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Reducing Implicit Racial Preferences: III.

A Process-Level Examination of Changes in Implicit Preferences

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Abstract

Implicit bias change was initially assumed to reflect changes in associations, but subsequent research demonstrated that implicit bias change can also reflect changes in control-oriented processes that constrain the expression of associations. The present research examines the process-level effects of 17 different implicit bias-reduction interventions and one sham intervention by analyzing data from over 20,000 participants who completed an intervention condition or a baseline control condition followed by a race Implicit Association Test (IAT). To identify the processes influenced by each intervention, we applied the Quadruple process model to participants' IAT responses, then meta-analyzed parameter estimates according to a taxonomy of interventions based on shared features. Interventions that relied on evaluative conditioning influenced control-oriented processes, whereas interventions that relied on counterstereotypic exemplars or strategies to override biases influenced both associations and control-oriented processes. In contrast, interventions that focused on egalitarian values, perspective taking, or emotion had no reliable influence on any of the processes examined. When interventions did change associations, they were much more likely to reduce positive White associations than negative Black associations. The present research extends upon traditional dual-process perspectives by identifying robust intervention effects on response biases. These findings connect features of interventions with changes in the processes underlying implicit bias.

KEYWORDS: Attitudes & Attitude Change, Prejudice & Stereotyping, Cognitive Control, Evaluative Conditioning, Self-Regulation

Reducing Implicit Racial Preferences: III. A Process-Level Examination of Changes in Implicit Preferences

In what is generally regarded as the first demonstration of implicit bias, pairings between words that were stereotype-consistent were more quickly identified than pairings that were stereotype-inconsistent (e.g., Black-lazy versus Black-ambitious; Gaertner & McLaughlin, 1983). Subsequent research showed that stereotype-related cues could bias judgments, even when those cues were presented subliminally (Devine, 1989). Based on this and other evidence that stereotype-relevant information does not require deliberate intent or conscious awareness to influence thoughts and behaviors, initial theorizing in the emerging field of implicit social cognition assumed that implicit biases operate automatically and invariantly and, thus, are largely impervious to control or change (e.g., Bargh, 1994; Devine, 1989; Dunton & Fazio, 1997; Fiske, 1998).[1]

Implicit Bias Change

Despite early assumptions about the immutability of implicit biases, subsequent research demonstrated a wide variety of conditions under which implicit biases could be changed (for reviews, see Dasgupta, 2013; Gawronski & Sritharan, 2010; Lai, Hoffman, & Nosek, 2013). For example, implicit bias can be reduced by exposure to counter-stereotypical people (Dasgupta & Greenwald, 2001): implicit preference for White relative to Black people is reduced on an Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) after exposure to

[1] We use the terms 'implicit bias' and 'implicit preference' synonymously to refer to behavioral responses on implicit measures, and the term 'associations' to refer to the underlying mental construct assessed by implicit measures. We make no strong assumptions or claims about the representational nature of the constructs assessed by implicit measures. For alternative perspectives on object-attribute relationship structures as constructed on-the-spot or as propositions, see Schwarz, (2007); Smith, Calanchini, Hughes, Van Dessel, & De Houwer, (2019); Van Dessel, Hughes, & De Houwer, (2018).

pictures of disliked White people and admired Black people (e.g., White serial killer Jeffrey Dahmer; Black actor Denzel Washington). Similarly, implicit bias is affected by contextual factors (Wittenbrink, Judd, & Park, 2001): implicit preference for White people relative to Black people is reduced on an evaluative priming task (Fazio, Jackson, Dunton, & Williams, 1995) after exposure to Black people in a positive context compared to a negative context (e.g., church versus graffiti-covered street corner). Implicit bias can also be changed through training (Kawakami, Dovidio, Moll, Hermsen, & Russin, 2000): implicit preference for White relative to Black people is reduced on a sequential priming task after a training task in which participants repeatedly respond to pictures of Black and White people that were paired with counterstereotypic versus stereotypic traits (e.g., Black-smart & White-violent, versus Black-violent & White-smart).

Though many paradigms demonstrate changes in implicit bias, relatively little attention has focused on the specific mental processes that are changing. Because early theories suggested that implicit measures primarily or solely reflect associations stored in memory (e.g., Fazio & Towles-Schwen, 1999), changes in responses on implicit measures were assumed to reflect changes in associations (e.g., Blair, 2002; Wilson, Lindsey, & Schooler, 2000). However, subsequent research has identified control-oriented processes that constrain the expression of associations, such as inhibition and accuracy-orientation (e.g., Conrey, Sherman, Gawronski, Hugenberg, & Groom, 2005; Meissner & Rothermund, 2013; Payne, 2001). For example, older people express larger implicit preferences for White compared to Black people than do younger people (Nosek et al., 2007). However, age-related differences in implicit racial bias do not correspond to differences in race-based associations; instead, older people are less able to inhibit the expression of associations than are younger people (Gonsalkorale, Sherman, & Klauer,

2009). The discovery that responses on implicit measures reflect control-oriented processes raises the question: To what extent do implicit bias-reduction interventions influence mental associations, control-oriented processes, or both?

Implicit Bias Change Reflecting Changes in Associations

As responses on implicit measures were generally assumed to primarily reflect associations stored in memory (e.g., Fazio & Towles-Schwen, 1999), association-focused proposals suggest that implicit bias change could happen through a variety of routes. One possibility is that pre-existing associations are strengthened (Kawakami et al., 2000): exposure to a positive Black exemplar increases the strength of positive Black-good associations relative to negative Black-bad associations (e.g., Dasgupta & Greenwald, 2001). A second possibility is that new associations are created that compete with older associations (Wilson et al., 2000): if a White person primarily associates Black people with negative attributes, information about a positive Black exemplar might be encoded as a subtype rather than be integrated into the existing, negative associations (e.g., Devine & Baker, 1991). A third possibility is that the appearance of implicit bias change may reflect the temporary activation of context-specific associations (Smith & Zárate, 1992): for example, a White person speaking with a Black person might selectively rely on positive Black associations in order to "tune" to the racial attitudes of their conversation partner (e.g., Sinclair, Lowery, Hardin, & Colangelo, 2005).

Which associations are changing? Though a variety of perspectives propose association-based mechanisms by which implicit bias can be changed, the specific associations that change from interventions has remained a topic of debate due to the relative nature of most implicit measures. In the context of intergroup bias, reduced implicit biases may reflect reductions in favorable associations with one group (e.g., White + good), changes in unfavorable

associations with another group (e.g., Black + bad), or both. Several theoretical perspectives posit that intergroup biases are driven primarily by favoritism towards one group rather than derogation of another group (e.g., ingroup favoritism versus outgroup derogation; Brewer, 1999; Greenwald & Pettigrew, 2014). Consequently, interventions should be expected to be more effective in reducing implicit bias when they attempt to reduce positive group associations rather than negative group associations. However, existing research has not cleanly distinguished these possible mechanisms. Many interventions to reduce implicit racial bias are explicitly framed in terms of reducing anti-Black animus, yet often employ procedures that focus on simultaneously changing both positive and negative associations (e.g., Kawakami et al., 2000; Olson & Fazio, 2006). This disconnect between theory and method has largely remained a moot point because implicit measures are traditionally scored in terms of relative differences in responses to one group compared to another (e.g., Black versus White). These relative difference scores make it impossible to examine whether changes reflect shifts in group favoritism or derogation. Other methods are needed to distinguish the two.

Implicit Bias Change Reflecting Control-oriented Processes

Though the dominant interpretation of implicit bias change in the early 2000s focused on associations, other perspectives were emerging that focused on the role of control-oriented processes such as motivation and regulation. For example, as an alternative to the associations account, Kawakami et al. (2000) proposed that counter-stereotypic training may create egalitarian goals that activate automatically in response to relevant stimuli. This account is congruent with the auto-motive model (e.g., Bargh, 1990; Bargh & Gollwitzer, 1994; see also Monteith, 1993; Moskowitz, Gollwitzer, Wasel, & Schaal, 1999), which posits that goals can become routinized through repeated practice or chronic salience to the point that they are

activated automatically by relevant stimuli. Consequently, goals or other control-oriented processes (e.g., inhibition) may change implicit biases by constraining the expression of biased associations without necessarily changing those associations. These control-oriented perspectives suggest that procedures often employed by implicit measures, such as obscuring what is being measured (e.g., subliminal presentation) or making responses difficult to deliberately manipulate (e.g., response deadline), do not eliminate the influence of control. Instead, participants can still exert influence on their responses to implicit measures.

Of course, association- and control-oriented explanations for implicit bias change are not mutually exclusive. An intervention could reduce implicit bias by simultaneously changing associations and influencing control-oriented processes. However, the extent to which implicit bias change reflected changes in associations versus control-oriented processes, as well as which associations specifically are changing, remained an open question.

Contributions of Multiple Processes to Implicit Bias

A key innovation for distinguishing associations and control-oriented processes in implicit bias change are multinomial processing trees (MPTs: Riefer & Batchelder, 1988). MPTs are used across the cognitive and social sciences to quantify the influence of multiple processes to responses on a single behavioral measure (for reviews, see Erdfelder, Auer, Hilbig, Aßfalg, Moshagen, & Nadarevic, 2009; Hütter & Klauer, 2016). An MPT is comprised of parameters that are hypothesized to represent the mental processes that influence categorical responses on a given task (e.g., correct/incorrect, old/new, low/mid/high confidence), and these parameters are articulated in a series of equations that specify how these processes contribute to responses to different stimuli or conditions in the task. Entering participants' actual responses as outcomes to the equations yields estimates of the influence of the processes hypothesized to produce those

outcomes. Model-fit statistics such as Pearson's chi-squared statistic can then quantify the degree to which MPT estimates correspond to the observed responses.

MPTs have been validated on many implicit measures, such as the IAT (Meissner & Rothermund, 2013), weapons identification task (Payne, 2001), affect misattribution procedure (Payne, Hall, Cameron, & Bishara, 2010), stereotype misperception task (Krieglmeyer & Sherman, 2012), go/no-go association task (Nadarevic & Erdfelder, 2011) and extrinsic affective simon task (Stahl & Degner, 2007). For the present research, we focus on applying an MPT called the quadruple process model (Quad model: Conrey et al., 2005) to the IAT.

The Quad Model

According to the Quad model, four distinct processes influence performance on implicit measures. The Activation of Associations (AC) parameter refers to the degree to which mental associations (e.g., between White people and "good") are activated when responding to a stimulus. All else equal, the stronger the association between the attitude object (e.g., White people) and the attribute (e.g., good), the more likely the association is to be activated and to drive behavior in an association-consistent direction. In the Race IAT, two AC parameters are estimated: one for associations between "White" and "good" (WAC), and another for associations between "Black" and "bad" (BAC). The Detection of correct responses (D) parameter is conceptualized as an accuracy-oriented process, and reflects the likelihood that the respondent can discriminate between correct and incorrect responses. Sometimes, activated associations conflict with the detected correct response. For example, on an IAT trial in which the categories "Black" and "good" share a response key (i.e., a so-called "incompatible" trial), activated associations (e.g., between Black and "bad") would conflict with the detected correct response (i.e., to press the same button for Black and "good" stimuli). The Quad model proposes

that the Overcoming Bias (OB) process resolves this conflict. As such, the OB parameter refers to an inhibitory process that prevents activated associations from influencing behavior when they conflict with detected correct responses. Finally, the Guessing (G) parameter does not represent a specific process, *per se*, but instead reflects a bias towards making pleasant versus unpleasant responses in the absence of influence from D, OB, or either of the AC parameters. The construct validity of the Quad model has been extensively demonstrated in previous research (for reviews, see Calanchini & Sherman, 2013; Sherman et al., 2008).

Process-level Effects of Bias-reduction Interventions

Because the Quad model separately estimates the contributions of multiple cognitive processes to responses on implicit measures, it is well-suited to clarify the process-level effects of implicit bias-reduction interventions. Moreover, because it estimates evaluative associations for each of the two target groups in an implicit measure, the Quad model can help to illuminate the extent to which implicit bias change is manifest on positive versus negative associations.

Past research using the Quad model has uncovered the process-level effects of the three bias-reduction interventions described previously in the review of implicit bias change. Relative to traditional stimuli, exposure to counter-stereotypic (i.e., positive Black and negative White) exemplars reduces the influence of both White-good (WAC) and Black-bad (BAC) associations but not other processes on an IAT (Gonsalkorale, Allen, Sherman, & Klauer, 2010). In contrast, depicting Black people in positive versus negative contexts (e.g., church versus graffiti-covered street corner) increases the influence of inhibition (OB) but not other processes on an evaluative priming task (Allen, Sherman, & Klauer, 2010). Finally, counter-stereotypic training to affirm Black-good and White-bad stimulus pairings decreases the influence of both White-good (WAC) and Black-bad (BAC) associations and increases the influence of accuracy-orientation (D) on an

IAT relative to both stereotype-consistent training (i.e., to affirm Black-bad and White-good stimulus pairings) and a no-training control condition (Calanchini, Gonsalkorale, Sherman, & Klauer, 2013).

These modeling examples reveal three different patterns of results at the process level for three qualitatively distinct implicit bias-reduction interventions. Such disparate effects are perhaps unsurprising, given the heterogeneity of these interventions: one paradigm relied on exemplars (Dasgupta & Greenwald, 2001), another paradigm focused on contexts (Wittenbrink et al., 2001), and yet another paradigm depended on counterstereotypic training (Kawakami et al., 2000). However, these three paradigms represent a thin slice of the hundreds of implicit-bias reduction interventions that have been tested to date (Lai et al., 2013). Consequently, the purpose of the present research is to apply the Quad model to a much broader selection of implicit racial bias-reduction interventions in a very large sample as a step towards identifying broad patterns in process-level change.

