevant may be largely pancultural and deeply embedded within societal norms (North & Fiske, 2015) and accrue via a lifetime of social learning. Therefore, our experimental approach of subtly manipulating social relevance of younger and older adults through an incidental learning paradigm may be insufficient to completely override this bias. Our predictions were nuanced: we anticipated a reduction in young-biased ensemble perception in the old-relevant (compared to young-relevant) condition, but not a complete elimination (or reversal) of such bias.

Method

Participants and Setting

We aimed to recruit approximately 200 young adults for Study 3. In total, we recruited 201 participants through Prolific Academic in the Spring of 2023. Seven participants dropped out of the study and were not included in analyses. In addition, we excluded 1 participant due to extreme emotional reactivity during the study. This resulted in a final sample size of 193 participants. The sample was majority White (56% White, 16% Hispanic/Latinx, 13% Black/African American, 11% Asian/Pacific Islander, 4% mixed race), majority men (59% men, 39% women, 2% non-binary), and had an average age of 25.89 (SD = 3.56). A sensitivity power analysis using G*Power (Faul et al., 2007) based on an alpha level 0.05 and power of 80% revealed that this sample (N = 193) was sufficient to detect an effect size of f = 0.16 ($\eta p^2 \approx 0.03$).

Materials and Procedure

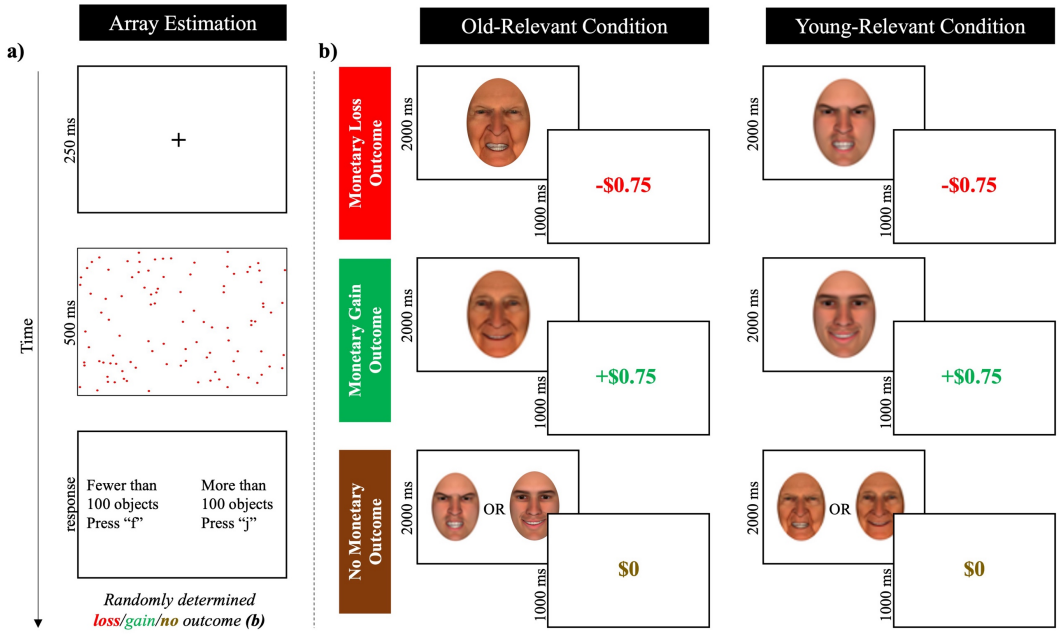
To temporarily manipulate the relevance of older vs younger adult faces, participants first completed an incidental learning paradigm. In the learning phase, participants were informed that they would play a game to win additional money in the study. On each trial in the game, participants were shown an array of objects (e.g., circles, squares, triangles) for 500ms and were asked to estimate the number of objects in the array. Specifically, participants were instructed to press "f" if they thought the array had less than 100 objects and to press "j" if they thought the array had more than 100 objects. Participants were informed that they would receive feedback on their performance at the end of each trial. If they had given a correct response for a given trial, they would see a "happy" face. If they responded incorrectly on that trial, they would see an "angry" face. In actuality, each array consisted of exactly 100 objects, and feedback on each trial was randomly determined. Participants were then informed that on roughly half of the trials there would be money at stake, but prior to the feedback (facial emotion) they would not know which trials had money at stake and which did not. On trials in which money was at stake, if participants answered correctly, they would see a happy face followed by the amount of money they had earned. However, if they answered incorrectly, they would see an angry face followed by the amount of money they had lost on that trial. On trials in which no money was at stake, they would see an angry or happy face, ostensibly indicating whether they had answered correctly or incorrectly, followed by "$0" indicating that they had not lost or gained money on that trial (see Figure 7). In total, participants completed 80 trials during the learning phase, with 40 trials resulting in a relevant monetary outcome (i.e., 20 trials with a monetary gain, and 20 trials with a monetary loss) and 40 trials no monetary gain or loss. Critically, participants were

randomly assigned to one of two age relevance conditions. In the young-relevant condition monetary gains and losses were always preceded by young adult emotional faces and outcomes on trials in which no money was at stake were always preceded by older adult emotional faces. In the old-relevant condition, monetary gains and losses were always preceded by older adult emotional faces and outcomes on trials in which no money was at stake were always preceded by younger adult emotional faces. Thus, whether the emotional expressions of older or younger adult faces predicted relevant monetary outcomes was experimentally manipulated, such that young adult emotional faces predicted monetary outcomes (young-relevant condition) or older adult emotional faces predicted monetary outcomes (old-relevant condition). The individual younger and older adult faces used in the incidental learning paradigm were taken from the same set of face models generated for the ensemble perception task used in Studies 1 & 2.

Next, participants completed the same ensemble perception of emotion task used in Studies 1 & 2. Finally, participants indicated their frequency and quality of contact with older and younger adults and completed the same measure of age-emotion stereotypes regarding expressions of anger and happiness used in Study 2 (Fabes & Martin, 1991). In general, participants did not have difficulties following the procedure or completing the learning phase or ensemble perception task. All experimental procedures and materials were reviewed and approved by the Institutional Review Board (IRB) at the researcher's university.

Figure 7

Learning Phase Design and Trial Structure



Note. Learning phase design and trial structure (80 trials). Participants were first randomly assigned to either the old-relevant condition or young-relevant condition. **(a)** Trials began with a fixation cross (250ms) followed by an array of 100 objects (500ms) and participants were then asked to estimate whether the array had more or fewer than 100 objects. **(b)** Immediately following their estimation, participants saw an emotional face on the screen followed by a monetary outcome. In the old-relevant condition, emotional older adult faces were paired with monetary gains and losses and young adult faces were paired with no monetary outcomes. In the young-relevant condition, emotional young adult faces were paired with monetary gains and losses and older adult faces were paired with no monetary outcomes.

Results

As described in detail below, we hypothesized and found evidence that young adult participants' age-bias in ensemble perceptions of emotion depended on the age-based relevance manipulation.

Emotion Ratings

Mean emotion ratings of each group type served as the dependent measure of interest. As in Studies 1 & 2, trials in which response times were under 300ms or over 30 seconds were excluded from analyses (15.7% of all trials). Consistent with Studies 1 & 2, we predicted that young adult participants would preferentially weight the emotional

expressions of young adult group members relative to older adult group members in their ensemble perceptions of emotion. To the extent that young-bias in ensemble perceptions of emotion is driven by perceived relevance, we hypothesized that this effect would be moderated by the learning manipulation in which younger or older adult faces were paired with task-relevant monetary outcomes. Specifically, we predicted that the tendency to overweight the emotional expressions of younger adult faces would be significantly *smaller* in the old-relevant condition compared to the young-relevant condition.

To test this hypothesis, we conducted a 2 (relevance condition: young-relevant, old-relevant) x 2 (age bias: young-positive, old-positive) x 3 (overall group emotion: angry, ambivalent, happy) mixed model ANOVA on ratings of group emotion. There was a main effect of overall group emotion, $F(2, 382) = 739.22$, $p < .001$, $\eta_p^2 = .80$. Angry groups ($M = 3.65$, $SD = 0.81$) were perceived as angrier than ambivalent groups ($M = 5.26$, $SD = 0.62$),), $t(192) = -27.18$, $p < .001$, $d = -1.96$, 95% CI [-1.73, -1.49] and happy groups ($M = 6.23$, $SD = 0.83$), $t(192) = -29.55$, $p < .001$, $d = -2.38$, 95% CI [-2.75, -2.40]. Happy groups were perceived as happier (less angry) than ambivalent groups, $t(192) = 19.41$, $p < .001$, $d = 1.40$, 95% CI [0.87, 1.06].

