Neurocognitive Mechanisms of Prejudice Formation: The Role of Time-Dependent Memory Consolidation

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Abstract
Prejudice is generally thought to derive from learned, emotion-laden experiences. The mechanisms underlying the formation of prejudice over time, however, remain unknown. In the present research, we proposed and tested hypotheses regarding prejudice formation derived from research on memory consolidation and social perception. We hypothesized that time-dependent memory consolidation would produce better implicit memory for negative out-group information and positive in-group information, compared with negative in-group information and positive out-group information. Fifty undergraduates learned positive and negative information about racial in-group (Latino) and out-group (African American) targets. Participants returned after both a short time delay (2–6 hr after the learning session) and a long time delay (48 hr after the learning session) to complete a lexical decision task. Results demonstrated that participants responded to information consistent with an in-group bias faster after a long time delay than after a short time delay. Our findings have important implications for the study of social perception and memory consolidation.

Prejudiced evaluations result from learned associations that lead to overgeneralized, negative evaluations of people based on social-group membership (e.g., race; Allport, 1954). Prejudiced associations are reflected in fast, automatic judgments that are positive toward in-group members and negative toward out-group members (Fazio, Jackson, Dunton, & Williams, 1995; Greenwald, McGhee, & Schwartz, 1998). These biases help maintain a positive in-group identity (Tajfel & Turner, 1986). We investigated memory mechanisms through which people maintain a positive in-group identity over time. Such mechanisms cause information that bolsters a positive in-group identity (e.g., "We are good. They are bad.") to be remembered better than information that promotes the out-group. Learned information that bolsters a positive in-group identity becomes integrated with existing memory structures to form a more stable positive in-group identity.

Negative emotional—versus neutral—information is more readily recalled over time (Choi, Kensinger, & Rajaram, 2013). Thus, we hypothesized that over time, racial in-group members become more automatically associated with positive traits, and racial out-group members with negative traits, even when individuals learn both types of information about members from both groups. We refer to this effect as *preferential social memory*. To test our hypothesis regarding preferential social memory, we assessed the accessibility of recently learned negative and positive traits for racial in- and out-group members during three experimental sessions spanning 2 days. Social-perception processes are typically tested within one experimental session. We tested how time influences the formation of social memories across multiple days to investigate memory-consolidation processes in a social psychological context.

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Prejudice is conceptually and neurologically distinct from stereotyping and relies more on emotional experiences and memories than does stereotyping (Amodio & Devine, 2006; Amodio & Frith, 2006). Participants demonstrate bias on an Implicit Association Test (Greenwald et al., 1998) and give negative evaluations of out-groups when intergroup contact activates emotions consistent with prejudice (e.g., homosexuals are disgusting; Cottrell & Neuberg, 2005; Dasgupta, DeSteno, Williams, & Hunsinger, 2009). Implicit prejudice also facilitates categorizing faces expressing emotions consistent with a given stereotype (e.g., African American with an angry facial expression categorized as angry; cf. Hugenberg & Bodenhausen, 2004). Thus, although prejudice is rooted in emotional experiences, stereotypic processing is also engaged.

Collectively, emotional information heightens prejudice when one encounters an out-group member and can facilitate stereotypic processing. We merged this prejudice-based approach with paradigms used to investigate memory consolidation, as research on memory consolidation suggests that emotional information is more strongly consolidated than nonemotional neutral information. Although we focused on emotion and prejudice, we believe that both stereotypes and prejudice are subject to memory-consolidation effects.

Stable, long-term, semantic and emotional memories take time to form (McGaugh, 2004). Time-dependent memory consolidation occurs primarily during off-line states (e.g., during sleep) and integrates recently learned information with well-established memory structures (McClelland, McNaughton, & O'Reilly, 1995). Over time, information becomes consolidated and associated with other stable memory traces to form a rich associative network. Consolidated information becomes more accessible and retrieved more automatically. Novel incoming information, in contrast, provides a labile, discrete memory trace dissociated from long-term memory structures and is less accessible and more susceptible to interference (McClelland et al., 1995; McGaugh, 2004; O'Reilly & Norman, 2002).