A Research Contest to Reduce Implicit Racial Biases

The dominant approach in research on implicit bias interventions is to focus on one mechanism for change at a time. This approach is very effective for demonstrating proof-of-concept for an intervention, but comes with an opportunity cost: little direct comparison between paradigms to identify the features of interventions that are most effective at changing implicit biases. To shore up this limitation in the extant literature, a research contest directly compared 17 interventions and one sham intervention within the same studies (Lai et al., 2014). The goal of this approach was to identify differences in intervention efficacy that would be difficult to uncover when testing interventions in isolation. In the first of these studies, research teams were invited to submit interventions to reduce implicit preferences for White over Black people. Then,

all of these interventions were tested within the same study and compared against a baseline control condition. Interventions were brief, at five minutes or less. After completing one intervention, participants took an IAT to examine the interventions' immediate impact on implicit biases. Over the course of the three additional studies, teams revised their interventions to be more effective, retained them as-is, submitted new interventions, or dropped out of the contest. In total, 18 interventions were tested 68 times at an average of 3.78 times each with a total of 17,021 participants. Of these 18 interventions, 9 were effective at reducing implicit biases as assessed by the *D*-score, a summary index of IAT performance based primarily on reaction times (Greenwald, Nosek, & Banaji, 2003).

A second phase of the research contest conducted two additional large-scale studies to examine the durability of implicit-bias reduction effects (Lai et al., 2016). Focusing on the 9 interventions that effectively reduced bias when measured immediately post-intervention (Lai et al., 2014), these additional studies measured the biases of 6,321 participants over a period of several days post-intervention. Replicating Lai et al. (2014), all of these interventions successfully reduced implicit bias immediately. However, none of these effects persisted for even a few days.

Process Modeling Provides Insight into How Implicit Biases Change

The results of this research contest suggest that implicit bias as indexed by the summary *D*-score is malleable. Process-level analyses build upon these findings, providing deeper insight into implicit bias change. Specifically, Quad model analyses can reveal which intervention effects reflected changes in associations versus control-oriented processes. Additionally, to the extent that an intervention influenced associations, Quad model analyses can identify whether White-good and/or Black-bad associations were changed.

The research contest also demonstrated that short-term implicit bias malleability does not necessarily translate into long-term change. Process-level analyses may provide insight into why effects on *D*-scores did not persist. For example, some theory suggests that associations are formed and changed through repeated learning and reinforcement (e.g., Baron & Banaji, 2006; Wilson et al., 2000). If an intervention primarily influenced associations and that change in associations did not persist, then the intervention's effects may have been undone by the same cultural and interpersonal forces that created the associations in the first place. Another possibility is that bias-reduction intervention effects persist at the process level, but not in a way that is captured in summary *D*-scores. For example, relative to baseline, an intervention might immediately reduce associations and increase control, which would manifest as decreased implicit bias in terms of *D*-scores. If associations were to return to baseline (e.g., through cultural reinforcement) but control remained heightened, the bias-reduction effects observed immediately on *D*-scores may be attenuated and not distinguishable from a null effect at time 2. However, the persistent effect on control may influence other judgments and behaviors. Consequently, a process-level investigation into bias-reduction intervention effects may be useful in revealing mechanisms underlying implicit bias change, as well as identifying persistent changes that are not manifest in *D*-scores.

The Present Research:

Examining Process-level Effects of Implicit Bias-reduction Interventions

To better understand the process-level effects of implicit bias interventions, the present research applied the Quad model to IAT data collected by Lai et al. (2014; 2016) and meta-analyzed the intervention effects across all six studies. Based on these meta-analyzed data, we report two sets of complementary follow-up analyses. The first set of analyses is based on a

theory-derived taxonomy proposed by Lai et al. (2014), which organized interventions according to shared features. This taxonomy consisted of six categories: Exposure to Counterstereotypical Exemplars, Intentional Strategies to Overcome Biases, Evaluative Conditioning, Appeals to Egalitarian Values, Engaging with Others' Perspectives, and Inducing Emotion. These analyses aim to identify correspondence between features of categories of interventions and their effects at the process level. To complement the theory-derived taxonomy analyses, we also report a data-driven cluster analysis based on each intervention's averaged effects. Whereas the Lai et al. (2014) taxonomy organizes interventions to reflect similarities in procedural and conceptual features, a cluster analysis reflects similarities in profiles of effects across interventions. Together, these theory- and data-driven analyses provide complementary perspectives on process-level intervention effects, and also shed light on similarities and differences between interventions.

Method

Participants. The total sample across all studies used in our analysis was 20,475 (*N*s = 3591, 4009, 1999, 5022, 1015, 4839). Participants from Studies 1-4 of Lai et al. (2014) were non-Black U.S. citizens or residents who registered at the Project Implicit research website (https://implicit.harvard.edu) and completed the study. Participants from Study 1 of Lai et al. (2016) were non-Black undergraduates from Brock University and the University of Virginia. Participants from Study 2 of Lai et al. (2016) were non-Black undergraduates from 17 American universities. For ease of presentation, in the remainder of this manuscript Lai et al. (2014) and Lai et al. (2016) are referred to as *L2014* and *L2016*, respectively.

A small percentage of participants in each study were excluded for responding too quickly (i.e. faster than 300ms on more than 10% of critical trials or 25% within a single block)

or making too many errors (i.e., error rates higher than 30% across critical trials or 50% within in a single block). There is no agreed-upon procedure for calculating *a priori* statistical power for the process modeling analyses we report in this paper. However, in the present research the average sample size is 1,078 participants per condition, which is more than an order of magnitude larger than previous studies examining experimentally induced change in Quad model parameters.

Procedure. All studies are available for self-administration at https://osf.io/lw9e8/ (L2014) and https://osf.io/um4ye/ (L2016). Materials for L2014 are available at https://osf.io/lw9e8/, and materials for L2016 are available at https://osf.io/um4ye/. All data and code for the analyses reported here, as well as all supplementary materials referenced below, are available at https:// https://osf.io/dbtns/.

L2014. Participants volunteered for studies at Project Implicit's research site after completing a demographics registration form. Once registered, participants could visit the research website and be randomly assigned to studies from the research pool. Participants were assigned to these studies only if they had never completed a study in the research pool.

Participants were randomly assigned to complete one of fourteen intervention conditions in Study 1, one of fifteen intervention conditions in Study 2, one of twelve intervention conditions in Studies 3 and 4, or a control condition. In the control condition, participants did not complete an intervention task. Then, participants completed the IAT. Study 4 differed from this procedure by randomly assigning half of the participants to take a pretest IAT.

L2016. In Study 1, undergraduate participants were provided a link to the study and completed the study online. Two-thirds of participants were randomly assigned to begin the

study by taking a pre-test IAT and one-third were assigned to not take a pre-test IAT. Participants were then randomly assigned to one of nine intervention conditions, or a control condition with no intervention. Next, all participants completed the IAT. Procedurally, this session was similar to L2014, Study 4. Between two and four days after completing the first testing session (and with reminders after two or three days), participants were emailed a link for the second testing session. On average, participants completed the second IAT 3.28 days (SD = 1.97 days) after the first testing session. The procedure for Study 2 was similar to Study 1 with two exceptions. First, thirteen sites collected data for the study online as in Study 1, but four other sites collected data for the first session in-lab and data for the second session online. Second, all participants in Study 2 completed a pretest IAT.[2]

Dependent Measure

The IAT. The IAT is structured as a categorization task, in which participants responded to stimuli related to two conceptual categories (i.e., White people, Black people) and two evaluative attributes (i.e., good, bad). The procedure followed the recommendations of Nosek, Greenwald, and Banaji (2005). Participants were instructed to categorize good and bad words and images of Black and White people as quickly as possible while also being accurate.

[2] Over the course of the six experiments reported in L2014 and L2016, participants also completed self-reported measures of racial attitudes (L2014), measures assessing support for pro-Black affirmative action, explicit racial prejudice, and effort (L2016). These other measures are not analyzed in the present research or discussed further. Additionally, in L2014 Experiment 3, roughly half of participants were randomly assigned to complete a Multi-Category IAT (Nosek, Sriram, Smith, & Bar-Anan, 2013). Those participants are not reflected in the *N* reported above, nor are their data included in the present analyses.

The IAT is comprised of seven blocks, with three practice blocks (omitted from analyses) and four critical blocks. In the first practice block (20 trials), participants categorized images of Black faces and White faces to categories representing Black people and White people on the upper left or right of the screen. In the second practice block (20 trials), participants categorized good and bad words to categories representing Good and Bad. In the third (20 trials) and fourth (40 trials) critical blocks, participants categorized images of Black and White faces and good and bad words on alternating trials, responding to Black faces and bad words with one key, and to White faces and good words with another key. In the fifth practice block (40 trials), participants categorized images of White and Black faces again, except the categories had switched sides. The face category originally on the left was now categorized with the right key, and the face category originally on the right was now categorized with the left key. In the sixth (20 trials) and seventh (40 trials) critical blocks, participants categorized pairings opposite to the ones in the third and fourth blocks, responding to White faces and bad words with one key, and to Black faces and bad words with the other key. To control for potential order effects, the two sets of critical blocks (i.e., third and fourth; sixth and seventh) were counterbalanced between participants (Greenwald et al., 1998), such that some participants responded to White/good and Black/bad pairings in the first critical blocks, but other participants responded to White/bad and Black/good pairings in the first critical blocks. Though the position of the good/bad categories remained invariant for each participant, it was randomized between participants: half the participants categorized good words to the left key and bad words to the right key, whereas the other half did the reverse.

L2014 Study 4 and L2016 Studies 1 and 2 deviated from this paradigm. In these studies, participants completed a shortened five-block IAT instead of the seven-block IAT. The five-

block IAT was structured similarly to the seven-block IAT. Instead of four critical blocks, the five-block IAT consisted of two critical blocks of 32 trials each, with 16, 24, and 24 trials for the first, second, and fourth practice blocks, respectively.

Interventions

Intervention Categories. In L2014, interventions were organized post hoc into one of six categories highlighting prominent procedural and/or conceptual features of the interventions: Exposure to Counterstereotypical Exemplars, Intentional Strategies to Overcome Biases, Evaluative Conditioning, Appeals to Egalitarian Values, Engaging with Others' Perspectives, and Inducing Emotion. These categories reflect themes that highlighted the most prominent features of the intervention designs, but were not exhaustive descriptions. Within each category, each individual intervention should be understood as a "package" of effects rather than as pure exemplars of a single operative mechanism. Nonetheless, there is communication value in using the categories to aggregate by prominent features.

In this meta-analysis, we investigate an additional set of features present in some of the interventions that were not deeply considered in L2014: evaluative instructions (EI) to think of Black people positively and/or White people negatively. In these interventions, EIs were originally included as an additional motivator to internalize the intervention rather than as a primary feature of the intervention. However, other research indicates that EIs alone can change implicit biases (e.g., De Houwer, 2006; Kurdi & Banaji, 2017; Van Dessel, De Houwer, Gast, Roets, & Smith, 2020). Additionally, in this meta-analysis we investigate three other features common to interventions that changed *D* scores in L2014 and L2016 but have not yet been analyzed systematically: including procedural elements of the IAT, including emotionally vivid content, and generating self-relevant responses.

Exposure to Counterstereotypical Exemplars. Exposure to individuals who defy stereotypes was one of the first methods discovered for changing implicit biases, and continues to be one of the most commonly used approaches in the literature (Blair, Ma, & Lenton, 2001; Dasgupta & Greenwald, 2001, Lai et al., 2013).

Vivid Counterstereotypic Scenario (L2014; L2016). Foroni and Mayr (2005) shifted implicit biases for flowers versus insects by presenting a fictional scenario that reversed real-world expectations by describing how flowers were dangerous and insects were good. In this intervention, participants read a vivid second-person story that also reverses real-world expectations. In the story, the participant imagines walking down a street late at night after drinking at a bar. Suddenly, a White man in his forties assaults the participant, throws him/her into the trunk of his car, and drives away. After some time, the White man opens the trunk and assaults the participant again. A young Black man notices the second assault and knocks out the White assailant, saving the day. After reading the story, participants are told the next task (i.e., the IAT) was supposed to affirm the associations: i.e., White = bad, Black = good. Participants were instructed to keep the story in mind during the IAT.

In L2014, the length and vividness of the story were increased between Study 1 and Study 2 (e.g., from "With sadistic pleasure, he bashes you with his bat again and again" to "With sadistic pleasure, he beats you again and again. First to the body, then to the head. You fight to keep your eyes open and your hands up. The last things you remember are the faint smells of alcohol and chewing tobacco and his wicked grin"). For L2014 Studies 3 and 4 and L2016, the instructions to affirm positive Black associations and negative White associations were revised to include pictures. These pictures showed the stimuli for Black people on the IAT paired with the word good and the stimuli for White people on the IAT paired with the word bad.

Practicing an IAT with Counterstereotypical Exemplars (L2014; L2016). Prior research found that exposure to counterstereotypical exemplars can shift implicit biases (Dasgupta & Greenwald, 2001; Joy-Gaba & Nosek, 2010). In a similar fashion, participants were first shown pictures of famous positive Black (e.g., Oprah Winfrey) and infamous negative White (e.g., Adolf Hitler) exemplars along with one-line descriptions of what they are known for. Then, participants completed a portion of an IAT with combined blocks consisting of the same stimuli used in the race IAT, along with six positive Black and six negative White exemplars.