Replicating Studies 1 & 2, we observed a main effect of age-bias, such that participants perceived more positive emotion in young-positive groups ($M = 5.22$, $SD = 0.59$), than in old-positive groups ($M = 4.87$, $SD = 0.58$), $F(1,191) = 114.77$, $p < .001$, $\eta_p^2 = .38$. Moreover, we again find an age-bias by overall group emotion interaction, $F(2, 382) = 12.39$, $p < .001$, $\eta_p^2 = .06$. Participants perceived more positive emotion in young-positive happy groups ($M = 6.42$, $SD = 0.92$) than old-positive happy groups ($M = 6.04$,

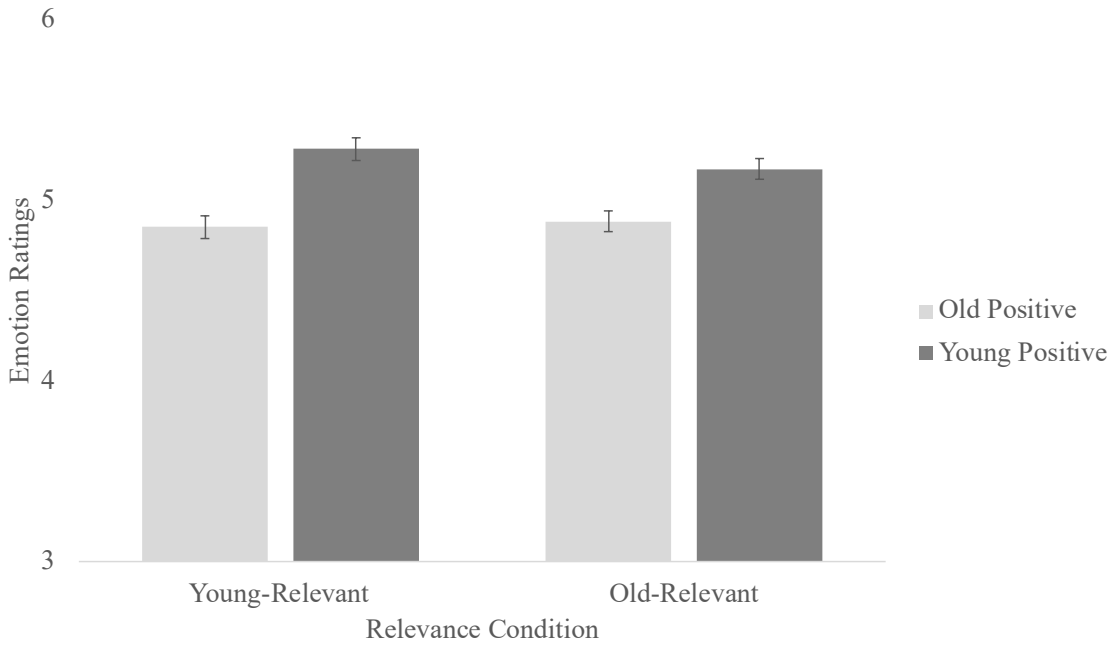
SD = 0.89), *t*(192) = 7.26, *p* < .001, *d* = 0.52, 95% CI [0.27, 0.48]. Participants also perceived more positive emotion in young-positive ambivalent groups (*M* = 5.52, *SD* = 0.75) than in old-positive ambivalent groups (*M* = 5.00, *SD* = 0.72), *t*(192) = 9.18, *p* < .001, *d* = 0.66, 95% CI [0.41, 0.64]. In addition, participants perceived more positive emotion in young-positive angry groups (*M* = 3.73, *SD* = 0.90) than in old-positive angry groups (*M* = 3.57, *SD* = 0.87), *t*(192) = 3.12, *p* = .002, *d* = 0.30, 95% CI [0.06, 0.26]. Although effects of age-bias emerged for each overall group emotion, the effects of age-bias were stronger for ambivalent (*M* = 0.53, *SD* = 0.80) relative to happy (*M* = 0.38, *SD* = 0.72) groups, *t*(192) = 2.00, *p* = .047, *d* = 0.14, 95% CI [0.002, 0.30], and for happy relative to angry (*M* = 0.16, *SD* = 0.72) groups, *t*(192) = 2.85, *p* = .005, *d* = 0.21, 95% CI [0.07, 0.36].

More importantly, and consistent with hypotheses, the main effect of age-bias was qualified by a significant interaction with relevance condition, *F*(1, 191) = 4.38, *p* = .038, η_p^2 = .02 (see Figure 8). Participants in the young-relevant condition, perceived more positive emotion in young-positive groups (*M* = 5.29, *SD* = 0.63) than old-positive groups (*M* = 4.85, *SD* = 0.57), *t*(87) = 8.38, *p* < .001, *d* = 0.89, 95% CI [0.33, 0.53]. Participants in the old-relevant condition also reported more positive emotion in young-positive groups (*M* = 5.17, *SD* = 0.55) than old-positive groups (*M* = 4.88, *SD* = 0.59), *t*(104) = 6.59, *p* < .001, *d* = 0.64, 95% CI [0.20, 0.38]. However, as predicted the effect of age-bias was significantly stronger in the young-relevant (*M* = 0.43, *SD* = 0.48) than old-relevant (*M* = 0.29, *SD* = 0.45) condition, *t*(191) = 2.09, *p* = .038, *d* = 0.30, 95% CI [0.01, 0.27]. Thus, participants preferentially weighted the emotional expressions of young adult group members relative to older adult group members in their ensemble perceptions

of emotions, and they did so to a greater extent when younger adult faces were incidentally made more relevant than older adult faces. Put differently, when older adult faces were incidentally made more relevant, the effect of young bias in ensemble perception of emotion was attenuated.

Figure 8

Mean Emotion Ratings for Each Relevance Condition



Note. Average emotion ratings for age-bias (old-positive vs young-positive) x relevance condition (young-relevant, old-relevant) for Study 3. Error bars represent □ 1 SEM.

Individual Differences in Ingroup Bias

We again reasoned that if biases in ensemble perception of emotion were driven by ingroup bias, then factors that increase ingroup bias should also increase the observed effects on ensemble perception. Specifically, we examined whether intergroup contact was associated with biased ensemble perception scores. Consistent with Studies 1 & 2, intergroup contact with younger and older adults was not correlated with biased ensemble perception scores (*p*s > .20).

Individual Differences in Age-Emotion Stereotypes

In addition, it is possible that participants' concepts of happiness or anger are age-biased (e.g., young adults may be more readily associated with happiness and older adults with anger), and this might influence the reported bias in ensemble perception of emotion. Thus, we next examined whether individual differences in age-emotion stereotypes were associated with biased ensemble perception scores. Before testing this hypothesis, we first examined the degree to which participants reported age-emotion stereotypes on average. Participants reported that young adults (M = 4.35, SD = 1.28) express less anger than older adults (M = 4.72, SD = 1.39), $t(191) = -3.00$, $p = .003$, $d = -0.22$, 95% CI [-0.62, -0.13]. In addition, participants reported that younger adults (M = 4.88, SD = 1.21) express more happiness than older adults (M = 4.44, SD = 1.18), $t(191) = 4.06$, $p < .001$, $d = 0.29$, 95% CI [0.22, 0.64]. Consistent with Study 2, age-emotion stereotypes were not correlated with biased ensemble perception scores (ps > .22). These analyses indicate that individual difference measures related to ingroup bias and age-emotion stereotypes were unrelated to social-identity bias in ensemble perceptions of emotion.

Discussion

In Study 3, the extent to which young adult participants exhibited an age-bias in their ensemble perceptions of emotion depended on the age-based relevance manipulation. Specifically, when the emotional expressions of young adult faces were made relevant (relative to the emotional expressions of older adult faces) via an incidental learning paradigm, participants subsequently overweighted the emotional expressions of young adult group members to a greater extent than the emotional

expressions of older adult group members. However, when older adult faces were made more relevant (relative to younger adult faces), the effect of young bias in ensemble perception of emotion was attenuated. Presumably, perceptions of younger (vs older) adults as more relevant have accrued via a lifetime of learning. As such, it is notable that a subtle manipulation of age-relevance via an incidental learning paradigm diminished the observed effect of young-bias in ensemble perceptions of emotion, though the effect was modest. Moreover, the results of Study 3 indicate that while young-bias in ensemble perceptions of emotion appears to be reliable, it may also be malleable and vary depending on the current relevance of older (vs younger) adults within a given context.

Chapter Five: Study 4

Study 4 was designed to directly test the idea—derived from my theoretical framework—that ensemble perceptions are sensitive to the context in which they occur. I have argued that certain social identities (e.g., younger adults) tend to be relevant to perceivers and are thus prioritized in ensemble perceptions. Consistent with this view, when older adult facial expressions were made more relevant via a reward learning task (Study 3), the young bias in ensemble perception was reduced. Although not the main purpose of Study 3, the findings also suggest that this young bias is sensitive to context, insofar as this bias depended on a preceding task. Yet this conclusion is relatively uninformative: virtually any variable can be regarded as "context" in experimental paradigms. Instead, the purpose of Study 3 was to examine whether *specific* contextual effects in ensemble perceptions follow from my theoretical framework.

My theory is rooted, in part, on Neel and Lasseter's (2019) account of relevance, in which relevance appraisals critically depend upon perceiver goals. In Studies 1-3, the participant's goal was to evaluate the average facial emotion among a group of faces, absent information about the context of those facial emotions. Yet perceiver goals may, at times, increase the relevance of older adults. For example, the emotional responses of older adults may be especially relevant to a focus group leader when the product of interest is an electric scooter (given that older adults are more likely than younger adults to purchase a scooter). Conversely, the emotional responses of older adults may be less

relevant for this focus group manager when the product is typically consumed by younger adults. In both cases, ensemble perceptions of group emotion are formed in the service of determining whether people will like a product, but because the primary audience for these products differ, so too should "whose" emotions are most relevant to their ultimate goal. Thus, if processing goals dictate the influence of context on young bias in ensemble perception, the focus group manager should exhibit a young bias for young-oriented products and an old-bias for old-oriented products.

In Study 4, we aimed to test this hypothesis by asking participants to evaluate how mixed-age groups felt about products made for, and marketed toward, older adults, younger adults, or a more general audience. Moreover, we aimed to use a design that more closely resembled a real-world context in order to extend the findings of Studies 1-3 to a more externally valid design.

Participants were informed that they would see groups of photographs taken from multiple focus groups. In reality, all faces were taken from the FACES database (Ebner et al., 2010). Participants were informed that the focus groups included individuals varying in age (i.e., included both younger and older adults) and that focus group members were asked to express how they felt about numerous products. They were told that members of the focus group were asked to evaluate a product and then pose for a photograph in which they were asked to express how they felt about the product via facial emotion. Participants were then informed that the goal of this study was to examine whether people can tell how the focus group felt about each product simply by seeing their posed photographs. Thus, in this study, they first saw the product the focus group members were ostensibly evaluating followed by pictures of multiple individuals from the focus

group depicting their emotional reaction to that product. Finally, participants were asked to estimate how much the focus group liked each product. We predict that when evaluating how the focus group felt about products designed for older adults, participants ensemble perceptions will favor older adult groups members. That is, in the context of products for older adults, older adult emotional expressions toward those products should be more informative or relevant. However, in the context of products designed for younger adults, or for all ages, participants may view younger adults' opinions or emotional expressions as more relevant and favor their expressions in their overall group perceptions.

