

## Neural attention and evaluative responses to gay and lesbian couples

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5 The goal of the current study was to examine whether differential neural attentional capture and evaluative responses for out-group (10) homosexual relative to in-group heterosexual targets occur during social categorization. To this end, 36 heterosexual participants were presented with pictures of heterosexual and homosexual couples in a picture-viewing task that was designed to assess implicit levels of discomfort toward homosexuality and explicit evaluations of pleasantness toward the images. Neural activity in the form of EEG was recorded during the presentation of the pictures, and event-related potentials resulting from these stimuli were examined. Participants also completed questionnaires that assessed the degree to which they socialized with gays and lesbians. Results demonstrated that relative to straight couples, larger P2 amplitude was observed in gay but not in lesbian couples. However, both gay and lesbian couples yielded a larger late positive potential than straight couples. Moreover, the degree to which participants differentially directed early neural attention to out-group lesbian versus in-group straight couples was related to their familiarity with homosexual individuals. This work, which provides an initial understanding of the neural underpinnings of attention toward homosexual couples, suggests that differences in the processing of sexual orientation can occur as early as 200 ms and may be moderated by familiarity.

**Keywords:** Event-related potentials; Sexual orientation; Social contact; Attentional capture; Couples.

20 In the last two decades, evaluations of sexual minorities have become more positive (Steffens & Wagner, 2004), with increasing opposition to discrimination on the basis of sexual orientation (e.g., Sherrill & Yang, 2000; Yang, 1997). While on one hand these trends may represent a meaningful shift in public attitudes, on the other they may represent tendencies to respond in a socially desirable manner. Heated political debates continue to arise over issues such as gay marriage, with many Americans still holding negative views about legalizing marriage between same-sex couples. Historically, similar discrepancies between increasingly tolerant self-reported attitudes and ongoing disparities in people's daily experiences have been observed for issues affecting people of color and women. These differences may stem from participants' unwillingness to report their true attitudes because of

their sensitivity to societal norms of equality (Dovidio & Gaertner, 2000; McConahay, 1986).

Because of problems with relying on self-reported measures of attitudes, studies of the perception of social groups have moved toward using implicit measures such as the Implicit Association Test (Greenwald, McGhee, & Schwartz, 1998) to investigate attitudes toward gays and lesbians. Studies have demonstrated that heterosexual participants generally hold more negative implicit attitudes toward homosexuals than heterosexuals when social groups are labeled (i.e., "heterosexual", "homosexual", or "gay males/lesbians") and when pictures of gay and straight couples are used (Banse, Seise, & Zerbes, 2001; Dasgupta & Rivera, 2006; Gabriel, Banse, & Hug, 2007; Inbar, Pizarro, Knobe, & Bloom, 2009; Rowatt et al., 2006).

55 Implicit prejudices and stereotypes are the result of  
social categorization, which occurs when people are  
thought of as members of a particular social group rather  
60 than as individuals (Macrae, Milne, & Bodenhausen,  
1994). Research examining social categorization has  
focused mainly on race, demonstrating that racial cate-  
gorization often occurs within a few hundred millise-  
conds (e.g., Dickter & Bartholow, 2007; Giner-Sorolla,  
65 García, & Bargh, 1999; Ito & Urland, 2003, 2005) ~~of  
viewing a face~~. Because social categorization automati-  
cally activates learned stereotypes and implicit associa-  
tions, it may lead perceivers to ascribe stereotypic traits  
70 to social group members (Brewer, 1988; Darley &  
Gross, 1983; Fiske & Neuberg, 1990) that can result in  
discriminatory behavior, especially toward those who  
are viewed to be different from the perceiver (Bargh,  
Chen, & Burrows, 1996; Correll, Park, Judd, &  
Wittenbrink, 2002; Jussim, Palumbo, Smith, & Madon,  
2000; Payne, 2001).