Due to a programming error in L2014 Study 1, participants learned that they were going to perform part of a race IAT and saw the positive Black and negative White exemplars that would accompany the standard Black and White images, but they did not actually complete the counterstereotypic practice. Consequently, these data were not included in the present analyses. For L2014 Study 2, the procedure was implemented as described above, with the combined block consisting of 90 trials. L2014 Studies 3 and 4 reduced the number of trials in the combined block to 52 trials, and L2016 further reduced it to 32 trials. All of the studies in L2014, as well as L2016 Study 1 used the same stimuli. However, because some of the negative White exemplars may not have been familiar to this cohort of undergraduate participants (i.e., John Gotti, Timothy McVeigh, Charles Manson, Ted Bundy), they were replaced in L2016 Study 2 with more recent exemplars (i.e., Bernie Madoff, Anders Breivik, Jared Loughner, Jerry Sandusky).

Shifting Group Boundaries Through Competition (L2014 S2-S4; L2016). Competition and outgroup threats lead to negative outgroup attitudes (Riek, Mania, & Gaertner, 2006). Using this principle, this intervention aimed to reduce implicit biases by giving participants experience cooperating with Black teammates to compete against White teammates. Participants played a simulated dodgeball game in which their teammates were Black and their opponents were White.

The Black teammates saved the participants from being knocked out and were good sports, whereas the opposing all-White team engaged in unfair play and were bad sports. At the end of the intervention, participants were instructed to make intentions to think "Black = good" and "White = bad" and to remember how their Black teammates helped them and their White enemies hurt them while completing the subsequent IAT.

This intervention was first tested in L2014 Study 2. To adhere with time constraints, in L2014 Study 3 sections requiring participant input were set to automatically advance if participants responded too slowly. L2014 Study 4 and L2016 retained this paradigm.

Shifting Group Affiliations Under Threat (L2014 S2-S4; L2016). This intervention followed a similar theoretical outlook to Shifting Group Boundaries Through Competition. In this intervention, participants experienced simulated ingroup friendships with Black people and outgroup threats from White people. Participants read a vivid and threatening post-nuclear war scenario. They were then shown profiles of people described as "close friends" in their camp, all of whom were Black and had helpful survival skills (e.g., doctor; hunter). They also viewed profiles of "terrible enemies" that were all villainous White people who plotted to destroy their camp. After reading the profiles, participants were told to "Please imagine and think about the friends and enemies you just read about while you complete these tasks."

This intervention was first tested in L2014 Study 2. L2014 Study 2 only included the "close friends" profiles, so L2014 Study 3 added the "terrible enemies" profiles. L2014 Study 4 changed the faces of the Black individuals to be more likable and the faces of the White individuals to be less likable, which is the same paradigm used in L2016.

Highlighting the Value of a Subgroup in Competition (L2014 S1). The common ingroup identity model predicts that highlighting superordinate identities will reduce biases toward outgroup members (Gaertner & Dovidio, 2000). This intervention was designed to remind participants that Black Americans have contributed to America's international standing, highlighting a superordinate group identity (American) that includes Black Americans. Participants read a description of international competition in basketball that described the United States as having one of the most successful basketball teams in the world, but is now facing heavy competition from other countries. Participants were then presented with a list of eight prominent basketball players' names (i.e., Dwyane Wade, Kobe Bryant, Jason Terry, Steve Nash, Brent Barry, Tim Duncan, Shaquille O'Neal, Kevin Garnett) and asked to mark which ones they recognized. This questionnaire aimed to indirectly remind participants of the mostly Black demographic composition of American basketball, though the racial identity of individual players was not made explicit.

Intentional Strategies to Overcome Biases. Performance on implicit measures can be altered via strategies to override implicit bias. Two interventions gave participants strategies to alter their implicit biases. The first intervention, Using Implementation Intentions provides a strategy to alter the expression of implicit biases themselves. The second intervention, Faking the IAT, is a sham intervention that subverts the IAT procedure and presumably does not directly change the processes that would normally influence IAT responses. Thus, Faking the IAT serves as a comparison condition to the other intervention conditions.

Using Implementation Intentions (L2014; L2016). Implementation intentions are if-then plans that automatically close the gap between intentions and behavior by tying a behavioral response to a situational cue (Gollwitzer, 1999). Before L2014, implementation intentions had

been used by Stewart and Payne (2008) to reduce implicit racial biases. Participants first completed a short tutorial on how to take the IAT, which informed them that people who complete the IAT tend to exhibit an implicit preference for White relative to Black people. Next, participants were instructed to commit themselves to an implementation intention) by saying to themselves silently, "I definitely want to respond to the Black face by thinking 'good.'" (adapted from Stewart & Payne, 2008).

In L2014 Study 1, this intervention proceeded as described above. In L2014 Study 2, participants completed practice trials of the IAT before being given the implementation intention instructions. This paradigm was retained in L2014 Studies 3 and 4, and in L2016.

Faking the IAT (L2014; L2016). The IAT can be faked through direct instructions on how to do so (e.g., Fiedler & Bluemke, 2005). As a comparison "sham" condition, participants completed an adapted version of Cvnecek et al.'s (2010) IAT faking manipulation. Participants completed a short tutorial on how to take the IAT, which informed them that people who complete the IAT tend to exhibit an implicit preference for White relative to Black people. Next, participants were then told that they were participating in a study about faking the IAT, and were instructed to slow down on blocks with "Black and Bad" paired together and to speed up on blocks with "White and Bad" paired together. Participants were also instructed to ignore instructions on the subsequent IAT that contradicted the faking instructions.

In L2014 Study 1, this intervention proceeded as described above. In L2014 Study 2, participants also completed IAT practice trials before being instructed how to fake their responses. This paradigm was retained in L2014 Studies 3 and 4, and in L2016.

Evaluative Conditioning. Repeatedly pairing attitude objects (e.g., pictures of Black and White people) with other valenced stimuli (e.g., positive and negative words) can influence implicit bias (e.g., De Houwer, Thomas, & Baeyens, 2001; Olson & Fazio, 2001). Theoretically, presenting one stimulus with another valenced stimulus could change the evaluations associated with the first stimulus.

Evaluative Conditioning (L2014; L2016). The co-occurrence of an attitude object with a valenced object shifts attitudes toward the attitude object in the direction of the valenced object (De Houwer et al., 2001; Olson & Fazio, 2001, 2002, 2006). Participants saw Black people's faces paired with positive words and White people's faces paired with negative words. The stimuli were the same faces and words as were used in the subsequent IAT. Participants viewed each picture-word pair one at a time in the center of their computer screen for 1s. After presentation of each stimulus pair, participants categorized the face as being either Black or White using the E or I key, and the correct key response was randomized for each trial. Participants were also instructed to memorize the words, which they subsequently were asked to recall at the end of the categorization task.

In L2014 Study 1, this intervention consisted of 48 trials of paired stimuli. In L2014 Study 2, participants did not complete the memorization / recall task. The memorization / recall task returned in L2014 Study 3, and the number of trials was reduced to 40, and L2014 Study 4 and L2016 retained this paradigm.

Evaluative Conditioning with the Go/No-Go Association Task (L2014; L2016). Participants completed a version of the go/no-go association task (GNAT; Nosek & Banaji, 2001) that used pictures of Black and White people and good and bad words. The logic underlying this intervention was that rapid associations between stimuli on the GNAT would

produce evaluative conditioning effects. Picture-word pairings were presented onscreen one at a time, and participants were instructed to make a response (i.e., press the space bar) when the stimulus pair matched two categories and to withhold a response when the stimulus pair did not match those categories. In the first block of trials, participants were instructed to make a response when the stimulus pair consisted of a picture of a Black person and a good word, and to withhold a response for all other stimulus pairings. The majority of stimulus pairings in this block consisted of pictures of Black people and good words. In the second block of trials, participants were instructed to make a response when the stimulus pair consisted of a picture of a White person and a good word, and to withhold a response for all other stimulus pairings. A minority of stimulus pairings in this block consisted of pictures of White people and good words.

In L2014 Study 1, this intervention consisted of 100 trials of paired stimuli. In L2014 Study 2, the number of trials was reduced to 60; additionally, the "go" category for both blocks was "Black and good", and the second block of trials required a faster response than did the first. L2014 Study 3 retained most of these features, but reduced the number of trials to 45, and instructed participants to count the number of times pictures of Black people were paired with good words over the course of the task. L2016 retained this paradigm.

Appeals to Egalitarian Values. Diversity education efforts often incorporate content that affirms egalitarian values (Kulik & Roberson, 2008).

Priming Feelings of Nonobjectivity (L2014). The goal of this intervention was to make participants aware that they have or could behave in a biased manner, thereby motivating them to take control of their biases on the subsequent IAT. In L2014 Study 1, participants attempted to recall nine past examples in which they behaved objectively. The logic underlying this intervention was that lack of ease in retrieving examples would lead participants to doubt their

ability to act objectively (Schwarz et al., 1991). In L2014 Study 2, participants reported how they personally *would* act given a particular decision, as well as how they thought society believes they *should* act when making the decision. For example, participants might report that there would be times when they would make a choice without considering the facts and based solely on their preference, but also report that social norms dictate that they should consider all the facts when making this decision. This discrepancy between what participants would and should do was expected to activate feelings of non-objectivity (Devine, Monteith, Zuwerink, & Elliot, 1991). In L2014 Study 3, participants read a fictitious excerpt from a popular science article about psychological biases outside of conscious awareness that may influence behavior (adapted from Pronin & Kugler, 2007). Educating people about the existence of unconscious bias was intended to activate feelings of non-objectivity.

Considering Racial Injustice (L2014 S1-S2). By considering injustices perpetrated by White people, participants could view White people less positively. Similarly, considering Black peoples' efforts to overcome inequality could lead participants to view Black people positively as agents of positive social change. Participants listed examples of injustices that White people inflicted on Black people in the past, examples of injustices that White people currently inflict on Black people, and examples of ways in which Blacks people have overcome racial injustice. In L2014, Study 1 participants listed two of each of these examples, but in L2014 Study 2 this was reduced to one of each example.

Instilling a Sense of Common Humanity (L2014 S2-S4). Expanding the boundaries of the ingroup to include outgroup members can make outgroup attitudes more positive (Gaertner, Dovidio, Anastasio, Bachman, & Rust, 1993). To test this possibility, participants viewed a

video of a man dancing with people in different countries all over the world (http://www.youtube.com/watch?v = zlfKdbWwruY).

Priming an Egalitarian Mindset (L2014). Priming egalitarian values can reduce explicit racial prejudice (Katz & Hass, 1988). In L2014 Study 1, participants completed the Humanitarian-Egalitarianism scale (Katz & Hass, 1988). In L2014 Study 2, participants wrote a short essay in favor of the statement, "All people and groups are equal; therefore, they should be treated the same way." In L2014 Studies 3 and 4, participants filled out a questionnaire that asked them how important it was to be egalitarian, then wrote about a time they failed to live up to egalitarian ideals.

Priming Multiculturalism (L2014 S3-S4; L2016). Multiculturalism is the ideology that racial differences should be acknowledged and celebrated, and priming multiculturalism can reduce implicit racial biases relative to other ideologies of interethnic relations (Richeson & Nussbaum, 2004). In this intervention, participants read a prompt advocating multiculturalism, summarized the prompt in their own words, and then listed two reasons why multiculturalism "is a positive approach to interethnic relations." (adapted from Richeson & Nussbaum, 2004). Additionally, participants were instructed to think "Black = good" on the subsequent IAT.

Engaging with Others' Perspectives. Perceiving a situation from the perspective of an outgroup is a powerful approach for changing intergroup biases (Galinsky & Moskowitz, 2000), and can be effective for changing implicit racial biases as well (Todd, Bodenhausen, Richeson, & Galinsky, 2011).

Training Empathic Responding (L2014 S1-S2). Interventions to increase empathy can reduce explicit prejudice toward outgroup members (Finlay & Stephan, 2000). Participants

played a game in which they observed Black people expressing different emotions (i.e., happy, sad, angry, or afraid). Each picture was accompanied by a first-person question (i.e., "What am I feeling?"), and participants selected an emotion from a list of response options that most clearly described the emotion being portrayed in the picture. Additionally, participants selected the likely reason the pictured person was feeling this way (e.g., for anger: "I got a parking ticket"). Participants were awarded points and given positive feedback for selecting the correct emotion, and were shown a smiling face and the phrase "Thanks for understanding." for selecting the correct rationale. In L2014 Study 1, participants chose among four response options for both the emotion identification and emotion rationale questions, but in L2014 Study 2 they chose among two options.

Perspective Taking (L2014 S1). Taking the perspective of an outgroup member can increase associations between the self and the outgroup, leading to downstream positive evaluations of the outgroup (Todd & Burgmer, 2013). Participants viewed five scenarios in which pictures of Black people were accompanied by an emotional context (e.g., "This person just found a $100 bill on the ground"). Participants were then asked to imagine that they were the person in the situation and write about how they felt.

Imagining Interracial Contact (L2014 S1-S2). Imagining contact with outgroup members can reduce implicit and explicit prejudice toward outgroups (Turner, Crisp, & Lambert, 2007; Turner & Crisp, 2010). In L2014 Study 1, participants were asked to imagine interacting with a Black stranger in a relaxed, positive, and comfortable environment, and to list as many details as possible about the imagined interaction. In L2014 Study 2, participants were instructed not only to imagine a positive interaction with a Black person but also to imagine a negative interaction

with a White person. Along with the corresponding prompts, participants saw a photograph of a smiling Black woman and a photograph of a frowning White woman.

Inducing Emotion.