Method

Participants and Setting

We recruited 161 young adults for this study. An *a priori* power analysis via G*Power (version 3.1.9.7) indicated that a sample size of 161 participants would provide sufficient power to detect a small effect for our within-subjects design. Participants were recruited from Prolific Academic in the Spring of 2024. Seven participants dropped out of the study and were not included in analyses. In addition, we excluded 2 participants due to self-reported visual impairments that impacted their ability to see the stimuli presented in the study. This resulted in a final sample size of 152 participants. The sample was majority White (52% White, 10% Hispanic/Latinx, 12% Black/African American, 20% Asian/Pacific Islander, 6% mixed race), majority men (54% men, 44% women, 2% non-binary), and had an average age of 26.47 (*SD* = 3.65).

Materials

As with Studies 1-3, it was critical to ensure that the emotion displayed on *individual faces* were not biased by the face's age. We therefore aimed to match younger and older adult faces on perceived emotion. We first conducted a pretest on individual faces and, as detailed below, we used pretest ratings to generate groups in which the emotional difference between younger faces and older faces was held constant across trials. Next, we conducted a second pretest to ensure that the products selected for this study were perceived to be associated with younger adults, older adults, and a more general audience, respectively.

Pretest for Younger and Older Faces

We first conducted a pre-test using young adult and older adult faces from the FACES database of emotional expressions (Ebner et al., 2010). The FACES database is a set of younger adult, middle-aged adult, and older-adult faces with multiple posed facial expressions (e.g., happy, angry, sad, disgust, neutral). For this study we used neutral and happy facial expressions of younger and older adults. We focused on neutral and happy expressions for two reasons. First, although we have observed evidence for young-bias in ensemble perception of emotion across angry, ambivalent, and happy groups, this effect was most reliable when extreme anger expressions were absent. Second, given the cover story for this study (i.e., a focus group being asked to pose for a picture that captures how they feel toward a product), it is possible that angry expressions would be particularly salient and simply odd (i.e., being angry toward a door mat might be atypical), regardless of group member age. Indeed, given this experimental context, it is likely that participants will expect facial expressions of emotion to range from neutral to happy. Only faces with a minimum of 75% emotion categorization accuracy (see Ebner et al.,

2010) were selected for inclusion in the pre-test, resulting in a total of 116 young adult faces and 104 older adult faces.

In the pretest, 20 participants evaluated individual facial emotion images on a 1 (extremely negative) to 100 (extremely positive) sliding scale. Each participant evaluated each facial image, one-by-one, and in a random order. For each facial image, we then computed the average perceived emotion across raters. We then used these ratings to select 60 individual young adult and 60 individual older adult faces that were matched on perceived emotional valence at each level of emotion (i.e., neutral, happy). For neutral expressions, young adult faces (M = 40.74, SD = 5.85) and older adult faces (M = 40.45, SD = 5.86) were perceived as displaying similar emotional valence, $t(19) = 0.31$, p = .760, d = .07, 95% CI [-1.64, 2.21]. For happy expressions, young adult faces (M = 77.78, SD = 4.52) and older adult faces (M = 77.81, SD = 5.92) were perceived as displaying similar emotional valence, $t(19) = -0.04$, p = .972, d = .01, 95% CI [-2.28, 2.20]. Thus, as intended, we selected a total of 120 faces for inclusion in Study 4, with an equal number of younger and older adult neutral and happy faces matched on perceived emotional valence.

Face Groups

Face groups always consisted of 4 young adult and 4 older adult faces. We created two types of face groups, young-positive and old-positive groups. In young-positive groups, young adults in the group expressed happy expressions while older adults displayed neutral expressions. Young adult happy faces and older adult neutral faces were randomly selected from the set of pre-test faces described above to generate young-happy groups. In old-positive groups, older adults expressed happy expressions

while young adults displayed neutral expressions. Young adult neutral faces and older adult happy faces were randomly selected from the set of pre-test faces described above to generate old-positive groups. Thus, although the average emotion of the group remained constant, whether younger or older adults displayed more positive emotion was manipulated. As with Studies 1-3, face groups were single gender, with an equal number of face groups consisting of men and women.

Pretest for Product Images

Next, it was critical to select products that were perceived to be associated with younger adults, older adults, and a more general audience. First, we collected a broad range of product images (e.g., related to healthcare, home supplies, games/exercise, food & beverages). Next, we created product labels (e.g., personal alert system, wearable fitness tracker, wristwatch) to reduce any potential ambiguity associated with the images. In addition, and to increase the credibility of the cover story, we created fake brand names for each product image. All name brands were blurred out and presented next to the product label for each product. In total, we selected 240 products images, with corresponding brand names and labels, for inclusion in the pretest.

In the pretest, 18 participants evaluated each individual product image on the age they thought the product was intended for ranging from 1 (young adults) to 7 (older adults). Each participant evaluated each product image, one-by-one, and in a random order. For each product image, we then computed the average perceived score across raters. We then used these ratings to select 40 products associated with a more general audience (i.e., near the midpoint of the scale), 40 products associated with younger adults, and 40 products associated with older adults. First, and as intended, products for a

general audience were rated near the midpoint of the scale (M = 4.04, SD = 0.53), t(17) = 0.35, p = .728, d = .08, 95% CI [-0.22, 0.31]. Old-oriented products (M = 6.22, SD = 0.40) were more closely associated with an older audience than general products, t(17) = 16.21, p < .001, d = 3.82, 95% CI [1.89, 2.46], or young-oriented products (M = 1.94, SD = 0.44), t(17) = 29.68, p < .001, d = 7.00, 95% CI [3.97, 4.58]. As expected, young oriented products were associated with a younger audience than the general products, t(17) = -21.85, p < .001, d = 5.15, 95% CI [-2.30, -1.90]. Finally, we aimed to ensure that young-oriented products and old-oriented products were perceived as similarly different from products intended for a more general audience. Indeed, the absolute difference between old-oriented products and general products (M = 2.17, SD = 0.57) was similar to the absolute difference between young-oriented products and general products (M = 2.10, SD = 0.41), t(17) = 0.40, p = .694, d = 0.09, 95% CI [-0.31, 0.46]. Thus, as intended, we selected a total of 120 product images for inclusion in Study 4, with 40 products associated with younger adults, 40 products associated with older adults, and 40 products associated with a more general audience.

Procedure

In Study 4, participants first read a cover story describing the study procedures. Participants were informed that they would view groups of individuals who recently took part in a focus group. They were informed that the focus group consisted of both younger and older adults and that focus group members were asked to express how they felt about various products via facial emotion. The participants were then be informed that we were interested in whether people can see—from photographs of these focus group members—how well the group liked each product. Thus, on each trial, they first saw one of the

products that the group ostensibly evaluated followed by the focus group. Critically, the type of products the participants saw was manipulated. Specifically, participants saw 40 products designed for older adults, 40 products for younger adults, and 40 products for a more general audience. For old-oriented products, participants were led to believe that the group was responding to products that are designed and marketed for older adults (e.g., slip-resistant shower mat). For young-oriented products, participants were led to believe that the group was responding to products that are designed and marketed for younger adults (e.g., yoga mat). For products designed for a more general age range participants were led to believe that the group was responding to products that are marketed for all-ages (e.g., door mat). In total, there were 120 unique product images that were each presented once and in a randomized order.

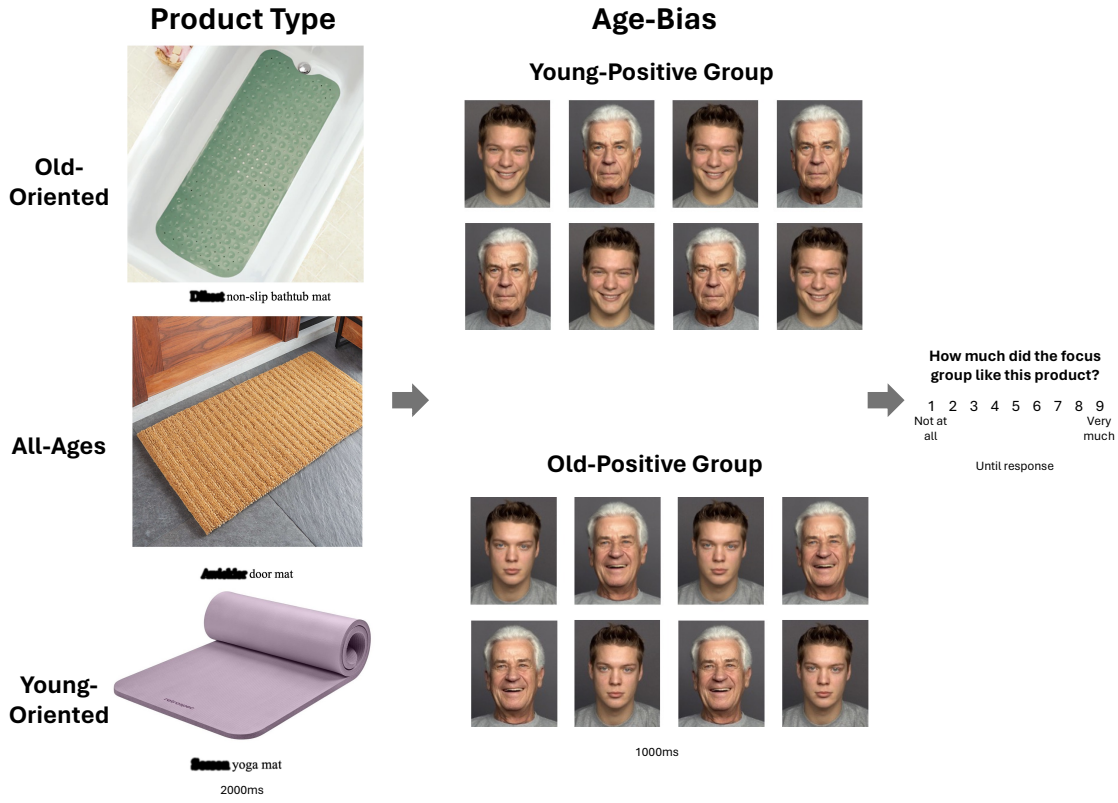
Following each product image, participants saw either an old-positive or a young-positive group ostensibly expressing their emotions toward the product participants had just seen. As described to participants, their task was to estimate the extent to which the entire group liked the product using a scale from 1 (not at all) to 9 (very much). Importantly, participants saw an equal number of young-positive and old-positive groups for each product target age (i.e., old-oriented, young-oriented, all-ages). Thus, this study used a 3 (product type: older-oriented, younger-oriented, or all-ages) x 2 (age-bias: young-positive, old-positive) fully within-subjects design (see Figure 9). Participants completed a total of 120 trials.