Emotion moderates how information is consolidated. Negative information is more readily remembered than neutral information after a time delay spanning 12 to 24 hr with a period of sleep (Hu, Stylos-Allan, & Walker, 2006; Payne & Kensinger, 2010, 2011; Walker & van der Helm, 2009). Thus, emotional (vs. neutral) memories are preferentially consolidated over time. Presumably, the memory advantage for emotional memory serves as a protective mechanism in anticipating future emotional events.

Negative emotion facilitates learning about out-group members (e.g., Dasgupta et al., 2009), and because prejudice relies on emotional experiences (Amodio & Devine,

2006), this may produce a bias in how individuals are later perceived. We hypothesized that memory consolidation of social-emotional information would produce prejudiced responses. Further, we hypothesized that after consolidation, the negativity bias observed in previous research on emotional memory (e.g., Payne & Kensinger, 2011) would extend to and interact with the racial-group membership of the social targets, which would result in increased implicit memory for negative information associated with racial out-group members and positive information associated with racial in-group members. Participants were tested multiple times over multiple days at both short (2–6 hr after learning) and long (48 hr after learning) time delays. We expected that time would produce effects of preferential social memory, such that responses to in- and out-group information would be biased over time.

The Current Study

To test the hypothesis, we asked participants to learn positive and negative trait information about racial in- and out-group targets (Latino and African American targets, respectively). Participants completed a lexical decision task, which allowed us to test for the strength of association between learned targets and trait information after a 2- to 6-hr and a 48-hr time delay. The 2-day delay was chosen to fit student schedules, and we had no hypotheses about what different effects might occur after a 24-hr versus a 48-hr delay. For learned targets, we hypothesized that out- and in-group targets paired with negative and positive trait information, respectively, would be more readily responded to after the longer time delay than after the shorter time delay.

Participants were also tested on novel and morphed photographs paired with learned information. Responses to novel targets were used to differentiate learning-specific target and trait pairs from simple effects of task practice. Thus, we hypothesized that participants would respond to novel targets faster on Day 2 than on Day 1 because of general practice effects and would not reflect any true group-learning process. Morphed targets were included as a test of generalization. We extended previous research on facial similarity and affective generalization (e.g., Verosky & Todorov, 2010, 2013) to test the effects of consolidation on generalization across similar faces of different races. Responses replicated those in other research; we observed affective generalization to the morphed targets (faster responses when morphed targets were paired with learned emotional traits than when they were paired with novel traits; cf. Verosky & Todorov, 2010, 2013), but time did not facilitate generalization as hypothesized and is therefore not discussed further.[1]

Method

Participants

Fifty-six Latino undergraduate students participated. We decided a priori on a sample size of 50 on the basis of a previous power analysis (Arms-Chavez, Enge, Lupo, Rivera, & Zárate, 2014), and data collection stopped when the sample size needed to achieve the desired power was obtained. Six subjects reported sleeping during the 4-hr delay (during which we assumed participants would go without sleep) and were excluded from analyses. The final sample therefore consisted of 50 (29 females, 21 males; mean age = 20.7 years). Participants reported between 3 and 10 hr of sleep during the first night ($M = 6.6$, $SD = 1.40$) and between 4 and 9 hr of sleep during the second night ($M = 6.6$, $SD = 1.38$).

Experiment protocol and task

Participants completed a three-part learning and memory task consisting of one learning session that included an impression-formation task followed by two test sessions that each included a lexical decision task. We employed a 3 (face type: learned vs. novel vs. morphed) × 2 (time delay: 2–6 hr after learning vs. 48 hr after learning) × 2 (learned trait type: negative vs. positive) × 2 (target group: Latino vs. African American) within-subjects design.

Materials

We used 48 photographs that were split into four sets of 12 photos each. Each photograph was in color, 3.5 in. × 5 in., and consisted of a frontal shot showing the head and neck. All targets displayed neutral facial expressions and lacked any identifying features. Photos were split into four sets to counterbalance each of our factors between participants. Each set consisted of 12 learned targets, 12 novel targets, and 12 morphs. Morphed photographs were made with one learned and one novel photograph of the same race; the morphs were created with Morpheus Software (Lansing, MI) and selected at a 50% morph gradient (i.e., each morph consisted of approximately half of the features of the learned target and half of the features of the novel target). Six photos in each set were of Latinos (the in-group) and six were of African Americans (the out-group); half of the photos in each ethnic group were women, and half were men. Participants were randomly assigned to learn about one set of targets. Novel photographs were presented only at test sessions, and different sets of novel targets were used at each test session. Participants were tested on half (3 Latino, 3 African American) of the learned targets and half of the novel targets (3 Latino, 3 African American) on Day 1 and the other half of the learned and novel targets on Day 2. Thus, participants were tested on each learned and novel photograph in one test session only (either Day 1 or Day 2) to rule out effects of repeated exposure to stimuli across our two test sessions.