Inducing Moral Elevation (L2014 S1-S2). Witnessing acts of charity, gratitude, or generosity can induce the emotion of "elevation" (Algoe & Haidt, 2009; Haidt, 2003) which may blur boundaries between the ingroup and the outgroup and, consequently, reduce implicit bias (Lai, Haidt & Nosek, 2014). In L2014 Study 1, participants viewed a video about a high school girls' softball game in which White players showed extraordinary sportsmanship by carrying an opposing White player around the bases after she injured herself as she hit a homerun. In L2014 Study 2, participants viewed a video in which a Black high school music teacher expresses his gratitude toward his former music teacher (also Black), who had seen promise in the young man when he was a teenager and saved him from a life of crime.

Parameter Estimation and Analysis

The Quad model has been implemented as a multinomial model (see Riefer & Batchelder, 1988) designed to estimate the independent contributions of multiple processes from responses on implicit bias measures (for reviews of this approach, see Sherman, 2006; Sherman et al., 2008). The structure of the Quad model is depicted as a processing tree in Figure 1, with Activation of Associations (AC), Detection (D), Overcoming Bias (OB), and Guessing (G) jointly producing responses on the IAT. In the tree, each path represents a likelihood. Processing parameters with lines leading to them are conditional on all preceding parameters. For instance, OB is conditional on both AC and D. The conditional relationships described by the model form a system of equations that predicts the numbers of correct and incorrect responses in different

conditions (i.e., compatible and incompatible trials). For example, there are three ways in which an incorrect response can be returned on a trial of the IAT in which "Black" and "good" share a response key. The first is the possibility that associations between "Black" and "bad" are activated (BAC), detection succeeds (D), and OB fails (1 − OB), which can be represented by the equation BAC × D × (1 − OB). The second is the possibility that biased associations are activated (BAC) and detection fails (1 − D), which can be represented by the equation BAC × (1 − D). The third is the possibility that biased associations are not activated (1 − BAC), detection fails (1 − D), and a bias toward guessing "bad" (1 − G) produces an incorrect response, which can be represented by the equation (1 − BAC) × (1 − D) × (1 − G). As such, the overall likelihood of producing an incorrect response on this trial type is the sum of these three conditional probabilities: [BAC × D × (1 − OB)] + [BAC × (1 − D)] + [(1 − BAC) × (1 − D) × (1 − G)]. The respective equations for each item category (i.e., White, Black, good, and bad, in both compatible and incompatible blocks) are then used to predict the observed number of correct and incorrect responses in a given data set.

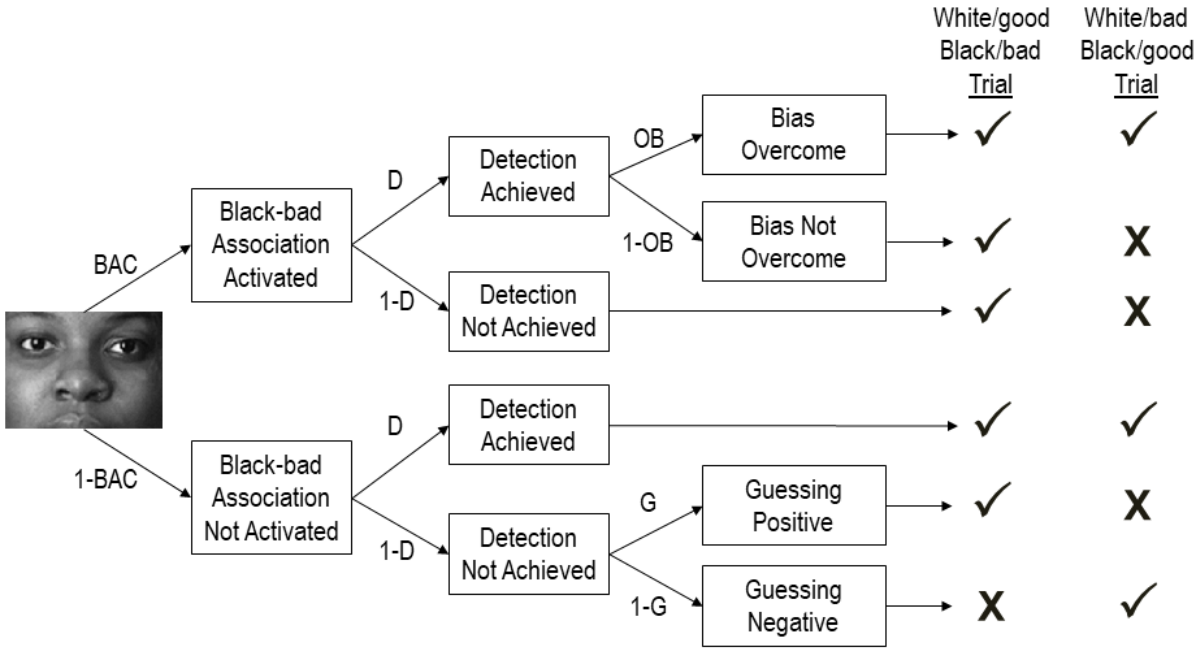

Figure 1. A portion of the Quad model depicting possible combinations of processes influencing responses to a Black stimulus on the IAT. Parameters with lines leading to them are conditional upon all preceding parameters. The table on the right side of the figure depicts correct (✓) and incorrect (**X**) responses as a function of process pattern and trial type. BAC = Activation of Black-bad Associations. D = Detection. OB = Overcoming Bias. G = Guessing.

To estimate the parameters specified in the Quad model, we employed the Bayesian approach proposed by Klauer (2010) and Matzke, Dolan, Batchelder, and Wagenmakers (2013) to fit an extension of the model that treats participants as random factors for each model parameter (Judd, Westfall & Kenny, 2012). Such an approach allows for participant-level heterogeneity while providing a means to aggregate across individuals for stable estimates. Whereas the *D*-scoring algorithm (Greenwald et al., 2003) that is traditionally used in IAT research primarily relies on the latency of participants' responses, the multinomial modeling

analyses we employed in the present research rely on the accuracy of participants' responses (i.e., the numbers of correct and incorrect responses to compatible versus incompatible trials). Based on the equations of the Quad model and the observed correct and incorrect responses, we estimated large samples of credible combinations of parameter values using Markov Chain Monte Carlo methods. As parameter estimates, we report the median of the parameter in this so-called posterior distribution, along with 95% highest-density intervals (HDI), which can be interpreted like confidence intervals. This Bayesian method provides two model checks to assess goodness of fit (Klauer, 2010): The T_1 statistic summarizes how well the model accounts for the pattern of observed response frequencies aggregated across participants within each condition, corresponding to the chi-square distributed goodness-of-fit statistic used in traditional modeling approaches (Riefer & Batchelder, 1988). The T_2 statistic summarizes how well the model accounts for the variances and correlations of these frequencies computed across participants, which thereby quantifies how well the model accounts for individual differences between participants in the individual response frequencies.

For each participant, we calculated two parameter estimates for AC, and one estimate each for D, OB, and G. One AC parameter (BAC) reflected the extent to which "Black-bad" associations were activated and the other AC parameter (WAC) reflected the extent to which "White-good" associations were activated. The G parameter was coded such that values greater than .5 represent a bias toward responding with the "good" key, values less than .5 represent a bias towards responding with the "bad" key, and .5 represents no response bias.

Results

Model Fit

The overall error rate across all conditions for IAT responses was 6.40%, and model fit was $T_1 = 1191.98$, $p < .001$, and $T_2 = 230703.81$, $p < .001$. The significant p values for both T_1 and T_2 indicate that the observed outcomes differed significantly from the outcomes predicted by the model. However, given our very large sample, the T_1 and T_2 statistics were highly powered to detect even small amounts of misfit. Statistic T_1 is Pearson's chi-squared statistic quantifying the discrepancy between observed versus predicted response frequencies. The effect size w (Cohen, 1992) associated with the observed value of T_1 provides a descriptive[3] index to quantify the extent to which the model is violated while controlling sample size: $w = .03$, which reflects a small amount of misfit. Statistic T_2 summarizes the discrepancy between observed versus predicted variances and covariances, but is not a chi-square-analogous statistic, and there is no analogous effect size metric to quantify the extent to which the model is violated while controlling for sample size. Consequently, we report in the Supplementary Materials S1 graphs of the observed versus predicted frequencies and the observed versus predicted variances and covariances for each intervention group in each study (see Heck & Erdfelder, 2017, for a similar approach). Visual inspection of these graphs indicates that the Quad model provides good fit to these data.

Relation Between IAT *D*-scores and Quad Parameters

Whereas *D*-scores are summary statistics which indicate that *some* mental processes are changed, Quad parameters identify specific cognitive processes (or constructs) that are changed. By considering the results of the present research in tandem with the findings of L2014 and

[3]Note, that w cannot be used to make interferences about test power, for example, because T_1 is not chi-squared distributed in the Bayesian framework in which our analyses are couched.

L2016, we can examine the extent to which interventions that changed *D*-scores also changed Quad parameters.

To quantitatively assess correspondence between *D*-scores and Quad parameters, we calculated Spearman's rank correlation coefficients between the ranked (descriptive) effectiveness of each intervention on the *D*-score and each of the Quad parameters (i.e., 1 = most effective; 18 = least effective). Interventions that had the strongest effects on reducing *D*-scores also had the strongest effects on reducing WAC, $r_s(16) = .478$, $p = .045$, and reducing BAC, $r_s(16) = .639$, $p = .004$. Interventions that had the strongest effects on reducing *D*-scores had the strongest effects on increasing OB, $r_s(16) = -.447$, $p = .063$. The extent to which an intervention influenced *D*-scores was unrelated to its influence on Detection, $r_s(16) = .377$, $p = .123$, or Guessing, $r_s(16) = .156$, $p = .537$.

Intervention Taxonomy Analyses

The analyses reported below are based on the taxonomy of intervention categories introduced by L2014. These analyses are organized into sections focusing on different Quad parameters, and each section reports two sets of analyses: one reporting the effect of each intervention relative to the control condition, and another reporting the overall effect of each intervention category relative to the control condition. For each Quad parameter, the analyses included fixed effects for study and intervention, and random effects for participants. Interventions were dummy-coded such that each intervention's effect was measured relative to the control group within each study. For ease of interpretation, we report intervention effects on an effect-size metric that is relative to the estimate of the standard deviation of the parameter (e.g., Cohen's *d*). Effects can be interpreted as reliable if the 95% HDI does not contain zero.

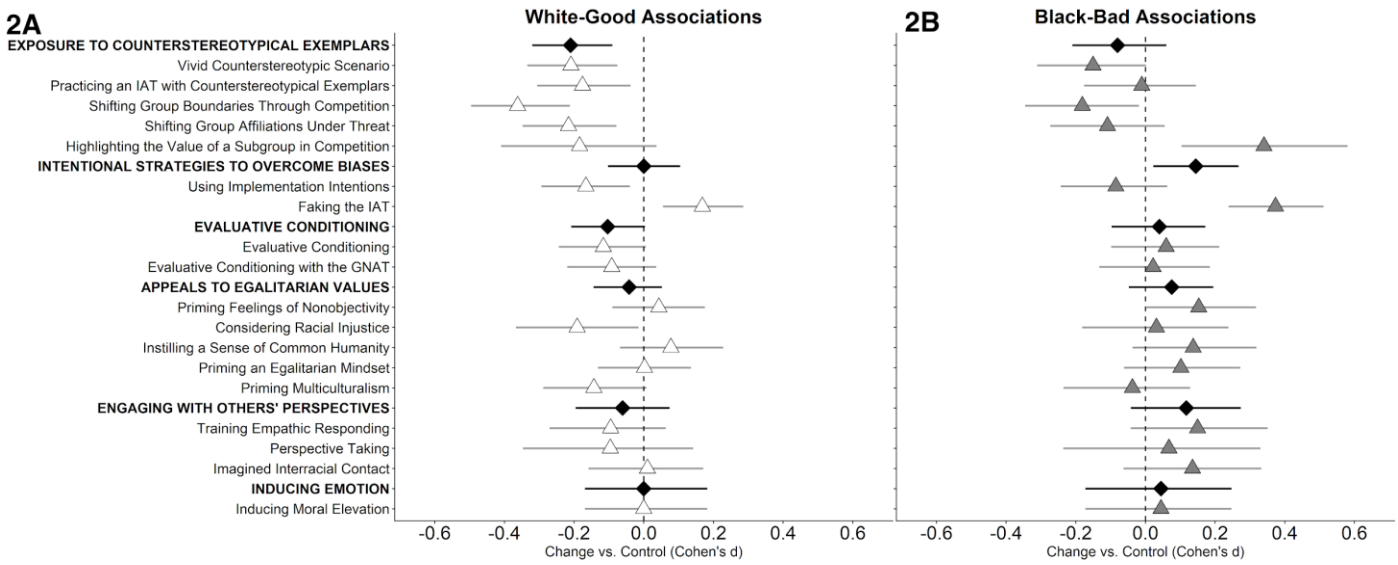

Figure 2. Meta-analytic effectiveness of interventions on White-Good (2A) and Black-Bad (2B) associations at Time 1. Negative values reflect reduced activation of biased associations, and positive values reflect increased activation of biased associations, relative to the control condition. Triangles reflect intervention-level effect sizes, and black diamonds reflect category-level meta-analytic effects. Lines = 95% highest density intervals.

Change in Associations. Because many perspectives assume that responses on implicit measures primarily reflect associations stored in memory (e.g., Fazio & Towles-Schwen, 1999; Wilson et al., 2000), implicit bias change is often also assumed to primarily reflect changes in associations (e.g., Dasgupta & Greenwald, 2001; Kawakami et al., 2000). We report below interventions that influenced associations, as reflected in the BAC and WAC parameters of the Quad model. The full results of these analyses are illustrated in Figure 2.