Finally, participants indicated their frequency and quality of contact with older adults and completed the same measure of age-emotion stereotypes regarding expressions of anger and happiness used in Studies 2-3 (Fabes & Martin, 1991). In addition, it is

possible that the pattern of young bias observed in Studies 1-3 owes, in part, to participants' lay beliefs about the extent to which emotion is perceptible from the facial cues of younger and older adults. That is, to the extent that people hold views that emotion is easier to perceive on young adult (versus older adult) faces, then they may correspondingly attend more to young adults in a group simply because those faces are believed to be more informative and thus more useful in group perception. To test this possibility, we included two additional items intended to assess young adults' lay beliefs about the extent to which emotion can be extracted from the facial cues of younger adults and older adults. Specifically, we asked participants to indicate "to what extent can you determine the emotion of [younger/older] adults simply by looking at their face?" from 0 (not at all) to 6 (entirely). In general, participants did not have difficulties following the procedure or completing the group perception task. All experimental procedures and materials were reviewed and approved by the Institutional Review Board (IRB) at the researcher's university. Study design and analytic plan were pre-registered on AsPredicted.org.

Figure 9

Example Trial Structures for Study 4



Note. Example trial structure for Study 4. Product types include a slip-resistant mat (for older adults), a yoga mat (for younger adults), and a door mat (for a general audience). Unique faces were never presented more than once in the same group and are only presented multiple times in the example groups above for publication purposes.

Results

Liking Ratings

Mean liking ratings served as the dependent measure of interest. As in Studies 1-3, trials in which response times were under 300ms or over 30 seconds were excluded from analyses (9.46% of all trials). We predicted that young adult participants' estimates of the extent to which the group liked a product would depend on the product target age (i.e., young-oriented, old-oriented, all-ages) and age-bias of the group. Critically, in the

context of old-oriented products, we anticipated an attenuation or possibly even a reversal of the young-bias effects observed in Studies 1-3, such that older adult expressions would be prioritized in ensemble perceptions of the group. In the context of products oriented toward younger adults or all-ages, we predicted a similar pattern of young bias in ensemble perceptions observed in Studies 1-3.

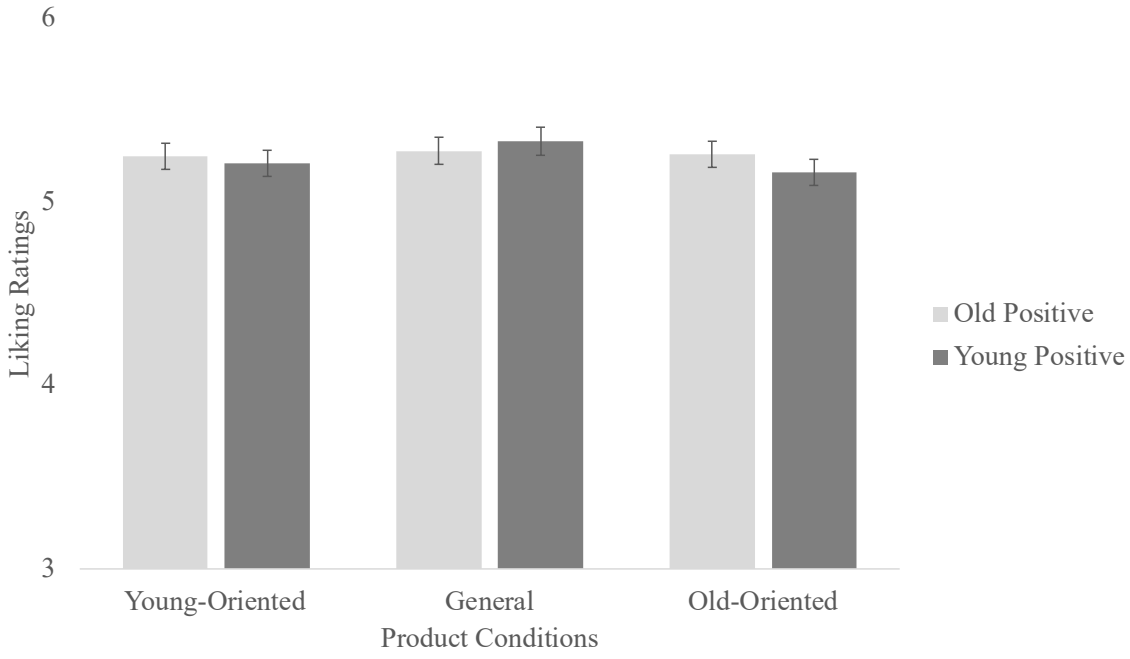
To test this hypothesis, we conducted a 3 (product target age: young-oriented, old-oriented, all-ages) x 2 (age-bias: young-positive, old-positive) repeated measures ANOVA on mean liking ratings. There was no main effect of the product target age, $F(2, 302) = 2.35$, $p = .097$, $\eta_p^2 = .02$, or age-bias, $F(1, 151) = 0.81$, $p = .369$, $\eta_p^2 = .005$, on liking ratings. More importantly, the interaction between product target age and age-bias approached significance, $F(2, 302) = 2.86$, $p = .059$, $\eta_p^2 = .02$ (see Figure 10).[3] Consistent with hypotheses, in the context of old-oriented products, participants reported greater liking ratings for old-positive groups ($M = 5.26$, $SD = 0.90$) than young-positive groups ($M = 5.17$, $SD = 0.89$), $t(151) = 2.06$, $p = .042$, $d = 0.17$, 95% CI [0.004, 0.19], an effect that did not emerge in other conditions (see below). Accordingly, we were able to *reverse* the bias that was present in Studies 1-3 with a strong manipulation of task-relevance—such reversal was not seen even in the Study 3 training manipulation.

[3] The main analyses and exclusion criteria reported above were preregistered on AsPredicted.org. However, in examining the data, one participant reported that they "did not pay attention" during the study. In exploratory analyses, excluding this participant resulted in a statistically significant product type x age bias interaction, $F(2, 300) = 3.16$, $p = .044$, $\eta_p^2 = .02$. Consistent with analyses reported above, there was a significant effect of age-bias on liking ratings for the old-oriented product condition, $t(150) = 2.11$, $p = .037$, $d = 0.17$, 95% CI [0.006, 0.19]. In addition, it is noteworthy that 3 participants reported that they have lived in the U.S. for less than one year. This was unexpected, and it is possible that these individuals have different associations between products and age than do participants who have lived in the U.S. for a significant period. In exploratory analyses, we find that excluding these participants resulted in a statistically significant product type x age bias interaction, $F(2, 296) = 3.40$, $p = .035$, $\eta_p^2 = .02$. Again, there was a significant effect of age-bias on liking ratings for the old-oriented product condition, $t(149) = 2.33$, $p = .021$, $d = 0.03$, 95% CI [0.02, 0.20].

However, contrary to hypotheses, we did not replicate the young-bias observed in Studies 1-3. There was no effect of age-bias in the context of young-oriented products, $t(151) = 0.89$, $p = .377$, $d = 0.07$, 95% CI [-0.05, 0.12], or products for all-ages, $t(151) = -0.99$, $p = .324$, $d = 0.08$, 95% CI [-0.15, 0.05]. This absolute difference between Study 4 and Study 3 could owe to a variety of methodological factors or processes (elaborated in the Discussion), such as differences in evaluating emotion versus liking or the role of context in ensemble perception. For this reason, I focus my interpretation on the *relative* differences among experimental conditions and in this respect, my theory was clearly supported: participants were more likely to favor older (vs younger) adults in ensemble perception when the context made older adults relevant and younger adults irrelevant, as compared to when the context was more relevant to younger adults or a general audience.

Figure 10

Mean Liking Ratings for Each Product Condition



Note. Average liking ratings for product type (young-relevant, general, old-relevant) x age-bias (old-positive vs young-positive) for Study 4. Error bars represent ± 1 SEM.

Individual Differences in Ingroup Bias

We again reasoned that if biases in ensemble perception were driven by ingroup bias, then factors that increase ingroup bias should also increase the bias in ensemble perception. Specifically, we examined whether intergroup contact was associated with biased ensemble perception scores. Consistent with Studies 1-3, intergroup contact with older adults was not correlated with biased ensemble perception scores in any of the product conditions (*p*s > .15).

Individual Differences in Age-Emotion Stereotypes and Facial Lay Beliefs

It is also possible that participants' concepts of emotion are age-biased (e.g., young adults may be more readily associated with happiness than older adults), and this might bias ensemble perceptions. Thus, we next examined whether individual differences in age-emotion stereotypes were associated with biased liking ratings. Before testing this hypothesis, we first examined the degree to which participants reported age-emotion stereotypes on average. Participants reported that young adults (M = 3.96, SD = 1.35) express less anger than older adults (M = 4.44, SD = 1.36), $t(150) = -3.81$, $p < .001$, $d = -0.31$, 95% CI [-0.72, -0.23]. In addition, participants reported that younger adults (M = 4.87, SD = 1.11) express more happiness than older adults (M = 4.52, SD = 1.25), $t(150) = 2.88$, $p = .005$, $d = 0.23$, 95% CI [0.11, 0.59]. Consistent with Studies 2-3, age-emotion stereotypes were not associated with liking ratings in any of the product conditions, (*p*s > .09).