Photos were paired with six negative and six positive news articles, approximately 97 to 120 words in length, which were created from current news articles posted on Google News (https://news.google.com) to accompany target photographs. The articles were pretested to identify whether they had a positive or negative valence. Stimuli were counterbalanced between participants such that positive and negative news articles were paired with each of our 48 faces across our four counterbalancing scripts.

Procedure

During the learning session, participants learned positive and negative traits about 12 target individuals (6 African American and 6 Latino) via a Microsoft PowerPoint slideshow. Each slide included a target face paired with a news article depicting the target's name and a positive or negative trait; the trait word was embedded within the article and headline (Figs. 1a and 1b). Participants viewed the presentation three times with the 12 slides in a randomized order for each viewing. The first presentation was 90 s per slide. While each slide was on screen, participants filled out an impression-formation questionnaire, on which they rated the faces' likeability (1 = *not at all*, 7 = *very much*) and friendliness (1 = *not at all friendly*, 7 = *very friendly*) on a Likert-type scale. During the second and third presentations, participants viewed each slide for 30 s and were instructed to focus on remembering the face and news article. Because each target, trait, and news article was presented three times, participants had time to form an impression of the target and encode the trait information (see Carlston & Skowronski, 1994).

The first test session was completed 2 to 6 hr after the initial learning session (Day 1). The second test session was completed 48 hr after the initial learning session (Day 2). During each test session, participants completed a lexical decision task with one half of the learned targets. The lexical decision task was consistent with tasks used in previous sleep research, in which participants were tested on more learned or similar items than on novel items (e.g., 128 learned and 128 similar items and 64 novel items; cf. Choi et al., 2013; Groch et al., 2011; Payne & Kensinger, 2011; Payne, Stickgold, Swanberg, & Kensinger, 2008; Strepenich et al., 2009). Thus, in each test session, 6 learned targets, 6 novel targets, and 6 morphed targets were paired with one positive trait, one negative trait (recall that either the positive or negative trait was learned), and one nonword (e.g., "losri"), for a

a

MAN SENTENCED FOR VILE CASE OF RAPE/MURDER

A session court sentenced 24-year old Jamie Thompson to life imprisonment holding him guilty for a vile case of murder and rape of a minor in January of this year. Thompson first held the victim's head down in a bucket of water and raped her when she fell unconscious, assuming she was dead. Later as she started gaining consciousness, he beat her to death with a rod and buried the body under his front porch. Police claim that the accused targeted minors who played in a neighboring park and coerced them to his home with a claim that he would show them magic tricks. After the child agreed, police claim they were then handcuffed.

Photograph of African American Male
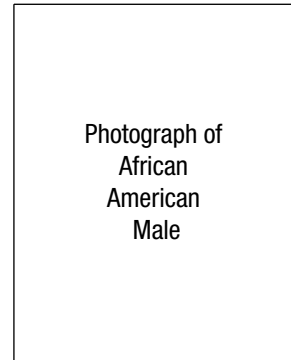
b

DEVOTED LOCAL RESIDENT RUNS A NONPROFIT FOOD BANK FOR PETS

Jim Wright, a devoted resident, runs the first nonprofit food bank for pets. Everything started back in 1997 when he decided to start his own nonprofit organization to meet the need of homeless pets. He bought pet food with his own money and gave it to people straight from his truck. The effort expanded in 2008 when Wright gave his organization a physical location. It's become one of the largest pet food banks in the nation, providing 600,000 pounds of food last year for dogs, cats and other pets. Wright says he wants to keep his organization growing and keep spreading the word so that fewer animals wind up being abandoned and ultimately put down.