Exposure to Counterstereotypical Exemplars. All five of the interventions that relied on Exposure to Counterstereotypic Exemplars influenced associations. Vivid Counter-stereotypic Scenario decreased WAC, d = -0.21, 95% HDI [-0.33, -0.08]; Practicing an IAT with Counterstereotypical Exemplars decreased WAC, d = -0.18, 95% HDI [-0.31, -0.038]; Shifting Group Boundaries Through Competition decreased both WAC, d = -0.36, 95% HDI [-0.50, -

0.21] and BAC, *d* = -0.18, 95% HDI [-0.35, -0.02]; Shifting Group Affiliations Under Threat decreased WAC, *d* = -0.22, 95% HDI [-0.35, -0.08]; and Highlighting the Value of a Subgroup in Competition increased BAC, *d* = 0.34, 95% HDI [0.10, 0.58]. Overall, this category of interventions did not have a reliable effect on BAC, *d* = -.02, 95% HDI [-0.14, 0.10], but reliably decreased WAC, *d* = -.23, 95% HDI [-0.33, -0.13].

Intentional Strategies to Overcome Biases. Both of the interventions that relied on Intentional Strategies to Overcome Bias influenced associations. Using Implementation Intentions decreased WAC, *d* = -0.17, 95% HDI [-0.29, -0.04]; and Faking the IAT increased both WAC, *d* = 0.17, 95% HDI [0.06, 0.29] and BAC, *d* = 0.37, 95% HDI [0.24, 0.51]. Overall, this category of interventions reliably increased BAC, *d* = 0.14, 95% HDI [0.02, 0.27], but did not have a reliable effect on WAC, *d* = 0.00, 95% HDI [-0.10, 0.10].

Evaluative Conditioning. Neither of the interventions that relied on Evaluative Conditioning influenced associations. Overall, this category of interventions did not have a reliable effect on BAC, *d* = 0.04, 95% HDI [-0.10, 0.17], or WAC, *d* = -0.10, 95% HDI [-0.21, 0.003].

Appeals to Egalitarian Values. Two of the five interventions that relied on Appeals to Egalitarian Values influenced associations. Priming Feelings of Nonobjectivity increased BAC, *d* = 0.15, 95% HDI [0.002, 0.32]; and Considering Racial Injustice decreased WAC, *d* = -0.19, 95% HDI [-0.37, -0.02]. Overall, this category of interventions did not have a reliable effect on BAC, *d* = 0.08, 95% HDI [-0.04, 0.19], or WAC, *d* = -0.04, 95% HDI [-0.14, 0.05].

Engaging with Others' Perspectives. None of the interventions that relied on Engaging with Others' Perspectives influenced associations. Overall, this category of interventions did not

reliably increase BAC, d = 0.12, 95% HDI [-0.04, 0.27], or WAC, d = -0.06, 95% HDI [-0.20, 0.07].

Inducing Emotion. Inducing Moral Elevation did not have a reliable effect on BAC, d = 0.04, 95% HDI [-0.17, 0.25], or WAC, d = 0.00, 95% HDI [-0.17, 0.18].

Change in Control-oriented Processes. In contrast to perspectives that assume implicit bias change primarily reflects changes in associations (e.g., Dasgupta & Greenwald, 2001), other perspectives focused on the role of control-oriented processes (e.g., Kawakami et al., 2000). We report below interventions that influenced control-oriented processes, as reflected in the Detection and Overcoming Bias parameters of the Quad model. The full results of these analyses are illustrated in Figure 3.

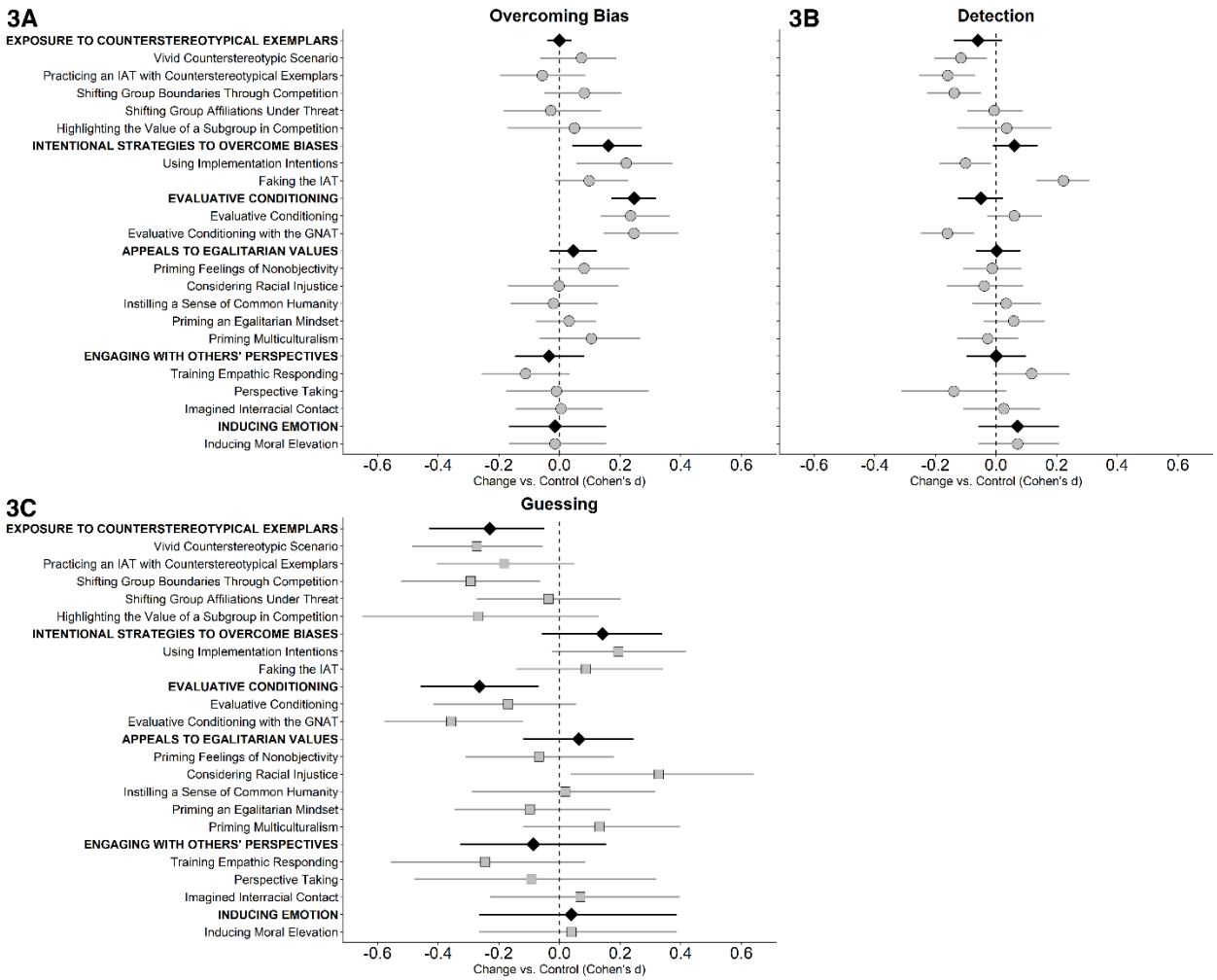

Figure 3. Meta-analytic effectiveness of interventions on Detection (3A), Overcoming Bias (3B), and Guessing (3C) at Time 1. For Overcoming Bias and Detection, negative values reflect reduced activation of these processes, and positive values reflect increased activation of these processes, relative to the control condition. For Guessing, negative values reflect an increased tendency to respond "bad", and positive values reflect an increased tendency to respond "good", relative to the control condition. Black diamonds reflect category-level meta-analytic effects. Gray shapes reflect intervention-level effect sizes, and black diamonds reflect category-level meta-analytic effects. Lines = 95% highest density intervals.

Exposure to Counterstereotypical Exemplars. Three of the five interventions that relied on Exposure to Counterstereotypical Exemplars influenced Detection. Vivid Counter-stereotypic Scenario decreased Detection, d = -0.12, 95% HDI [-0.20, -0.03]. Shifting Group Boundaries Through Competition decreased Detection, d = -0.14, 95% HDI [-0.23, -0.05]. Practicing an IAT with Counterstereotypical Exemplars decreased Detection, d = -0.16, 95% HDI [-0.25, -0.07].

Overall, this category of interventions had a reliable effect on Detection, d = -.08, 95% HDI [-0.14, -0.002], but did not have a reliable effect on Overcoming Bias, d = .02, 95% HDI [-0.06, 0.12].

Intentional Strategies to Overcome Biases. Both of the interventions that relied on Intentional Strategies to Overcome Biases influenced one or more control-oriented process. Using Implementation Intentions decreased Detection, d = -0.10, 95% HDI [-0.19, -0.02], and increased Overcoming Bias, d = 0.22, 95% HDI [0.06, 0.37]; and Faking the IAT increased Detection, d = 0.22, 95% HDI [0.13, 0.31]. Overall, this category of interventions reliably increased Overcoming Bias, d = .16, 95% HDI [0.04, 0.27], but did not have a reliable effect on Detection, d = .06, 95% HDI [-0.01, 0.14].

Evaluative Conditioning. Both of the interventions that relied on Evaluative Conditioning influenced one or more control-oriented processes. Evaluative Conditioning increased Overcoming Bias, d = 0.24, 95% HDI [0.14, 0.37]. Evaluative Conditioning with the Go/No-Go Association Task increased Overcoming Bias, d = 0.25, 95% HDI [0.15, 0.39], and decreased Detection, d = -0.16, 95% HDI [-0.25, -0.07]. Overall, this category of interventions reliably increased Overcoming Bias, d = .25, 95% HDI [0.17, 0.32], but did not have a reliable effect on Detection, d = -.05, 95% HDI [-0.13, 0.02].

Appeals to Egalitarian Values. None of the five interventions that relied on Appeals to Egalitarian Values influenced control-oriented processes. Overall, this category of interventions did not have reliable effects on Detection, d = .002, 95% HDI [-0.07, 0.08], or Overcoming Bias, d = .05, 95% HDI [-0.03, 0.12].

Engaging with Others' Perspectives. None of the three interventions that relied on Engaging with Others' Perspectives influenced control-oriented processes. Overall, this category

of interventions did not have reliable effects on Detection, d = .00, 95% HDI [-0.10, 0.10], or Overcoming Bias, d = -.03, 95% HDI [-0.14, 0.08].

Inducing Emotion. Inducing Moral Elevation did not have reliable effects on Detection, d = .07, 95% HDI [-0.06, 0.21], or Overcoming Bias, d = -.01, 95% HDI [-0.17, 0.15].

Change in Guessing. The G parameter of Quad model accounts for the influence of processes not otherwise reflected in AC, D, and OB on responses. Consequently, G does not fit cleanly into either associative or control-oriented categories. Instead, G is coded as a positivity bias, such that lower values reflect a tendency to respond "bad" and higher values reflect a tendency to respond "good". Conceptually, response biases have played prominent roles in other domains of social psychology (e.g., Nisbett & Wilson, 1977), other process models (e.g., Swets, Tanner, & Birdsall, 1961), and specifically in MPT research (e.g., Buchner, Erdfelder, & Vaterrodt-Plunnecke, 1995; Hütter, Sweldens, Stahl, Unkelbach, & Klauer, 2012). However, response biases have largely been overlooked in the dual-process, automaticity-versus-control framework that has dominated theories of implicit social cognition. We report below interventions that influenced response biases, as reflected in the Guessing parameter of the Quad model. The full results of these analyses are illustrated in Figure 3.

Exposure to Counterstereotypical Exemplars. Two of the five interventions that relied on Exposure to Counterstereotypical Exemplars influenced Guessing. Vivid Counter-stereotypic Scenario decreased Guessing, such that responses were biased to be more negative, d = -0.27, 95% HDI [-0.49, -0.06]. Shifting Group Boundaries Through Competition decreased Guessing, such that responses were biased to be more negative, d = -0.29, 95% HDI [-0.52, -0.06]. Overall, this category of interventions reliably decreased Guessing, such that responses were biased to be more negative, d = -.21, 95% HDI [-0.39, -0.03].

Intentional Strategies to Overcome Biases. Neither of the interventions that relied on Intentional Strategies to Overcome Biases influenced Guessing. Overall, this category of interventions did not have a reliable effect on Guessing, d = .14, 95% HDI [-0.06, 0.34].

Evaluative Conditioning. One of the interventions that relied on Evaluative Conditioning influenced Guessing. Evaluative Conditioning with the Go/No-Go Association Task decreased Guessing, such that responses were biased to be more negative, d = -0.36, 95% HDI [-0.58, -0.12]. Overall, this category of interventions reliably decreased Guessing, such that responses were biased to be more negative, d = -.26, 95% HDI [-0.46, -0.07].

Appeals to Egalitarian Values. One of the five interventions that relied on Appeals to Egalitarian Values influenced Guessing. Considering Racial Injustice increased Guessing, such that responses were biased to be more positive, d = 0.33, 95% HDI [0.04, 0.64]. Overall, this category of interventions did not have a reliable effect on Guessing, d = .06, 95% HDI [-0.12, 0.12].

Engaging with Others' Perspectives. None of the three interventions that relied on Engaging with Others' Perspectives influenced Guessing. Overall, this category of interventions did not have a reliable effect on Guessing, d = -.09, 95% HDI [-0.33, 0.15].

Inducing Emotion. Inducing Moral Elevation did not have a reliable effect on Guessing, d = .04, 95% HDI [-0.27, 0.39].