In addition, it is possible that participants' lay beliefs about the extent to which emotion is perceptible from facial cues of younger versus older adults may contribute to bias in ensemble perception. Thus, we next examined whether individual differences in

lay beliefs about the perceptibility of facial emotion from younger and older adult faces were associated with biased liking ratings. Before testing this hypothesis, we first examined the extent to which participants believed they could determine the emotion of younger and older adult faces. Participants reported that they could determine the emotion of younger adults (M = 5.03, SD = 1.14) to a greater extent than older adults (M = 4.78, SD = 1.22) simply by seeing their faces, $t(151) = 2.22$, $p = .028$, $d = 0.18$, 95% CI [0.03, 0.46]. However, lay beliefs about facial emotion were not associated with biased ensemble perception scores in any of the product conditions (ps > .48). These analyses indicate that individual difference measures related to ingroup bias, age-emotion stereotypes, and lay beliefs about facial emotion were unrelated to social identity bias in ensemble perception.

Discussion

In Study 4, we manipulated the social context in which ensemble perception occurred to further test our relevance account. We predicted that older adults' contributions to a group may be particularly informative or important within the context of evaluating products designed specifically for older adults. Thus, we predicted that when evaluating the extent to which mixed-age focus groups liked products designed for older adults, participants should weight the emotional expressions of older adults more heavily. Consistent with predictions, participants appeared to prioritize the emotional expressions of older adults in the group when the product of interest was oriented toward older adults. That is, participants reported that focus groups liked old-oriented products more if older adults displayed positive emotion (relative to younger adults) but *only* if the product was oriented toward older adults.

Thus, the relative differences between experimental groups were consistent with hypotheses (more old-bias for older-adult products). However, the absolute effects within each condition were not: participants did not appear to overweight the emotional expressions of young adult group members in their group perceptions following young-oriented products or products intended for a general audience. There are several reasons that we did not replicate the young-bias observed in Studies 1-3. In particular, although we pre-tested the association between young-oriented products and young adults and old-oriented products and older adults, perceived differences in the usage of these products might still exist. Specifically, old-oriented products may be viewed as exclusively used by older adults, while young-oriented products might be perceived as suitable for both age groups. For example, dentures may be viewed as exclusively for older adults, whereas yoga mats may be perceived as suitable for younger and older adults, despite being associated more readily with younger adults. Thus, our *relevance* manipulation may have been more effective in the context of old-oriented products. Regardless, the results of Study 4 represent a notable departure from the young bias observed in Studies 1-3 and provide additional evidence that perceived relevance *can* impact ensemble perceptions. More specifically, Study 4 suggests that ensemble perceptions may prioritize the emotional expressions of older adults in a mixed-age group in social contexts in which their opinions are more task-relevant.

Chapter Six: General Discussion

To our knowledge, this is the first set of studies to examine *incidental* effects of social identity on ensemble perceptions of emotion. Where prior work has focused on whether ensemble perceptions of social identity are accurate, the current work focuses on whether ensemble perceptions of emotion can be biased by *task irrelevant* social identities in visible groups. We reasoned that if ensemble perceptions of facial emotion function (in part) to support social well-being, then its operating characteristics should support this function. Specifically, ensemble perceptions appear to be based on a weighted sub-sample of faces in a group and we hypothesized that social identity of group members drives the implementation of this process. The result should be ensemble perceptions of emotion that are biased toward the emotions expressed by group members with more self-relevant social identities. Moreover, these biased ensemble perceptions should inform the degree to which perceivers think a group presents a meaningful opportunity for affiliation. As described below, we observed support for these hypotheses in four experiments exploring the effects of age-based social identities on ensemble perceptions of emotion, belongingness, and liking. Moreover, Studies 3-4 examined relevance as the driver of these bias effects.

Participants briefly viewed crowds of 8 faces and evaluated the average emotion of the entire crowd. In Study 1, we observed a young-bias, such that participants weighted young (vs. older) adult emotions more heavily in their ensemble perceptions. In

Study 2, both younger adult and older adult participants exhibited a young-bias, ruling out a simple ingroup bias as the entire explanation for the young-bias in ensemble perception of emotion. In Study 3, we examined the role of perceived relevance through a learning manipulation in which older or younger adult faces were predictive of participant monetary outcomes. As expected, participants were less likely to exhibit a young-bias after they had learned that older faces had a greater impact on their monetary outcomes than did younger faces. Finally, in Study 4, we were able to *reverse* the young-bias by manipulating the context in which the face group was said to be responding to. When the context was clearly more relevant to older than younger adults, participants exhibited an *old-bias* favoring older adult emotion expressions over younger adult emotional expressions.

Thus, across 4 studies drawing from both young and older adult samples, we found support for our hypotheses that ensemble perceptions of emotion can be biased toward the emotions expressed by group members with more self-relevant social identities and these biased ensemble perceptions can inform the degree to which perceivers think a group presents an opportunity for affiliation.

Implications for Ensemble Perception

A burgeoning ensemble perception literature indicates that perceivers are capable of rapidly extracting meaningful summary statistics from bodies and faces, such as the average of a group's gaze (Sweeny & Whitney, 2014), sex-ratio (Yang & Dunham, 2019), race-ratio (Phillips et al., 2018), and emotion (Haberman & Whitney, 2007; 2009). Given the human necessity of effectively interacting with groups, researchers have speculated that ensemble perception is critical for adaptive social functioning (Phillips et

al., 2014; Sweeny et al., 2013; Whitney et al., 2014). For example, extracting the average emotion of a group may be particularly important for making inferences about that group's goals and intentions (Alt et al., 2019; Goodale et al., 2018). Aligned with this theoretical perspective, we have argued that if ensemble perceptions operate (at least in part) to maximize social functioning in groups, then this should be reflected in its operating characteristics.

Building on evidence that perceivers base their ensemble perceptions on a sub-sample of visible group members (Allik et al., 2013; Goldenberg et al., 2021; Maule & Franklin, 2016), we proposed, and found evidence, that ensemble perceptions are biased by the contributions of individuals in a group who are most relevant to the perceiver. Although it remains possible that low-level stimulus features influenced study results—the observed results of Studies 3-4 provide evidence against this alternative. For example, in Study 3 a reward learning paradigm was used to effectively manipulate relevance prior to the ensemble perception task and the young-age bias was reduced when older facial emotions were made more relevant. These results cannot be easily reconciled with the idea that the stimuli themselves (rather than perceivers cognitions about those stimuli) drove the results: the stimuli were identical in the young-relevant and old-relevant conditions. Moreover, in Study 4, changing the context of the ensemble perception itself effectively altered the young-bias effect: again, stimuli were identical across context conditions suggesting that stimulus-driven effects alone cannot fully account for the data. Conversely, our theoretical account of relevance is directly tied to the results across all 4 studies, and we therefore regard that theory as a more parsimonious (and thus useful) interpretation of the results. While previous research has shown that low-level visual

features can influence the weighting of individual elements in ensemble perception (e.g., larger circles being more salient and weighted more heavily in estimates of average circle size; Kanaya et al., 2018), our findings suggest that higher-level social factors, such as the perceived relevance of social identities, may determine the extent to which individual faces are weighted in ensemble perception of emotion. We argue that the salience of individual faces is not exclusively determined by low-level visual features but also by the perceiver's assessment of the relevance of each face's social identity. This additional layer of relevance appraisal distinguishes our findings from those focusing on low-level visual features and highlights the importance of considering social relevance in ensemble perceptions of groups. Rather than equally weighting all individuals in a group, perceivers in these studies preferentially attended to those who were higher in social-identity relevance. Accordingly, our findings suggest that ensemble perceptions of human faces may depend on processes that selectively summarize the characteristics of the most self-relevant group members. As such, these four studies provide insight about the processes underlying ensemble perception of faces and perhaps selective summarization in particular.

It is worth noting that measurement of ensemble perception is varied, including the method-of-adjustment (Haberman et al., 2009), forced choice and PSE (Haberman & Whitney, 2007, 2009; Kanaya et al., 2018), and Likert scales (Alt et al, 2019; Goodale et al., 2018; Leib, Kosovicheva, & Whitney, 2016). Of these measurement tools, the method-of-adjustment may best approximate a *visual* representation whereas measures that require conceptual labels (Likert, force-choice) allow for greater influence from judgment processes (Haberman et al., 2009). In the current work, however, the method of

adjustment would have been problematic. Specifically, the age identity of the test face would likely cause perceivers to "sample" faces of similar age from the visual representation of the group, thus interfering with our ability to test hypotheses. We therefore elected to use a scale to assess bias in ensemble perception, understanding that this measure is likely to index both visual and semantic representations.

More generally, much of the literature on ensemble perception has focused on accuracy rather than bias. The findings reported here suggest that examining biases, rather than accuracy, may provide a particularly fruitful means of examining the social function of ensemble perception. If ensemble perceptions can be biased by incidental social factors such as social identity of group members, as suggested here, then studies on ensemble perception of emotion should not be agnostic toward the social identities of group members. For example, ensemble perception studies in which all faces are young white males may need to limit conclusions to those social identities-- given the biasing effects we observed, groups that include a mixture of social identities are likely to be perceived differently than groups that include one specific combination of social identities.