Photograph of Latino Male
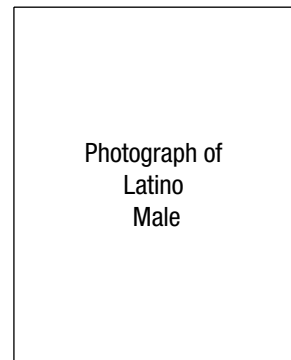
Fig. 1. Example of (a) a negative article paired with an out-group face and (b) a positive article paired with an in-group face.

total of 54 trials (18 trials per condition; 36 trials on learned and morphed targets and 18 novel target pairs). The faces served as primes, with traits serving as target words. Participants were shown each pairing of face and letter string, and they had to indicate whether the latter was a word or a nonword. Participants completed the lexical decision task three times, with trials administered in a random order, for a total of 162 trials per test session. Participants were tested on different targets for each test session.

After the learning session, participants returned 2 to 6 and 48 hr later for a lexical decision task. First, a blank screen was presented for 1,000 ms. Then, a fixation cross was centrally presented for 500 ms, followed by a prime stimulus (a learned, novel, or morphed target photograph) for 400 ms. After a 50-ms interstimulus interval,

participants saw a letter string. The task was to determine whether or not that letter string was an English word (e.g., "vile") or a nonword (e.g., "losri"). Participants responded by pressing the correct button (labeled "word" or "non-word," respectively). Test words were positive and negative traits viewed during the learning session. This version of the lexical decision task was used because faster reaction times (RTs) to correctly identify a letter string as a word after presentation of the prime indicates stronger learned associations between the word and the prime (e.g., Zárate, Stoever, Maclin, & Arms-Chavez, 2008).

Participants completed questionnaires regarding their quantity and quality of sleep between each session. Their responses were also used to determine if they slept during the 2- to 6-hr delay on Day 1 and the number of hours slept on Nights 1 and 2 during the 48-hr delay.

Table 1. Mean Reaction Time (in Milliseconds) at Short and Long Time Delays

Face type and trait type	Short delay	Long delay	Difference
	Learned faces		
African American			
Negative	576 (103)	541 (94)	35*
Positive	558 (104)	533 (87)	25*
Latino			
Negative	552 (110)	545 (86)	7
Positive	567 (97)	514 (78)	53**
	Novel faces		
African American			
Negative	583 (119)	525 (84)	58**
Positive	575 (112)	513 (91)	62**
Latino			
Negative	563 (102)	541 (98)	22*
Positive	552 (96)	529 (86)	23*

Note: $N = 50$. Standard deviations are given in parentheses. The short delay was 2 to 6 hr after learning (time delay without sleep), and the long delay was 48 hr after learning (time delay with sleep).
*$p < .05$. **$p < .01$.

Results

RTs for correct responses only were analyzed. Data were first corrected for multivariate normality by comparing inverse, log, and truncation methods (Ratcliff, 1993). We truncated RTs at 2.5 standard deviations above the grand mean ($M = 566$ ms, $SD = 96$) for learned and novel targets (all of the dependent variables were included in the multivariate analyses reported here; $M = 806$ ms), as this most appropriately adjusted for normality. Nonresponses and responses less than 200 ms were coded as errors; such errors constituted 8% of all trials across both test sessions. Error rates did not differ between Day 1 and Day 2 by condition or by participant sex, all ps > .25. The number of hours participants reported sleeping during the first night was not related to RTs for any dependent variable on Day 2, $F(1, 44) = 1.05$, $p = 0.31$.

Data were analyzed using a 2 (face type: learned vs. novel) × 2 (trait type: negative vs. positive) × 2 (target group: Latino in-group vs. African American out-group) × 2 (time of test: before sleep vs. after sleep) repeated measures analysis of variance (using PROC GLM in SAS Version 9.3; SAS Institute, 1989). Participant sex did not influence the results and is not reported. This analysis yielded multiple main effects and interactions, but most relevant to our hypothesis was a significant four-way interaction between face type, trait type, target group, and time of test, $F(1, 45) = 4.92$, $p = .03$ (see Table 1). Our hypothesis was that responses to learned, but not to novel, targets would vary as a function of target group

and trait type on Day 2. Thus, the four-way interaction was decomposed using a 2 (trait type) × 2 (target group) × 2 (time of test) repeated measures analysis of variance for learned and novel targets separately.