Summary of Intervention Taxonomy Analyses. These analyses illustrate that the bias-reduction interventions differ considerably in their effects on the processes underlying implicit biases. Four interventions (Shifting Group Affiliations Under Threat; Highlighting the Value of a Subgroup in Competition; Priming Feelings of Nonobjectivity; Considering Racial Injustice) reliably influenced associations but not control-oriented processes, whereas two interventions

(Evaluative Conditioning; Evaluative Conditioning with the Go/No-Go Association Task) and one category of interventions (Evaluative Conditioning) reliably influenced control-oriented processes but not associations. Five interventions (Vivid Counterstereotypic Scenario; Practicing an IAT with Counterstereotypical Exemplars; Shifting Group Boundaries Through Competition; Using Implementation Intentions; Faking the IAT) and two categories of interventions (Exposure to Counterstereotypical Exemplars; Intentional Strategies to Overcome Biases) had broader effects, and reliably influenced both associations and control-oriented processes. These results support both associative and control-oriented perspectives on implicit bias change. Moreover, these results extend traditional dual-process perspectives by demonstrating that four interventions (Vivid Counterstereotypic Scenario; Shifting Group Boundaries Through Competition; Evaluative Conditioning with the Go/No-Go Association Task; Considering Racial Injustice) and two categories of interventions (Exposure to Counterstereotypical Exemplars; Evaluative Conditioning) reliably influenced response biases.

These analyses also shed light on which associations are changed by the bias-reduction interventions. Six interventions (Vivid Counterstereotypic Scenario; Practicing an IAT with Counterstereotypical Exemplars; Shifting Group Boundaries Through Competition; Shifting Group Affiliations Under Threat; Using Implementation Intentions; Considering Racial Injustice) and one category of interventions (Exposure to Counterstereotypical Exemplars) reliably decreased WAC, whereas only one intervention (Faking the IAT) and no categories of interventions reliably increased WAC. In contrast, one intervention (Shifting Group Boundaries Through Competition) and no categories of interventions reliably decreased BAC, whereas three interventions (Highlighting the Value of a Subgroup in Competition; Faking the IAT; Priming Feelings of Nonobjectivity) and one category of interventions (Intentional Strategies to

Overcome Biases) reliably increased BAC. Taken together, these results suggest that the interventions have more influence on White-good than Black-bad associations.

Finally, considering the effects of Faking the IAT against the other interventions sheds light on the process-level differences between faking and actual interventions. Faking the IAT was one of only three interventions that reliably increased BAC. Additionally, Faking the IAT was the only intervention that increased Detection or WAC, whereas the actual intervention that relied on Intentional Strategies to Overcome Biases (Using Implementation Intentions) had the opposite effect, decreasing Detection and WAC. Notably, Faking the IAT reliably decreased *D*-scores in L2014 and L2016. Typically, *D*-scores are negatively related to the WAC and BAC parameters of the Quad model (Conrey et al., 2005), so it is surprising that Faking the IAT can simultaneously reduce *D*-scores and increase WAC and BAC. Such countervailing effects may be a hallmark of faking on the IAT.

Cluster Analysis

The taxonomy of interventions reported in L2014 was created based on a combination of shared procedural features and shared constructs assumed to be targeted by the intervention procedures. To complement this theory-driven taxonomy, we also conducted a cluster analysis to create a data-driven taxonomy of interventions. Cluster analysis identifies regularities in data, so we adopted this approach to highlight similarities in intervention effects, rather than similarities in intervention procedures.

To group bias-reduction interventions in a data-driven fashion, we calculated the average effect of each intervention on each Quad parameter across all six studies, and entered them into a cluster analysis to assess the extent to which each intervention's profile of effects on the five Quad parameters is similar to every other intervention's profile of effects using SPSS v.25 (See

Supplementary Materials S7 for data file and SPSS code). The resulting dendogram (Figure 4) quantifies the similarity between interventions in terms of distance on the x-axis: Interventions that connect at lower values on the x-axis are more similar than interventions that connect at higher values. Five clusters emerged at a similarity value of 8, which we selected to balance parsimony with theoretical interpretability. The analyses reported below reflect the effect of each cluster on each Quad parameter relative to the control condition. They are coded in the same way as the analyses based on the L2014 taxonomy.

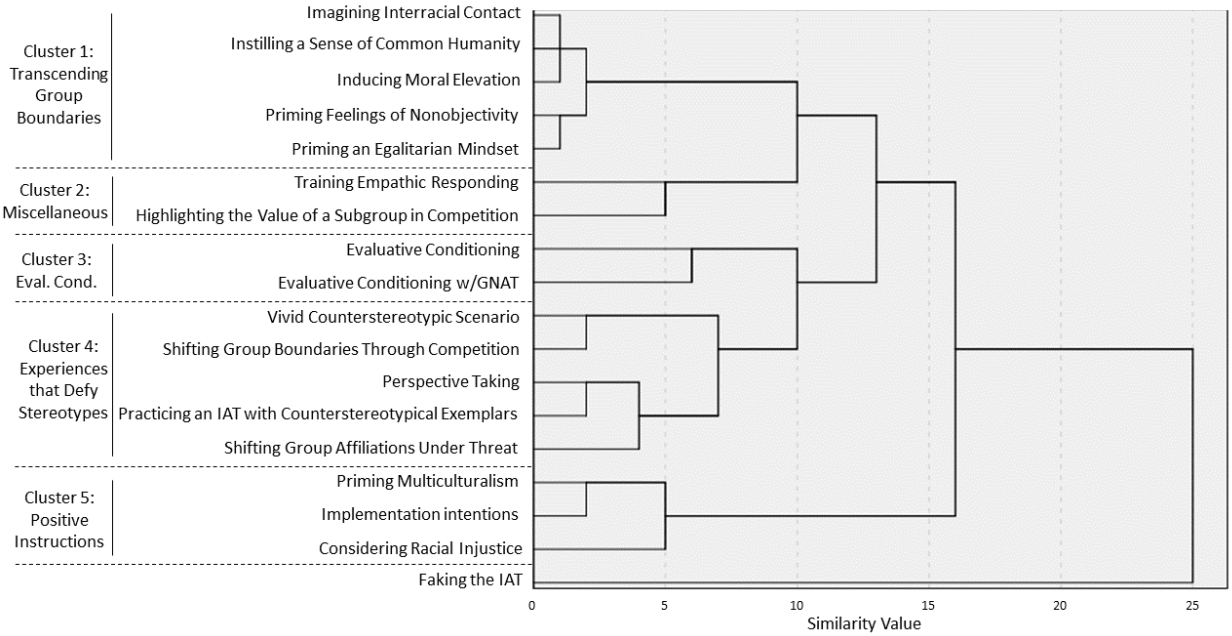

Figure 4. Dendogram of bias-reduction interventions based on cluster analysis.

Cluster 1: Transcending Group Boundaries. The interventions in this cluster generally share a focus on transcending group boundaries: Imagining Interracial Contact, Instilling a Sense of Common Humanity, Inducing Moral Elevation, Priming Feelings of Nonobjectivity, and Priming an Egalitarian Mindset. Cluster 1 did not have a reliable effect on associations: BAC d = .02, 95% HDI [-0.08, 0.12], WAC d = .11, 95% HDI [-0.01, 0.24]; did not have a reliable effect

on control-oriented processes: D *d* = .04, 95% HDI [-0.04, 0.11], OB *d* = .02, 95% HDI [-0.05, 0.08]; and did not have a reliable effect on response biases: G *d* = -.01, 95% HDI [-0.21, 0.17].

Cluster 2: Miscellaneous The two interventions in this cluster (Training Empathic Responding and Highlighting the Value of a Subgroup in Competition) did not share an obvious and distinctive shared feature. Cluster 2 reliably increased BAC *d* = .25, 95% HDI [0.07, 0.42], but did not influence WAC *d* = -.14, 95% HDI [-0.30, 0.01]. This cluster of interventions did not have a reliable effect on control-oriented processes: D *d* = .08, 95% HDI [-0.03, 0.18], OB *d* = -.04, 95% HDI [-0.19, 0.11]; and did not have a reliable effect on response biases: G *d* = -.26, 95% HDI [-0.53, 0.03].

Cluster 3: Evaluative Conditioning. Both interventions that relied on evaluative conditioning paradigms were grouped into this cluster: Evaluative Conditioning and Evaluative Conditioning w/GNAT. Cluster 3 did not have a reliable effect on associations: BAC *d* = .04, 95% HDI [-0.10, 0.17], WAC *d* = -.10, 95% HDI [-0.21, 0.003]. This cluster of interventions reliably increased OB *d* = .25, 95% HDI [0.17, 0.32], but did not influence D *d* = -.05, 95% HDI [-0.13, 0.02]. This cluster of interventions reliably decreased G, such that responses were biased to be more negative, G *d* = -.26, 95% HDI [-0.46, -0.07].

Cluster 4: Experiences that Defy Stereotypes. The interventions in this cluster generally share a focus on stereotype-inconsistent experiences: Vivid Counterstereotypic Scenario, Shifting Group Boundaries Through Competition, Perspective Taking, Practicing an IAT with Countersteotypical Exemplars, and Shifting Group Affiliations Under Threat. Cluster 4 reliably decreased WAC *d* = -.21, 95% HDI [-0.31, -0.11], but did not influence BAC *d* = -.07, 95% HDI [-0.20, 0.05]. This cluster of interventions reliably decreased D, *d* = -.11, 95% HDI [-0.18, -0.04], but did not influence OB, *d* = .02, 95% HDI [-0.06, 0.09]. This cluster of

interventions did not have a reliable effect on response biases: G *d* = -.17, 95% HDI [-0.36, 0.01].

Cluster 5: Instructions to think of Black people positively. The interventions in this cluster all include instructions to think of Black people positively: Priming Multiculturalism, Implementation Intentions, and Considering Racial Injustice. Cluster 5 reliably decreased WAC *d* = -.17, 95% HDI [-0.28, -0.06], but did not influence BAC *d* = -.03, 95% HDI [-0.17, 0.10]. This cluster of interventions reliably increased OB *d* = .11, 95% HDI [0.003, 0.23], but did not influence D *d* = -.05, 95% HDI [-0.13, 0.02]. This cluster of interventions also reliably increased G, such that responses were biased to be more positive, G *d* = .22, 95% HDI [0.03, 0.42].

Summary of Cluster Analysis. The clusters that emerged from this data-driven approach were mostly consistent with the theoretically-driven taxonomy proposed by L2014. Cluster 1: Transcending Group Boundaries did not influence any of the Quad parameters, and largely corresponds to the taxonomy category Appeals to Egalitarian Values, which was also generally ineffective at influencing Quad parameters. Cluster 3: Evaluative Conditioning increased OB and decreased G, and maps perfectly onto the taxonomy category Evaluative Conditioning. Cluster 4: Experiences that Defy Stereotypes decreased both WAC and D, and largely corresponds to the taxonomy category Exposure to Counterstereotypical Exemplars.

That said, some differences between the clusters and the L2014 taxonomy also emerged. Cluster 2: Miscellaneous increased BAC; this cluster does not map well onto any of the taxonomy categories, but instead consists of interventions that either backfired (i.e., increased BAC: Highlighting the Value of a Subgroup in Competition) or were ineffective at influencing any of the Quad parameters (Training Empathic Responding). Cluster 5: Instructions to think of Black people positively decreased WAC, and increased OB and G, and does not map cleanly

onto any of the intervention categories. Indeed, Cluster 5 is a puzzle: it consists of one intervention that decreased WAC and D and increased OB (Using Implementation Intentions), one intervention that decreased WAC and increased G (Considering Racial Injustice), and one intervention that influenced none of the Quad parameters (Priming Multiculturalism). Moreover, though these three interventions share a common feature of instructions to think positively about Black people, other interventions also include such instructions (i.e., Vivid Counterstereotypic Scenario, Shifting Group Boundaries Through Competition; Faking the IAT) but are not included in this cluster. One possible explanation of these findings is that evaluative instructions are a relevant feature of interventions, but that other features (e.g., stereotype-defying experiences) are more relevant. Consequently, an intervention that includes evaluative instructions as well as a more relevant feature will be clustered according to the latter feature.

Finally, none of the clusters identified at a similarity value of 8 included Faking the IAT. Instead, Faking the IAT was not included in a cluster until a similarity value of 25. Whereas the other interventions tested here intend to influence one or more processes that are assumed to contribute to responses on the IAT, Faking the IAT explicitly provides participants with strategies to subvert the measure itself. Thus, this cluster analysis not only highlights the qualitative distinction between the other interventions and Faking the IAT, but also quantifies the magnitude of this difference.

Long-term Change

Whereas L2014 demonstrated that a variety of interventions can reduce implicit bias as operationalized by the *D*-score, L2016 indicated that these effects do not persist for even a few days. The Quad model posits a collection of cognitive processes that jointly contribute to

responses on an implicit measure. Consequently, an intervention might plausibly have a persistent influence on one or more process, but in a way that this influence is not reflected in *D*-scores. Below, we report analyses examining the effects of each intervention measured an average of 3.28 days after intervention. We summarize only the credible effects below. Note that some of the interventions tested at Time 1 (L2014; L2016) were not tested at Time 2 (L2016).

Model fit. The overall error rate across all conditions was 8.92%, and model fit was T_1, $p < .001$, $w = .03$, which reflects a small amount of misfit when controlling for sample size (Cohen, 1992), and $T_2 = 3076.00$, $p < .001$. In Supplementary Materials S1, we report graphs of the observed versus predicted frequencies and the observed versus predicted variances and covariances for each intervention group in each study. Visual inspection of these graphs indicate that the Quad model provides good fit to these data.