Implications for Social Identity Effects for Evaluations of Groups

The current findings point to social identity biases that emerge only in the context of groups. Indeed, the stimuli used in these studies were carefully controlled to ensure that facial emotions in *individual* young-adult faces were equivalent to facial emotions in *individual* old-faces, both objectively (in Studies 1-3) and subjectively. Thus, the biases we observed in ensemble perception indicate a bias which emerges when people perceive small groups but not when they perceive those group members *in isolation*. Such effects

are consistent with recent research suggesting that groups of individuals with shared social category membership elicit greater stereotyping than the same individuals perceived by themselves (Cooley et al., 2018). In both our studies and Cooley et al, a group setting caused effects to emerge that did not emerge (or were weaker) when individuals were perceived in isolation. In the current case, however, we find evidence for a bias based on social identity *relevance* and we attribute this effect to attentional factors that emerge in group settings rather than stereotypes. It is thus possible that perceptual and attentional biases introduced by social identity emerge more strongly in the context of perceiving groups than in the context of perceiving individuals. More broadly, these findings suggest that person perception biases and *people perception* biases are not equivalent. Rather, more precise theories can be formed to explain how the unique properties of small groups may result in different biases than those that emerge for individuals (e.g., Phillips et al., 2014).

One alternative explanation, drawn from research on social-identity biases, is that age-emotion stereotypes account for our findings. We addressed this potential alternative through methodological controls and measures of individual differences. First, we matched young adult and older adult faces on both objective and subjective facial emotion—we thus controlled for age-emotion stereotypes (e.g., younger = happier) in our design. This control was instituted at the level of individual faces. However, it is worth noting that in our pre-test, participants were able to view the individual younger and older adult faces for as long as they wanted before indicating a response. Therefore, we cannot rule out the possibility that the brief duration times used in our main studies made it more difficult to discriminate emotions on older adult faces compared to younger adult faces.

Regardless, experimental manipulations of relevance attenuated the pattern of young-bias in Study 3 and fully reversed it in Study 4, suggesting that any differences in the discriminability of younger and older adult faces under short viewing durations cannot fully account for our results. Rather, our findings support our theory that the relevance of group members' social identities played a key role in shaping ensemble perceptions of emotion, over and above any potential influence of age-emotion stereotypes or differences in the discriminability of emotion between younger and older adult faces.

It is also possible that age-emotion stereotypes operate uniquely at the group level. For example, if participants more readily associate younger adults with happiness and older adults with anger, these age-emotion stereotypes could have biased their attention to group members displaying stereotype congruent expressions. For this reason, we measured participants' age-emotion stereotypes (self-reported) in Studies 2-4 and observed no evidence that these stereotypes explained our results or had any effects on participants' ensemble perceptions. In addition, it is possible that participants hold lay beliefs that facial emotion is more readily perceptible on young adult faces compared to older adult faces. For example, older adults tend to have more facial wrinkles which could obscure their emotional expressions (Hess et al., 2012). Although we control for subjectively perceived emotion in younger and older adult faces in all our studies, it is still possible that participants' beliefs about perceptibility of facial emotion could have impacted who they attended to in the group. Contrary to this hypothesis, we did not find evidence that lay beliefs regarding facial emotion in younger and older adults impacted bias in ensemble perceptions in Study 4. Thus, our data argue against an explanation based on age-emotion stereotypes and instead support our theory that ensemble

perceptions of emotion (and belongingness ratings) are biased in favor of group members holding the greatest relevance to the perceiver.

Implications for Small Groups and Organizations

As described in Phillips, Weisbuch, & Ambady (2014), ensemble perceptions are likely to have important implications for group and organizational contexts. We have largely argued that ensemble perceptions are biased in favor of individuals who are able to directly influence one's well-being. However, navigating group contexts may be more nuanced in the real-world. For example, individuals in a group may not only directly influence the self (e.g., through their ability to help or harm), but they may also indirectly influence the self through their ability to impact the overall thinking or behavior of the group. Consider the role of higher-status individuals within a group or organizational context. Their opinions may frequently carry more weight and disproportionately impact group norms, attitudes, and decision making (Berger et al., 1972; Kalkhoff & Barnum, 2000; Melamed & Savage, 2013; Moore Jr, 1968; Raven & French, 1959). As such, preferentially attending to the emotional expressions of individuals holding greater influence within a specific group or organizational setting may be particularly relevant to understanding the group as a whole. Thus, future research should examine the impact of direct versus indirect influence of group members on the self in ensemble perceptions of emotion and belongingness.

More broadly, emotion expressions are one of the primary means by which people form initial evaluations of a others (Hess et al., 2000; Knutson, 1996; Montepare & Dobish, 2003; Zebrowitz, 2017), suggesting that initial group evaluations (as a whole) may significantly underrepresent the emotions of older adults present in a group. For

example, in workplaces with mixed-age groups, overweighting young adult emotional expressions could lead to company policies or decision making that inadvertently ignores the opinions or needs of older adult employees. Similarly, in group discussions, such as town hall meetings, outcomes centered around group consensus may systematically favor young adults if their emotional expressions are weighted more heavily than older adults. However, the results of Studies 3 & 4 suggest that social contexts in which older adults are perceived as more relevant than younger adults may lead to a reduction, or even a reversal, in this young-bias in group perception. As such, group evaluations may overrepresent the emotions of older adults in social contexts in which older adults are perceived to be more relevant than younger adults. Finally, it is important to acknowledge that the role of self-relevance in ensemble perceptions of emotion should not be limited to age-based identities. Rather, social identities that are frequently associated with low relevance (e.g., Black women, people with disabilities; Neel & Lassetter, 2019) may also tend to be underweighted in people's representations of a group.

Limitations and Constraints on Generality

This package of studies included several unanswered questions which call for future research. First, our theory regarded visible social identities associated with low relevance in general, yet we only examined one type of social identity—identity associated with young versus old age. Although the findings support our theory, it is possible that the observed effects are specific to age-based social identities. We believed that age-based identities were a better starting point for testing our theory than were race- or gender-based identities, as both of the latter received an unusual amount of media

attention during data collection (i.e., Studies 1 & 2 were conducted during the American Presidency of Donald Trump) which could have biased results. In general, we used a theory-testing approach and found support for our hypotheses. However, to confirm that our theory applies to other social identities associated with low relevance, it will be necessary to examine if equivalent effects are observed with other visible social identities. Although my theory can—in principle--be applied to any perceived social identities, the results of Study 4 suggest that specific contextual effects can have a strong influence on perceived relevance. Accordingly, it is possible that a lifetime of social learning "teaches" people less about the general relevance of a given identity (e.g., older adult, woman) but rather context-specific relevance. That is, when a social identity is clearly more relevant within a given context, that identity may be overweighted in ensemble perceptions. In addition, stereotypes associated with certain social identities may inform perceived relevance within specific contexts. For example, perceivers holding stereotypical views of Black men as aggressive (Cottrell & Neuberg, 2005; Hugenberg & Bodenhausen, 2003, 2004; Wilson et al., 2017) may view facial anger on Black men's (versus White men's) faces in a group as particularly salient within ambiguous or threatening contexts and weight their emotional expressions more heavily in ensemble perception. Of course, in Studies 1-2, we observed young-bias absent a true context for groups of faces and these decontextualized effects may reflect a general, or cross-context, cognitive representation of relevance (e.g., if young adults are more relevant in most social contexts). Thus, while our findings provide initial support for the role of social identity relevance in ensemble perception, further research is needed to test the generalizability of this theory to other social identities, and critically, the package of

studies presented here points to the importance of understanding *how* people learn about the relevance of certain social identities.

A second limitation regards effects for specific group emotions. In general, ensemble perceptions and belongingness ratings were biased in favor of young group members' facial emotions, but when the average emotion in a group was "angry", effects were less reliable. Among young adult perceivers, ensemble perceptions of angry groups favored younger group members in Studies 2 & 3 but not in Study 1. Moreover, in Studies 1 & 2, young adult perceivers reported greater affiliative potential (belonging) for young-positive happy groups and emotionally-ambivalent groups but not for young-positive angry groups. We anticipated that an anger bias might supersede any effects of age-bias on ensemble perception (especially since we measured ensemble perceptions of emotion, not age), and thus lead to limited effects of age-bias on angry groups. Although perceivers should generally prioritize social identities that are typically more relevant to their outcomes, Neel and Lassetter (2019) argue that in threatening contexts (e.g., an angry crowd), cues to threat may take precedence (cf. Neel & Lassetter, 2019). Participants may have attended to salient indicators of threat (e.g., extreme anger expressions) and weighted those expressions more heavily in their ensemble perceptions of emotion regardless of whether the group members displaying those expressions were younger or older adults. This explanation, however, is speculative and was not thoroughly tested. For example, it is also possible that reduced effects for angry groups reflect a more general negativity bias that is not specific to threat. If so, young-bias in ensemble perceptions of emotion may be expected to be diminished when the overall emotion of a group is negatively valenced (e.g., sad, fear, shame). Given that young-bias

did emerge for angry groups in Studies 2 and 3, the safer conclusion is that for young adult participants, the young-age-bias in (a) ensemble perception and (b) ratings of affiliative potential is diminished for perceptions of groups in which the only expressed emotion is anger.

Conversely, older adult participants exhibited a young-age-bias in ensemble perception regardless of the overall emotional tenor of the group (happy, ambivalent, angry). Moreover, older adult participants exhibited a complicated pattern of findings with respect to affiliative potential. As with young adult participants, older adult participants reported more *affiliative potential* for young-positive (vs. old-positive) ambivalent groups. Older adults also exhibited this age-bias effect on affiliative potential for *angry* groups but not happy groups (whereas young adults exhibited an age bias effect for happy groups and not angry groups). It is possible that for older adult participants in our study, seeing extremely positive emotion displayed by older adult group members (i.e., old-positive happy groups) served as a robust cue for belonging that counteracted the typical pattern of young-bias that was observed for angry and ambivalent groups. Despite these emotion-specific effects on affiliative potential ratings, our main hypothesis was that age-bias in ensemble perception of emotion would be associated with age-bias in evaluations of affiliative potential, and we generally observed such correlational effects for both young and old participants across emotions.

In addition, the findings in Studies 3 & 4 were nuanced. In Study 3, we directly manipulated the self-relevance of younger and older adults via an incidental learning paradigm. Although the young bias in ensemble perception of emotion was attenuated when older adults were incidentally made more self-relevant, it was not fully eliminated.