Learned targets

The analysis of learned targets revealed a main effect of time of test, $F(1, 46) = 11.49$, $p = .001$. Participants responded faster on Day 2 ($M = 533$ ms, $SD = 70$) than on Day 1 ($M = 563$ ms, $SD = 95$; $d = 0.36$). No other main effects were significant. This effect was qualified by the predicted three-way interaction between trait type, target group, and time of test, $F(1, 46) = 5.81$, $p = .02$. As predicted, participants were faster to respond to out-group targets paired with negative traits on Day 2 than on Day 1, $F(1, 47) = 5.46$, $p = .02$, $d = 0.35$. No significant differences were found for responses to in-group targets paired with negative traits between Day 1 and Day 2, $F(1, 47) = 0.37$, $p = .55$, $d = 0.07$. For in-group targets paired with positive traits, participants responded significantly faster on Day 2 than on Day 1, $F(1, 49) = 27.99$, $p < .0001$, $d = 0.60$. Unexpectedly, responses to out-group targets paired with positive traits were significantly faster on Day 2 than on Day 1, $F(1, 49) = 3.91$, $p = .05$, $d = 0.26$.

To follow up this unpredicted effect, we tested the interaction for positive terms and target group. This analysis revealed a significant two-way interaction between target group and time of test, $F(1, 49) = 4.22$, $p = .05$. We then computed two difference scores, one for out-group and one for in-group targets paired with learned positive information on Day 1 and Day 2 (Day 1 – Day 2). Larger difference scores represent a greater change in RTs between test sessions. If responses to learned positive items vary over time for in-versus out-group targets in a manner consistent with our hypothesis, then we expected to find what did in fact occur: Difference scores for in-group targets paired with learned positive information ($M = 52$ ms, $SD = 70$) were significantly greater ($M = 24$ ms, $SD = 87$) than difference scores for out-group targets paired with learned positive information ($M = 28$ ms, $SD = 97$), $t(49) = 2.05$, $p = .04$, $d = 0.35$.

Novel targets

For novel targets, the predicted main effect of time of test was revealed, $F(1, 45) = 19.19$, $p < .0001$, and it was not qualified by trait type, $F(1, 45) < 1$. A significant two-way interaction between target group and time of test occurred, $F(1, 45) = 9.97$, $p = .003$. On Day 1, participants responded faster to novel in-group targets ($M = 557$ ms, $SD = 93$) than to novel out-group targets ($M = 579$ ms, $SD = 107$), $F(1, 49) = 5.07$, $p = .03$, $d = 0.22$. Participants

responded faster to novel in-group targets on Day 2 ($M = 536$ ms, $SD = 84$) than on Day 1 ($M = 557$, $SD = 93$), $F(1, 49) = 4.90$, $p = .03$, $d = 0.24$, and significantly faster to out-group targets on Day 2 ($M = 520$ ms, $SD = 82$) than on Day 1 ($M = 579$ ms, $SD = 107$), $F(1, 49) = 25.64$, $p < .0001$, $d = 0.62$. In other words, participants' responses were facilitated on Day 2 across all novel targets, but more so for out-group than for in-group targets. These results are consistent with a general practice effect and show no evidence that participants differentially responded to novel targets paired with target-specific positive and negative information (the traits specific to learned targets) on Day 2.

We did not predict prejudice-consistent responding on Day 1 because research shows that learning new information can interfere with memory for other information (McCloskey & Cohen, 1989). Given that this is the first study to use consolidation-based manipulations to investigate social cognitive processes over time, we expected a departure from the traditional one-session studies, even those that investigate the malleability of social memories (e.g., Kunda, Davies, Adams, & Spencer, 2002). Results demonstrated that on Day 1, participants responded similarly to out-group ($M = 583$ ms, $SD = 119$) and in-group ($M = 563$ ms, $SD = 102$) targets paired with negative traits, $F(1, 49) = 2.62$, $p = .11$, $d = 0.18$, and marginally faster to in-group ($M = 552$ ms, $SD = 96$) than to out-group ($M = 575$ ms, $SD = 112$) targets paired with positive traits, $F(1, 49) = 3.72$, $p = .06$, $d = 0.22$.[2]

Discussion

As predicted, for learned targets, participants responded significantly faster to out-group than to in-group targets paired with negative traits and to in-group than to out-group targets paired with positive traits, but only after a 48-hr delay. Responses to in-group targets paired with negative traits did not differ across time. For novel targets, responses to all targets were simply faster over time and not in a biased fashion. Day-2 responses to learned targets reflected preferential learning of social information as a function of trait type and target-group membership, whereas Day-2 responses to novel targets reflected a practice effect between the test sessions.