Results. When implicit bias was measured several days after treatment, Quad modeling revealed only 2 credible effects out of 45: Shifting Group Boundaries Through Competition decreased BAC, $d = -0.29$, 95% HDI [-0.57, -0.01], and Evaluative Conditioning with the Go/No-Go Association Task decreased Detection, $d = -0.18$, 95% HDI [-0.33, -0.01]. Both of the credible effects observed at Time 2 were also observed at Time 1, with effect sizes that are not reliably different from one another. Taken together, these results suggest that a few specific interventions produce persistent effects on the Quad parameters, but that none of the overarching categories of interventions produce the consistent pattern of effects observed at Time 1.

Analyses using Alternative Intervention Categories and Contrasts

The primary focus of the present research is to examine the process-level effects of a wide variety of implicit bias-reduction interventions, and to identify commonalities across interventions, from the perspectives of both the theory-driven taxonomy proposed by L2014 and

the data-driven cluster analyses. In this section we briefly summarize the results of several additional analyses which we report in full in Supplementary Materials S2.

Alternative intervention categories. In addition to the analyses based on the original L2014 taxonomy and the cluster analyses, we also examined intervention efficacy based on several other *post hoc* distinctions: evaluative instructions, procedural elements of the IAT, emotionally vivid content, and the self-generation of self-relevant responses. All four alternative approaches to categorizing interventions reliably influenced Quad parameters. Interventions with evaluative instructions to think of Black people positively and/or White people negatively reliably decreased BAC, decreased WAC, and increased Overcoming Bias relative to interventions that did not include evaluative instructions. Interventions that incorporated procedural elements of the IAT reliably increased BAC relative to interventions that did not. Interventions that were emotionally vivid reliably decreased BAC and WAC relative to non-vivid interventions. Finally, interventions that prompted participants to generate self-relevant responses reliably decreased BAC, WAC, and Guessing relative to interventions that did not.

Comparisons among intervention categories. We conducted additional planned contrasts comparing the effects of the intervention categories to one another, in order to determine the extent to which the categories differed from one another. Like in the cluster analyses, we found that effects of the Intentional Strategies to Overcome Biases category (which includes Faking the IAT) was reliably different from the effects of many of the other categories on all five Quad parameters.

Procedural changes between studies. Because many of the authors in the original contest study (L2014) modified their intervention procedures between studies with the goal of maximizing effectiveness, we examined whether changes in intervention procedures between

studies in L2014 and L2016 moderated intervention efficacy. Only 14 credible differences out of 305 comparisons (i.e., 61 between-study comparisons x 5 parameters) emerged, which is in line with a 5% false-positive rate (i.e., 4.59%). These analyses suggest that the procedural changes made across studies in L2014 had little process-level impact in the aggregate.

General Discussion

We meta-analyzed IAT data from over 20,000 participants who completed 1 of 18 interventions or a control condition to identify the effects of these interventions at the process level. These analyses revealed relatively consistent effects within intervention category. Interventions that relied on evaluative conditioning influenced control-oriented processes, whereas interventions that relied on counterstereotypic exemplars or strategies to override biases influenced both associations and control-oriented processes. In contrast, interventions that focused on egalitarian values, perspective taking, or emotion were largely ineffective at influencing any of the processes examined. When interventions did change associations, they were much more likely to reduce positive White associations than negative Black associations. Follow-up analyses based on a data-driven intervention taxonomy largely replicated these findings.

Changes in Associations

One of the primary findings to emerge from the present research is that 9 of 18 interventions influenced associations. Given the primacy that many prominent theoretical perspectives assign to associations in implicit social cognition (e.g., Fazio & Towles-Schwen, 1999), the finding that half of interventions tested here do not influence associations is noteworthy.

Reliable effects on associations were clustered in two of the six intervention categories: Exposure to Counterstereotypical Exemplars and Intentional Strategies to Overcome Biases. Among the individual interventions that influenced associations, more than twice as many influenced White-good as influenced Black-bad associations. When Black-bad associations did change, interventions tended to increase rather than decrease them. Three interventions (Highlighting the Value of a Subgroup in Competition, Faking the IAT, Priming Feelings of Nonobjectivity) increased Black-bad associations and only one intervention decreased Black-bad associations (Shifting Group Boundaries Through Competition). This outcome is remarkable, given that most of the interventions in the research contest were designed to reduce anti-Black animus. This pattern of results suggests several theoretical implications for our understanding of implicit bias. One potential implication may be that White-good associations are more malleable than Black-bad associations. This would be congruent with previous findings that negative information is more resistant to change than is positive information, especially in familiar or well-learned contexts (e.g., Ledgerwood & Boydstun, 2014; Sparks & Ledgerwood, 2017). Alternately, given that our samples were largely White and included no Black participants, another interpretation of these findings may be that positive ingroup associations are more malleable than negative outgroup associations – at least in North American Black/White race relations. This interpretation dovetails with theoretical perspectives that posit the primacy of ingroup favoritism over outgroup derogation (e.g., Brewer, 1999; Greenwald & Pettigrew, 2014). To the extent that implicit bias is driven more strongly by ingroup favoritism than by outgroup derogation, the interventions tested here appear to have affected the associations with the strongest conceptual correspondence to implicit bias. Supporting this account, in the present research White-good associations are descriptively larger contributors to IAT performance than

Black-bad associations (see Supplementary Materials S3 for a full list of all parameter estimates for each study and intervention). Greater evidence of change for White-good than Black-bad associations may be a direct consequence of there being more White-good associations to change in the first place. Taken together, these perspectives suggest that implicit bias-reduction interventions may be more effective if they target reductions in favoritism for White people rather than on reductions in negativity towards Black people.

Changes in Control

Though the dominant perspectives of implicit bias and implicit bias change have largely focused on associations, other perspectives focus on the role of control-oriented processes (e.g., Kawakami et al., 2000; Monteith, 1993; Moskowitz et al., 1999). The Quad model posits the influence of two qualitatively-distinct control-oriented processes: accuracy-oriented Detection and inhibitory Overcoming Bias. In the present research, six interventions influenced Detection, three influenced Overcoming Bias. Of the three interventions that influenced Overcoming Bias, two also influenced Detection.

Reliable effects on control-oriented processes were clustered in three intervention categories: Exposure to Counterstereotypical Exemplars, Intentional Strategies to Overcome Biases and Evaluative Conditioning. Five of the six individual interventions that influenced Detection decreased it (Vivid Counterstereotypic Scenario, Practicing an IAT with Counterstereotypic Exemplars, Shifting Group Boundaries Through Competition, Using Implementation Intentions, Evaluative Conditioning with the Go/No-Go Association Task). To the extent that increased accuracy should result in less biased responding, the consistency with which bias-reduction interventions decreased Detection is perhaps surprising. However, on the IAT, participants are typically instructed to respond as accurately *and* quickly as possible.

Previous research suggests that participants balance the speed versus accuracy of their responses according to the perceived difficulty of a given block of IAT trials (Brendl, Markman, & Messner, 2001), adopting a more conservative (i.e., slow but accurate) approach in incompatible blocks and a more liberal (i.e., fast but imprecise) approach in compatible blocks. To the extent that response speed influences response accuracy, and vice versa, future research into the role of speed/accuracy trade-offs in the context of implicit measures (e.g., Klauer, Voss, Schmitz, & Teige-Mocigemba, 2007) may help to resolve this puzzling pattern of effects on the Detection parameter.

Every intervention that influenced Overcoming Bias increased it (Using Implementation Intentions, Evaluative Conditioning, Evaluative Conditioning with the Go/No-Go Association Task). This finding is consistent with the claim that individuals can spontaneously constrain the expression of biased associations without necessarily changing those associations (e.g., Monteith, 1993; Moskowitz et al., 1999). Interventions that rely on Evaluative Conditioning appear to operate in this manner, in that both of these interventions increased Overcoming Bias without affecting associations. That said, the lack of evaluative conditioning effects on association is, in itself, surprising.

Evaluative conditioning without changes in evaluative associations? Neither of the evaluative conditioning interventions influenced associations. This outcome is surprising because many theoretical perspectives on evaluative conditioning explicitly assume that the process of repeatedly pairing a neutral stimulus with a valenced stimulus creates evaluative associations (e.g., Baeyens, Eelen, Crombez, & Van den Bergh, 1992; Jones, Fazio, & Olson, 2009; Martin & Levey, 1994), and the AC parameters in the Quad model as operationalized in the present research are conceptualized to reflect evaluative associations of racial groups.

One possible explanation for the lack of evaluative conditioning effects observed in the present research might be the uniqueness of evaluative conditioning in the context of Black/White race relations. Previous research has identified evaluative conditioning effects using the Quad model in the context novel attitudes that were created *ad hoc* in the laboratory (Smith, Calanchini, et al., 2019). In contrast, the present research focused on racial attitudes that were likely formed over a lifetime of experience. Evaluative conditioning effects are more readily observed when there are no pre-existing associations to compete with them, but are obscured (or minimized) by existing, countervailing associations (Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010). From this perspective, pre-existing racial associations may be too strongly entrenched to be susceptible to evaluative conditioning effects in the present research. In any case, future research is necessary to better understand the role of evaluative processes in implicit bias-reduction interventions modeled on the evaluative conditioning paradigm.

Another explanation for the lack of evaluative conditioning effects relates to idiosyncrasies in how the evaluative conditioning tasks were conducted here. In a typical evaluative conditioning paradigm, the conditioned and unconditioned stimuli are consistently and repeatedly presented together, and the conditioned stimulus is not presented with any other valenced stimuli that compete with the unconditioned stimulus. Mixed pairings may lead to the creation of associations that conflict with each other. In the Evaluative Conditioning with the Go/No-Go Association Task intervention, stimulus pairings were crossed such that participants saw mostly counter-stereotypical Black-good and White-bad pairings, but also saw a few pro-stereotypical Black-bad and White-good pairings. The conflicting information implied by the stereotypical and counter-stereotypical pairings may have created either neutral or ambivalent associations that caused overall null effects on the AC parameters. If so, effective conditioning of

associations about White and Black people may depend on a high degree of contingency between race and evaluative information. Supporting this point, previous research on novel attitudes that relied on a typical evaluative learning paradigm with consistent pairings of conditioned and unconditioned stimuli reliably detected effects of evaluative conditioning on the AC parameters (Smith, Calanchini, et al., 2019). Consequently, we speculate that the lack of effects of evaluative conditioning on the AC parameters observed here reflect idiosyncrasies of the content domain (i.e., race) and/or the paradigms employed here.

Both evaluative conditioning paradigms affected non-associative processes: specifically, both paradigms affected the Overcoming Bias parameter and the Evaluative Conditioning with the Go/No-Go Association Task intervention affected the Detection parameter. These results are congruent with research using MPT modeling that has identified the contributions of other non-associative processes to evaluative conditioning, such as memory for the valence of the unconditioned stimulus (e.g., Hütter et al., 2012) and memory for information about how the conditioned and unconditioned stimuli relate to one another (e.g., Hecke & Gawronski, 2019). Importantly, these other investigations focus on *ad hoc*, novel evaluations, rather than the kinds of pre-existing evaluations examined in the present research. The Quad model has also been applied to evaluative conditioning of novel evaluations and, in this context, evaluative conditioning effects consistently manifest only on AC parameters (Smith, Calanchini, et al., 2019). This pattern of results suggests that evaluative conditioning of well-learned evaluations (e.g., towards racial groups) affects processes that constrain or facilitate the expression of associations rather than the associations themselves. Such a conclusion is compatible with the finding that evaluative conditioning effects are larger when the conditioned stimulus is evaluatively neutral (Hofmann et al., 2010). Thus, evaluative conditioning may be more effective

on novel evaluations because it can influence both associative and non-associative processes (Hecke & Gawronski, 2019; Hütter et al., 2012) or only associative processes (Smith, Calanchini, et al., 2019), relative to well-learned evaluations where it only influences non-associative processes.

Changes in Both Associations and Control

Whereas some perspectives on implicit social cognition have focused on associations, and other perspectives have focused on the role of control-oriented processes, the process-modeling methods employed in the present research have been instrumental in highlighting the joint contributions of both associations and control-oriented processes to implicit bias (e.g., Conrey et al., 2005; Krieglmeyer & Sherman, 2012; Meissner & Rothermund, 2013; Nadarevic & Erdfelder, 2011; Payne, 2001; Payne et al., 2010; Stahl & Degner, 2007). Indeed, one of the strengths of process modeling is that it can quantify the separate contributions of associations and control-oriented processes.

In the present research, five interventions influenced both associations and control-oriented processes (Vivid Counter-stereotypic Scenario, Practicing an IAT with Counterstereotypical Exemplars, Shifting Group Boundaries Through Competition, Using Implementation Intentions, Faking the IAT). These effects were clustered in two intervention categories: Exposure to Counterstereotypic Exemplars, and Intentional Strategies to Overcome Biases. Among interventions that influenced both types of process, the most common pattern of results was to decrease both White-good associations and Detection. However, one intervention (Faking the IAT) demonstrated the opposite pattern and increased White-good associations, Black-bad associations, and Detection. Taken together, this pattern of results may reflect a hydraulic relationship between associations and accuracy orientation: when associations exert

less biasing influence on responses, less accuracy is required to compete with them. To the extent that Detection depends on cognitive resources (Conrey et al., 2005), this observed relationship between associations and Detection suggests the intriguing possibility that reducing biased associations could also reduce cognitive load. That said, there does not appear to be a perfect relationship between associations and Detection: four interventions influenced associations without influencing Detection (Shifting Group Affiliations Under Threat, Highlighting the Value of a Subgroup in Competition, Priming Feelings of Nonobjectivity, Considering Racial Injustice) and one intervention influenced Detection without influencing associations (Evaluative Conditioning with the Go/No-Go Association Task). Nevertheless, the relationship between associations and accuracy orientation, and their joint effects on implicit bias, merits further investigation.