Yet, our relevance account suggests that there should be certain contexts in which older adults are prioritized in ensemble perception. Indeed, in Study 4 we obtained an old-bias in ensemble perception in the context of old-oriented products. However, perhaps surprisingly, we did not observe a young-bias in the context of young-oriented products (or for products oriented toward a more general audience). There are several possible reasons why young-bias in ensemble perception may not have emerged in Study 4. First, to create an experimental context that manipulated the perceived relevance of younger and older adults, Study 4 focused on ensemble perceptions of liking, rather than emotion. Importantly, ensemble perceptions of liking required an additional step, such that participants needed to infer the extent to which the group liked a product *from* facial cues of emotion. This shift in processing goals may have diminished the typical young-bias observed in Studies 1-3. Moreover, the social context in Study 4 may have reduced ambiguity regarding the group's emotion. For example, knowing that a group's emotion is directed toward a product, rather than the self, may reduce the general tendency to overweight young-adults' emotional expressions in ensemble perceptions. In addition, the cover story (i.e., that we specifically recruited younger *and* older adults to be part of the focus group) may have increased the salience of older adults throughout the group perception task regardless of the product relevance manipulation. That is, older adults may not generally be considered for focus groups and thus seeing that approximately half of all focus group members were older adults may have stood out to participants. Indeed, encountering "unexpected" individuals in one's environment has been linked to increased attention toward those individuals (Kardosh et al., 2022). Importantly, Studies 1-3 did not provide participants with this type of social context for the group perception task. Thus,

while younger adults may *generally* be perceived as more relevant in broader social contexts—reflected by the consistent young bias observed in Studies 1-3—our findings also suggest that ensemble perceptions can be highly context-specific, such that weighting (or sampling) in ensemble perception may be dynamically adjusted based on the perceived relevance of younger (versus older) adults within a given social context.

A third potential limitation in our studies regards our use of FaceGen, which generates realistic 3D human faces using parameters obtained from three-dimensional face scans (Blanz & Vetter, 1999; Singular Inversions, 2005), to create younger and older adult faces in Studies 1-3. The use of FaceGen allowed for precise control in creating the face stimuli used in this work. Moreover, FaceGen faces have been widely used in studies of social perception, including ensemble perception. For example, studies have used FaceGen faces to examine a range of ensemble perception processes, including perceptions of a group's race, gender, dominance, and trustworthiness (Phillips et al., 2018; Chew et al., 2023; Marini et al., 2023). In addition, recent research suggests that FaceGen faces may *underestimate* social identity bias in social perception studies when compared to real faces (Gaither et al., 2019). We attempted to address this limitation with the use of real faces in Study 4. However, given the methodological changes to Study 4 detailed above (e.g., shifting from emotion ratings to liking ratings), it remains an empirical question as to whether the results on ensemble perception of emotion obtained in Studies 1-3 would differ with real human faces.

The current studies also do not include an analysis of the exact processing operations underlying perception of social identity and emotion in ensemble coding. Specifically, the time course of visual processing of age and emotion was not examined.

Prominent models of face perception suggest that processing of invariant facial characteristics, including age, gender, and race, are processed independently, but in parallel, with more variant facial characteristics, such as facial emotion (Bruce & Young, 1986; Haxby et al., 2000). Indeed, Kubota & Ito (2007) used event-related brain potentials (ERPs) to examine the time course of social identity (i.e., race) and emotion processing and found evidence that both are processed early and independently in the visual system. Other work utilizing speeded categorization tasks has found that categorization of age, gender, and race (i.e., invariant facial characteristics) consistently preceded emotion categorizations and that social identity information even interfered with emotion categorization (Craig & Lipp, 2018; Karnadewi & Lipp, 2011). However, these studies have focused on individual faces whereas the current work required integrating multiple faces into an ensemble. It is possible that ensemble perception facilitates a more interactive processing strategy in which age and emotion cues are processed simultaneously and each type of information dynamically informs the other. Alternatively, it is possible that processing of group member age preceded processing of group member emotion. That is, participants may have first sampled from the group based on group member age and only after did they process emotion on those faces. Conversely, group member emotions may have been processed first, with estimates of overall group emotion being adjusted based on the ages of group members expressing those emotions. Thus, future work should examine how invariant facial cues (i.e., age, gender, race) and variant facial cues (i.e., emotion) interact in ensemble perception. Moreover, examining the time course of these processing operations could provide

insight into the mechanisms underlying the social identity biases observed in the current studies.

Finally, it is possible that the young bias in ensemble perceptions of emotion observed in these studies depends on the culturally prescribed social relevance of older adults. For example, individuals in East Asian cultures may hold older adults in high esteem as well as place a greater emphasis on respect and care for older adults relative to individuals in Western cultures (Ng, 1998). However, it is notable that recent meta-analytic findings have suggested that negative stereotypes about older adults permeate many Eastern (including East Asia) cultures (North & Fiske, 2015). To the extent that older adults are perceived as holding high social value within a cultural context, young bias in ensemble perceptions of emotion may be mitigated, or even eliminated.

Conclusion

In this work, we applied a socio-functional framework to examine the operating characteristics of ensemble perception. Specifically, we set out to test whether ensemble perceptions can be biased by incidental social factors. Consistent with hypotheses, four experimental studies revealed a social identity-based bias in (a) the operation of ensemble perception processes and (b) downstream consequences of ensemble perception. Indeed, both younger and older adult participants preferentially weighted more self-relevant (young adult) group members relative to less self-relevant (older adult) group members in their ensemble perceptions of emotion, these age-based biases in ensemble perception of emotion had a meaningful impact on judgments of belongingness with the group, and importantly, this bias appeared to be malleable and vary depending on the perceived relevance of younger (versus older) adults within a given context.

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APPENDIX A

Face Pretesting

We manipulated group emotion using objective emotion parameters from FaceGen and FACSgen. We aimed to examine whether these experimental manipulations reflected subjective evaluations of facial emotion as well. To address this question, we recruited a separate sample of 116 participants from MTurk to evaluate the emotion of the facial images using a 1 (extremely angry) to 9 (extremely happy) scale. Participants evaluated 40 facial images, one-by-one, so that each image was evaluated by between 17 and 21 participants. For each facial image, we then computed the average perceived emotion across raters and aggregated these subjective emotion ratings for each group type.

First, we aimed to ensure that individual young adult and individual older adults faces were equated on subjective emotion ratings for all five levels of emotion used in this study. For extremely angry expressions, young adult faces (M = 2.74, SD = 0.44) were perceived as displaying similar emotion as older adult faces (M = 2.70, SD = 0.55), $t(36) = 0.25$, $p = .801$, $d = 0.08$, 95% CI [-0.56, 0.72]. For moderately angry expressions, young adult (M = 4.18, SD = 0.60) were perceived as displaying similar emotion to older adult faces (M = 4.29, SD = 0.76), $t(32) = -0.48$, $p = .633$, $d = -0.17$, 95% CI [-84, 0.51]. For neutral expressions, young adult faces (M = 5.19, SD = 0.43) were perceived as displaying similar emotion to older adult faces (M = 5.34, SD = 0.59), $t(35) = -0.86$, $p = .398$, $d = -0.28$, 95% CI [-0.93, 0.37]. For moderately happy expressions, young adult (M = 6.65, SD = 0.31) were perceived as displaying similar emotion to older adult faces displaying moderately happy expressions (M = 6.39, SD = 0.41), $t(30) = 1.95$, $p = .060$, d

= .69, 95% CI [-0.29, 1.40]. For extremely happy expressions, young adult faces (M = 7.50, SD = 0.36) were perceived as displaying similar emotion to older adult faces (M = 7.35, SD = 0.38), $t(30) = 1.18$, $p = .246$, $d = 0.42$, 95% CI [-0.29, 1.12]. Thus, individual young adult and individual older adult facial expressions were equated on subjective emotion ratings across all five levels of emotion.

To construct groups, we aimed to establish that each overall group emotion (angry, ambivalent, happy) included faces that differed, on average, in subjective emotion ratings. As expected, the happy groups included faces that were rated, on average, as displaying more positive emotion (M = 6.30, SD = 0.34) than ambivalent (M = 5.34, SD = 0.28), $t(78) = 13.91$, $p < .001$, $d = 3.11$, or angry groups (M = 3.99, SD = 0.31), $t(78)$ = 31.75, $p < .001$, $d = 7.10$. Ambivalent groups included individuals faces that were rated, on average, as displaying more positive emotion than angry groups, $t(78) = 20.38$, $p <$ .001, $d = 4.56$. Next, we aimed to establish that the aggregated emotional difference between individual young faces and individual old faces was similar for young-positive and old-positive groups. Specifically, for groups in which younger faces were objectively happier than individual older faces (young-positive groups), the individual younger faces were subjectively rated as happier (M = 6.43, SD = 1.02) than individual older faces (M = 4.10, SD = 1.03), $t(59) = 401.06$, $p < .001$, $d = 51.78$. For groups in which individual younger faces were objectively angrier than individual older faces (old-positive groups), the individual younger faces were also subjectively angrier (M = 3.97, SD = 1.00) than individual older faces (M = 6.34, SD = 0.95), $t(59) = 174.54$, $p < .001$, $d = 22.53$. Thus, the aggregated emotional difference between individual young faces and individual old faces was as intended for young-positive and old-positive groups.

APPENDIX B

Perceptions of Group Emotions or Perceptions of Several Individuals Emotions?