That there were significant differences over time for positive information for learned out-group targets (but smaller differences than for in-group targets) is interesting. This may reflect a simple effect of task practice. Alternatively, it suggests that it might be useful to act on positive information about an out-group member in future interactions instead of relying on prejudice.

The research reported here merges memory-consolidation research with social-perception research (e.g., McClelland et al., 1995; Stickgold & Walker, 2013). We manipulated the time between learning and test,

assuming that the long time delay would include sleep. We did not isolate the effects of time and sleep. Future research will benefit from doing so. Sleep provides the optimal environment for memory consolidation; through reduced sensory input to the brain and protein synthesis in the hippocampus, memories are "replayed" to become integrated into long-term, cortical-based memory structures that reflect the gist of recently learned information (Lewis & Durrant, 2011; Zárate & Enge, 2013).

We propose three effects of memory consolidation on social perception: integration, accessibility, and generalization. Recently learned information becomes integrated into existing memory structures over time, which increases accessibility to that information because of the interconnections with other memories. Integrated information is more readily generalized to novel information. These processes should qualitatively change social-perception processes. Social perception may be more malleable than is often assumed, and further research will investigate the consequences of time on group and person perception.

Over time, memories retain the gist of learned information rather than episodic details (e.g., Payne et al., 2009). Thus, prejudice formation may involve the forgetting of person-specific behaviors (e.g., "John got in a fight because he felt threatened") and the subsequent formation of gist memories consistent with existing memory structures (e.g., "John got in a fight because African Americans are violent"). Memory consolidation predicts, for instance, that as new information about a group member gets integrated with information about the group, that negative information may be seen over time as representative of the entire group and not just for that individual.

We manipulated the valence of learned traits with the idea that we were manipulating prejudice via emotion; however, stereotypic processing can occur in emotional contexts (Hugenberg & Bodenhausen, 2004). Target-group entitativity can explain differences between stereotypes and prejudice (Newheiser & Dovidio, 2012). High entitativity is a key predictor of stereotyping. Memory consolidation facilitates gist-based memories (e.g., stereotypes about a group); we find this aspect of consolidation crucial in further understanding the formation of biased social memories. This study provides an avenue to test how consolidation influences person versus group processing.

Conclusions

This research extends and merges work on emotional-memory consolidation with research on social perception to reveal a novel framework for studying the dynamics of social-memory formation. For the social psychologist, this study suggests that time, sleep, and memory influence social psychological processes. For the

social and cognitive neuroscientist, social and emotional context qualitatively change the effects that memory consolidation produces (Payne & Kensinger, 2011; Zárate & Enge, 2013). Collectively, the findings underscore the importance of investigating the dynamic nature of memory and its effects on behavior over time rather than relying on single-session study designs that limit the characterization of social-cognitive phenomena to static processes.

Author Contributions

L. R. Enge and M. A. Zárate developed the study concept. All authors contributed to the study design. L. R. Enge and A. K. Lupo supervised data collection and analyzed and interpreted the data under the supervision of M. A. Zárate. All authors had full access to the data. L. R. Enge drafted the manuscript, and A. K. Lupo and M. A. Zárate provided critical reviews. All authors approved the final version of the manuscript for submission.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Supplemental Material

Additional supporting information can be found at http://pss.sagepub.com/content/by/supplemental-data

Open Practices

All data and materials have been made publicly available via Open Science Framework and can be accessed at https://osf.io/rh9x6/?view_only=65ae8ed424e84dfda8594efa5b3aa714. The complete Open Practices Disclosure for this article can be found at http://pss.sagepub.com/content/by/supplemental-data. This article has received badges for Open Data and Open Materials. More information about the Open Practices badges can be found at https://osf.io/tvyxz/wiki/view/ and http://pss.sagepub.com/content/25/1/3.full.

Notes

1. Results did not substantively change when morphed targets were excluded, so these findings are not discussed.
2. For supplemental statistical analyses and other information (e.g., common questions and concerns), see the Supplemental Material available online.

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