Changes in Guessing

The Guessing parameter of the Quad model is operationalized to reflect a bias to respond with the positive versus negative key, though it is more broadly conceptualized to reflect any guides to responding other than associations, Detection, and Overcoming Bias. Associations and control-oriented processes both play prominent roles in theories of implicit social cognition, but response biases have received considerably less attention. We are not aware of any theoretical perspective that articulates a role for response biases in changing implicit preferences.

Among the interventions examined here, the effects on Guessing were descriptively the largest observed effects. That said, the direction of intervention effects on Guessing might, at first glance, be surprising: two categories of interventions (Exposure to Counterstereotypical Exemplars, Evaluative Conditioning) reliably decreased Guessing and no categories of interventions reliably increased Guessing. However, as reflected in Supplementary Materials S3,

nearly all Guessing parameters in all conditions are reliably greater than .5, and none are reliably lower than .5. Given that Guessing values > .5 reflect a tendency to respond with the positive rather than negative key, there appears to be a persistent positivity bias among our participants. Thus, interventions that decrease Guessing tend to attenuate this positivity bias, which is to say, influence responses to be more neutral.

To the extent that Guessing is a catch-all, of sorts, that reflects any processes that guide responses other than associations, Detection, and Overcoming Bias, one interpretation of the relatively large Guessing effects observed here is that many of these interventions influence processes not specified in the Quad model. Faking the IAT is qualitatively distinct from the other interventions tested here and was the most plausible candidate for influencing processes not specified by the Quad model. However, Faking the IAT had no reliable effect on Guessing, which speaks against (but does not rule out) the possibility that large Guessing effects primarily reflect variance unaccounted for by the Quad model, *per se*. Other research has indicated that Guessing varies across attitude domains (e.g., race, age, sexual orientation; Calanchini, Sherman, Klauer, & Lai, 2014). This suggests that response biases may also vary within attitude domains, such that separate Guessing parameters could be estimated for Black people and White people. Future research should investigate this possibility and continue to examine the role of response bias in implicit social cognitions.

Changes Over Time

Whereas L2014 examined which interventions were most effective at reducing implicit racial bias, L2016 examined the extent to which intervention effects persisted over time. By measuring implicit bias twice – once immediately after intervention, and again approximately a

day later – L2016 found that none of the intervention effects on *D*-scores persisted over time. In contrast, the process-level analyses reported here identified two intervention effects that persisted over time. Shifting Group Boundaries Through Competition reduced Black-bad associations at both measurement times, and Evaluative Conditioning with the Go/No-Go Association Test reduced Detection at both measurement times. Additionally, the sizes of both of these effects are not reliably different between measurement times. The fact that both of the effects observed at Time 2 were also observed at Time 1 speaks against (but does not rule out) the possibility that they are false positives. Moreover, given that many theoretical perspectives assume that associations are formed and changed through repeated experience (e.g., Baron & Banaji, 2006; Wilson et al., 2000), the fact that one short, five-minute intervention (i.e., Shifting Group Boundaries Through Competition) had lasting effects on associations is noteworthy, and represents a potentially fruitful direction for future research aimed at long-term bias change.

Changes in IAT *D*-scores versus Quad Parameters

The present research's focus on error rates complements prior implicit bias research that has relied on response-latency-based IAT *D*-scores: *D*-scores indicate that some mental processes are changing, and Quad parameters help to locate that change on specific cognitive processes. We examined correspondence between *D*-scores and Quad parameters quantitatively, and found that interventions that reduced D-scores also reduced BAC and WAC, but increased Overcoming Bias, and that intervention effects were unrelated to Detection and Guessing.

We also observed that interventions that influenced *D*-scores generally influenced one or more Quad parameters. However, correspondence between *D*-scores and Quad parameters within each intervention is not perfect. For example, Priming Multiculturalism had a relatively strong effect on *D*-scores in L2014 and L2016, with Cohen's *d* ~0.25, but did not reliably influence any

of the Quad parameters. This pattern of results suggests that the cognitive processes influenced by the Priming Multiculturalism intervention do not affect the accuracy of responses and/or are not captured in the Quad model.[4] Conversely, three interventions that influenced one or more Quad parameters did not influence *D*-scores: Highlighting the Value of a Subgroup in Competition, Priming Feelings of Nonobjectivity, and Considering Racial Injustice. Highlighting the Value of a Subgroup in Competition and Priming Feelings of Nonobjectivity increased the activation of Black-bad associations, which is the opposite of what would be expected from a bias-reduction intervention. Overall, these results suggest a high (but not perfect) degree of correspondence between Quad parameters and *D*-scores.

Implications and Future Directions

Developing interventions with longer-lasting effects. As the present research demonstrates, 11 of the 18 interventions tested influenced one or more Quad parameter, with most influencing either associations or Detection. However, only two of the intervention had any effect that persisted over the span of a few days. Future research could examine long-term effectiveness could be improved by adapting the current interventions to directly incorporate procedural features shown to increase the longevity of intervention effects (e.g., habit-forming, external reinforcement; Frey & Rogers, 2014).

The interventions tested here were inspired by the state of the implicit bias-reduction literature as of 2014 (when the first contest paper, L2014, was published). However, L2016 indicates that the effects of these interventions on *D*-scores do not persist over even a few days. The present research largely corroborates this outcome, finding few persistent process-level

[4] Though, interestingly, Priming Multiculturalism also did not have a reliable effect on Guessing, which is where the influence of other processes would be expected to manifest.

effects. Some theories of implicit attitudes conceptualizes associations to be learned early and changed slowly (e.g., Baron & Banaji, 2006; Wilson et al., 2000), or constrained to specific contexts (Gawronski et al., 2018). From these perspectives, perhaps it is unsurprising that five-minute interventions like the ones tested here are not well-positioned to permanently change associations across contexts. Interventions that are longer or more intensive may be better positioned to affect long-term change (e.g., Shook & Fazio, 2008; Neto, da Conceiçao Pinto, & Mullet, 2016).

Alternately, Vuletich and Payne (2019) argue that the lack of long-term change observed in L2016 could reflect stability in social environments rather than cognitive processes that resist change. Using the L2016 data, which were collected at 17 different American universities, Vuletich and Payne (2019) found that *D*-scores were more strongly linked to campus-level means than individual attitudes. Thus, to the extent that implicit bias is a property of situations rather than a property of individuals (Payne, Vuletich, & Lundberg, 2017), interventions aimed at changing aspects of situations rather than minds of individuals should be expected to have longer-lasting effects.

Generalizability of implicit bias-reduction interventions. Six of the interventions reliably influenced Detection and three reliably influenced Overcoming Bias. Given that these two processes operate similarly across domains (Calanchini et al., 2014), the present research raises the intriguing possibility that the effects of a bias-reduction intervention that targets one or both of these processes might not be limited to a specific domain but may instead reduce bias towards a variety of attitude objects. For example, efforts to increase Overcoming Bias in Black-White relations may also extend to increased Overcoming Bias in Hispanic-White relations or other social attitudes. The present research cannot test this hypothesis because we assessed only

implicit bias towards Black and White people, but future research can examine the generalizability of bias-reduction interventions by assessing bias across multiple social categories.

Moreover, implicit bias change that is manifest on the Detection or Overcoming Bias parameters might not be accurately characterized as attitude-related change, *per se*, but still influence attitude-related outcomes. As an analogy, a bank might implement a program to motivate loan officers to accurately evaluate applications with cash bonuses for low default rates. One outcome of this increased attention to accuracy might be reduced racial disparity in loan approvals in the form of fewer approvals of underqualified White applicants (e.g., Axt & Lai, 2019; Messick, 2009; Pager, 2007). Just as Detection and Overcoming Bias are attitude-unrelated processes (Calanchini et al., 2014), the increased accuracy motivation in this hypothetical example is unrelated to applicant race, yet reduces racial disparity in lending. Thus, to the extent that the processes assessed by implicit measures influence behavior (e.g., Fazio, 1990), the present research suggests that interventions that influence domain-general processes may still influence attitude-related outcomes.

Finally, the generalizability of the interventions tested here may be limited to the IAT, in that some interventions "taught to the test" by incorporating procedural elements of the IAT. Directly incorporating the IAT may have led to greater changes that do not generalize to other measurement contexts. However, interventions that relied on elements of the IAT were not more effective than other interventions at reducing implicit bias. Instead, these interventions backfired and increased BAC. Thus, task/measure correspondence did not appear to increase intervention effectiveness.

Other interventions included evaluative instructions to respond in a specific way on the IAT (e.g., to think 'Black = good' and 'White = bad'; Shifting Group Boundaries Through Competition) reliably decreased BAC, decreased WAC, and increased Overcoming Bias relative to interventions that did not include evaluative instructions. On their surface, these instructions might appear to be IAT-specific -- and, thus, not generalize to other measures -- but other studies on evaluative instructions find that instructions like these are effective in changing performance on other implicit measures (e.g., De Houwer, 2018; Smith, Calanchini et al., 2019).

Connecting procedural features of interventions to cognitive processes. Our meta-analyses provide evidence of the validity of the original L2014 intervention taxonomy. Interventions within categories largely had similar effects on Quad parameters. The cluster analysis also supports the validity of the L2014 taxonomy: two of the most effective intervention categories in the L2014 taxonomy (i.e., Evaluative Conditioning; Exposure to Counterstereotypical Exemplars) and one ineffective category (Appeals to Egalitarian Values) also emerged in the cluster analysis (i.e., Evaluative Conditioning; Experiences that Defy Stereotypes; Transcending Group Boundaries). Taken together, this pattern of results is an important step in connecting procedural and conceptual features of implicit bias reduction interventions to specific cognitive processes.

The present research also extends upon the L2014 taxonomy, and identifies other intervention features that reliably influence Quad parameters. As reported in greater detail in S2, interventions that included evaluative instructions, were emotionally vivid, or prompted participants to generate self-relevant responses all reliably reduced both BAC and WAC. In contrast, interventions that incorporated procedural elements of the IAT backfired and increased BAC. Additionally, interventions that included evaluative instructions increased Overcoming

Bias, and interventions that prompted participants to generate self-relevant responses increased Guessing. These findings not only merit further investigation, but also lay the foundation for future research to continue to connect features of implicit bias reduction interventions to the cognitive processes they influence.

Limitations

Despite the advantages offered by the Quad model to reveal the contributions of multiple underlying processes from observed data, this analytic approach is also limited in some ways. For example, the Quad model assumes a direction of compatibility, such that one target category is associated with positive concepts and the other target category is associated with negative concepts. This assumption precludes the possibility that both target categories are associated with the same evaluation (e.g., White-good, Black-good), or that a target category is simultaneously associated with positive and negative concepts (i.e., ambivalence). The issue of competing evaluations is relevant to the present research because many of the interventions aim to produce positive associations with Black people. Because positive and negative evaluations of the same target can exist simultaneously as an ambivalent attitude, increasing positive evaluations of a target group may not necessarily decrease negative evaluations of that group. Consequently, the Quad model may not be well-positioned to detect the full breadth of effects of some of the interventions tested here. That said, other process models allow for the possibility that both target groups are associated with the same evaluation (e.g., Payne, 2001; Meissner & Rothermund, 2013), but cannot distinguish between neutral (i.e., neither positive nor negative) and ambivalent (i.e., simultaneously positive and negative) evaluations. Future research should continue to investigate the extent to which changes to one dimension of an evaluation (e.g., positive) affect the other dimension of the evaluation (e.g., negative).

Another limitation of the present research is that the Quad model (and MPT models more generally) exclusively focuses on response accuracy, and the *D*-score primarily focuses on response latency. Consequently, both approaches may provide limited insight into mental contents. Other analytic methods exist that take advantage of both response latency and accuracy, such as drift-diffusion modeling (e.g., Ratcliff, Gomez, & McKoon, 2004; Ratcliff & Rouder, 1998). New forms of MPT models have recently been developed that include response times (RT-MPTs: Heck & Erdfelder, 2016; Klauer & Kellen, 2018). Both drift-diffusion and RT-MPT modeling approaches employ all available data and potentially provide more comprehensive insight into mental contents than do either *D*-scores or traditional MPTs. Future research into the cognitive processes related to implicit bias-reduction interventions should employ these approaches.

Finally, although the large sample sizes yielded precise estimates of intervention effectiveness, the design was limited by the type of interventions studied. All of the interventions were developed to be administered within a short 5-minute interval. In contrast, more intensive interventions or experiences that are deployed over weeks or months have had greater success in creating long-term change (e.g., McNulty et al., 2017; Dasgupta & Asgari, 2004). For instance, White college freshmen that were randomly assigned to a Black roommate rather than a White roommate showed reduced racial bias on an implicit measure after a semester of living with that roommate (Shook & Fazio, 2008).

Conclusion

The present research examined the extent to which 18 interventions influenced associations versus control-oriented processes. We found that associations and control-oriented processes were equally susceptible to change, and that White-good associations were more

susceptible to change than Black-bad associations. This outcome dovetails with existing theory positing the primacy of favoritism over derogation to intergroup bias, and suggests that implicit bias-reduction interventions that focus on reducing favoritism for White people could be more effective than interventions that focus on reducing negativity towards Black people. Taken together, this research can be used as a conceptual roadmap for connecting procedural features of interventions to the processes they influence.

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