We observed an effect of age-bias on ensemble perceptions of emotion (see main text), which we regard as an effect that *emerges* in group contexts. Conversely, pretest ratings regarded evaluations of *individual* facial emotions. To isolate such group-emergent effects, we first computed the *expected* group emotion value for each trial on the basis of individual-level, pretest ratings. This was computed by averaging ratings from pretest participants for each individual face, and then aggregating these individual-face ratings for each visible group. Thus, the "expected group emotion value" was derived entirely from the *individual* face ratings collected at pretest *and describes what would be expected if participants were simply aggregating their evaluations of individual faces*. Next, we controlled for these values in our main analyses of emotion ratings. Positive (covariate-adjusted) scores reflect more positive ratings than would be expected based on the individual-face ratings alone and negative scores reflect more negative ratings than would be expected based on individual-face ratings alone. We thus expected these analyses to produce similar results as the main analyses (that did not control for pretest ratings), such that young-positive groups will receive more positive scores than old biased groups. Critically, this analysis produced a highly similar pattern of means and statistical significance as in the main analyses, in which subjective ratings were not controlled.

Study 1

To examine if the results of Study 1 hold when controlling for individual-face ratings, we conducted a 2 (age-bias: young-positive, old-positive) x 3 (overall group

emotion: angry, ambivalent, happy) repeated measures ANOVA on the difference score between the *expected* group emotion rating and participants' *actual* rating for each group. There was a main effect of age-bias, such that young-positive groups were rated as happier (M = .01, SD = .49) than old-positive groups (M = -.17, SD = .55) even when accounting for individual face-emotion ratings, $F(1,81) = 10.10$, $p < 01$, $\eta_p^2 = .11$. As in the primary analyses, this main effect was qualified by a significant age-bias by overall group emotion interaction, $F(2, 162) = 3.82$, $p < .05$, $\eta_p^2 = .05$. Participants perceived more positive emotion in young-positive happy groups (M = .07, SD = .58) than in old-positive happy groups (M = -.25, SD = .61), $t(81) = 4.10$, $p < .001$, d = .45. Participants also marginally perceived more positive emotion in young-positive ambivalent groups (M = .19, SD = .63) than in old-positive ambivalent groups (M = .04, SD = .72), $t(81) = 1.67$, p = .098, d = .19. However, participants did *not* perceive more positive emotion in young-positive angry groups (M = -.23, SD = .81) than in old-positive angry groups (M = -.30, SD = .82), $t(81) = 1.03$, p = .305, d = .11. Notice, however, there is an obvious anger-bias in group ratings—regardless of age-bias, participants rated groups as angrier than would be expected from the individual face-ratings. Thus, similar to the pattern of results reported in the main text, participants' ensemble perceptions of emotion were biased to favor higher-status (young) social identities for happy groups and ambivalent groups, even when accounting for the individual face-emotion ratings.

Study 2

Next, to examine if the results of Study 2 hold when controlling for subjective ratings, we conducted a 2 (age-bias: young-positive, old-positive) x 2 (participant age-group: young adult, older adult) x 3 (overall group emotion: angry, ambivalent, happy)

mixed model ANOVA on the difference score between the *expected* value of the group emotion rating and participants' *actual* rating for each group. There was a main effect of age-bias, such that young-positive groups were rated as happier (M = .27, SD = .55) than old-positive groups (M = -.03, SD = .62) even when controlling for individual face-emotion ratings, $F(1,187) = 99.78$, $p < 001$, $\eta_p^2 = .35$. In addition, there were significant 2-way interactions between age-bias and participant age-group, $F(2,374) = 14.36$, $p < .001$, $\eta_p^2 = .07$, and overall group emotion and participant age-group, $F(2,374) = 3.84$, $p < 05$, $\eta_p^2 = .02$. Importantly, these effects were qualified by a significant 3-way interaction, $F(2,374) = 8.97$, $p < 001$, $\eta_p^2 = .05$. To interpret this 3-way interaction, we next report results for young adult participants and older adult participants separately.

Young Adult Participants. We conducted a 2 (age-bias: young-positive, old-positive) x 3 (overall group emotion: angry, ambivalent, happy) repeated measures ANOVA on young adult participants' difference score between the expected value of the group emotion rating and their actual rating for each group. There was a main effect of age-bias, such that young adult participants rated young-positive groups as happier (M = .15, SD = .57) than old-positive groups (M = -.26, SD = .61) even when accounting for individual face-emotion ratings, $F(1, 95) = 92.98$, $p < .001$, $\eta_p^2 = .50$. Importantly, there was a significant age-bias by group emotion interaction, $F(2,190) = 9.55$, $p < .001$, $\eta_p^2 = .09$. Young adult participants perceived more positive emotion in young-positive happy groups (M = .34, SD = .67) than old-positive happy groups (M = -.23, SD = .68), $t(95) = 9.52$, $p < .001$, d = . 97. Young adult participants also perceived more positive emotion in young-positive ambivalent groups (M = .39, SD = .78) than in old-positive ambivalent groups (M = -.06, SD = .80), $t(95) = 6.17$, $p < .001$, d = .63. In addition, young adult

participants perceived more positive emotion in young-positive angry groups (M = -.28, SD = .79) than in old-positive angry groups (M = -.48, SD = .80), $t(95) = 3.21$, $p < .01$, d = .33. Thus, similar to the pattern of results reported in the main text, even when accounting for the individual face-emotion ratings, young adult participants' ensemble perceptions of emotion were biased to favor higher-status (young) social identities for all group emotions. However, this ensemble perception bias was significantly stronger for happy and ambivalent groups than for angry groups.

Older Adult Participants. We conducted a 2 (age-bias: young-positive, old-positive) x 3 (overall group emotion: angry, ambivalent, happy) repeated measures ANOVA on older adult participants' difference score between the expected value of the group emotion rating and their actual rating for each group. There was a main effect of age-bias, such that older adult participants rated young-positive groups as happier (M = .40, SD = .51) than old-positive groups (M = .21, SD = .54) even when accounting for individual face-emotion ratings, $F(1, 92) = 19.67$, $p < .001$, $\eta_p^2 = .18$. There was no interaction between age-bias and overall group emotion, $F(2,184) = 1.73$, $p = .179$, η_p^2 = .02. Thus, similar to the pattern of results reported in the main text, even when accounting for the individual face-emotion ratings, older adult participants' ensemble perceptions of emotion were biased to favor higher-status (young) social identities for all group emotions.

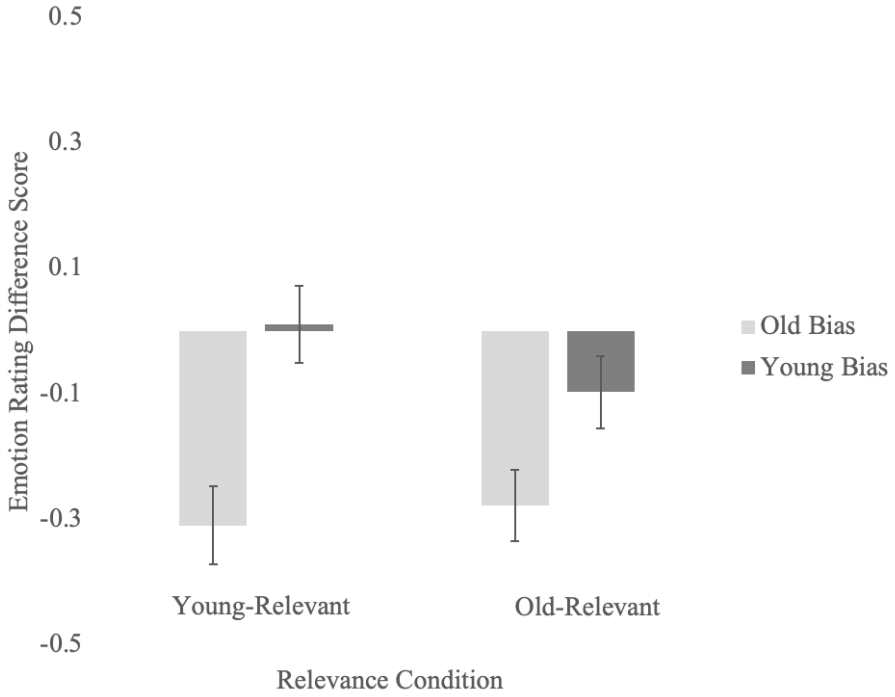
Study 3

Finally, to examine if the results of Study 3 hold when controlling for subjective ratings, we conducted a 2 (relevance condition: young-relevant, old-relevant) x 2 (age bias: young-positive, old-positive) x 3 (overall group emotion: angry, ambivalent, happy)

mixed model ANOVA on the difference score between the *expected* value of the group emotion rating and participants' *actual* rating for each group. There was a main effect of age-bias, such that young-positive groups were rated as happier (M = -0.05, SD = 0.58) than old-positive groups (M = -0.29, SD = 0.58) even when controlling for individual face-emotion ratings, $F(1,191) = 54.57$, $p < 001$, $\eta_p^2 = .22$. In addition, and central to our hypotheses, there was a significant 2-way interaction between age-bias and relevance condition, $F(1, 191) = 4.22$, $p = .041$, $\eta_p^2 = .02$ (see Figure 1). Specifically, participants in the young-relevant condition, perceived more positive emotion in young-positive groups (M = 0.01, SD = 0.63) than old-positive groups (M = -0.31, SD = 0.57), $t(87) = 6.22$, $p < .001$, d = 0.66, 95% CI [0.22, 0.42]. Participants in the old-relevant condition also reported more positive emotion in young-positive groups (M = -0.10, SD = 0.54) than old-positive groups (M = -0.28, SD = 0.59), $t(104) = 4.05$, $p < .001$, d = 0.40, 95% CI [0.09, 0.27]. However, as predicted the effect of age-bias was significantly stronger in the young-relevant (M = 0.32, SD = 0.48) than old-relevant (M = 0.18, SD = 0.46) condition, $t(191) = 2.05$, $p = .041$, d = 0.30, 95% CI [0.01, 0.27].

Figure 11

Mean Emotion Rating Difference Scores as a Function of Relevance and Age Bias



Note. Emotion rating difference score (i.e., expected value of group emotion rating subtracted from actual group rating) as a function of age-bias (young-positive, old-positive) x relevance condition (young-relevant, old-relevant) for Study 3. Error bars represent □ 1 SEM.