In addition, researchers have investigated the extent  
to which rapidly unfolding, attention-related processes  
might differ as a function of social categorization.  
75 Investigating early attention to social categories is  
important, as differential attention to in-group versus  
out-group members may lead to differences in later  
processing and person perception (e.g., Bettencourt,  
Dill, Greathouse, Charlton, & Mulholland, 1997;  
80 Dickter & Bartholow, 2007; Dickter & Gyurovski,  
2012). Using implicit behavioral tasks such as the  
dot-probe paradigm, researchers have demonstrated  
that perceivers allocate differential attention to out-  
group versus in-group members (Brosch & Van  
85 Bavel, 2012; Trawalter, Todd, Baird, & Richeson,  
2008), whereas others have not (Dickter, Gagnon,  
Gyurovski, & Brewington, 2014; Donders, Correll, &  
Wittenbrink, 2008), ~~suggesting~~ that multiple mechan-  
isms may be responsible for differences in implicit  
90 attention to social groups. While some research sug-  
gests that attentional bias to out-group relative to in-  
group faces is moderated by the degree of threat asso-  
ciated with the out-group (Donders et al., 2008), addi-  
tional factors such as the degree to which perceivers  
95 are familiar with the out-group (Dickter et al., 2014) may  
also serve as moderators.

Although informative in understanding attentional  
processes, reaction time-based measures such as the  
dot-probe task are limited when examining the cogni-  
100 tive processing of social groups. First, they are depen-  
dent on the speed of motor processes and task  
requirements (Ito & Cacioppo, 2000). Second, they  
may be affected by cognitive control processes and  
thus may not be ideal when investigating responses to  
105 groups about which there may be concerns about  
social presentation (e.g., not wanting to appear

prejudiced). An alternative approach that does not  
suffer from these limitations involves using psycho-  
physiological measures, which provide a multifaceted  
110 view of the underlying neural events associated with  
the social categorization process. Event-related brain  
potentials (ERPs) in particular provide an ideal mea-  
sure of implicit attention during social categorization  
due to their high temporal resolution. Additionally,  
115 because they are independent of the conscious control  
of the participant (Ito, Thompson, & Cacioppo, 2004),  
they are particularly well-suited to examine responses  
to stimuli ~~to which individuals may be motivated~~ to  
appear non-prejudiced or to inhibit negative responses  
120 to derogated social groups.

ERP research examining the categorization of  
social groups has demonstrated that early attention is  
directed differentially to in-group and out-group mem-  
bers; much of this research has focused on attention to  
race (e.g., Bartholow & Dickter, 2008; Dickter &  
125 Bartholow, 2007; Ito & Bartholow, 2009; Ito et al.,  
2004; Ito & Urland, 2003, 2005). There are several  
ERP components of interest when measuring early  
implicit attention to stimuli, namely the N1, P2,  
N2 and the P3/LPP (i.e., late positive potential).  
130 Amplitudes for each of these components represent  
the degree to which participants are attending to a  
certain type of stimulus. The N1 component occurs  
approximately 120 ms post-stimulus and, although  
there are inconsistencies across studies of social cate-  
135 gorization, some studies have demonstrated that the  
N1 is larger to racial out-group relative to in-group  
members (e.g., Ito & Urland, 2003). The P2 compo-  
nent (~180 ms post-stimulus) is more reliable and is  
consistently larger to racial out-group than in-group  
140 faces (e.g., Dickter & Bartholow, 2007; Ito & Urland,  
2003, 2005). N1 and P2 amplitudes are associated  
with early orientation to novel, less familiar targets  
(Ito & Bartholow, 2009). After about 250 ms post-  
145 stimulus, attention shifts, as reflected by greater  
amplitudes, to racial and non-racial in-group faces  
~~shown~~ in the N2 ERP component (Dickter &  
Bartholow, 2007, 2010; Hehman, Stanley, Gaertner,  
& Simons, 2011), which is typically seen distributed  
150 over the anterior scalp and is consistent with medial  
prefrontal cortex activation (Ito & Bartholow, 2009).  
Attention shifts again in the P3/LPP component  
(~400–800 ms post-stimulus), with greater attention  
155 to out-group relative to in-group faces (e.g., Dickter &  
Bartholow, 2007). The LPP is linked to the locus-  
coeruleus norepinephrine system that processes ~~stimuli  
that are motivationally significant~~ (Ito &  
Bartholow, 2009). The LPP is thus associated with  
160 negative evaluative judgments, even when partici-  
pants overtly respond positively (Cacioppo, Crites,

AQ1  
AQ2

Berntson, & Coles, 1993; Crites, Cacioppo, Gardner, & Berntson, 1995; Ito & Cacioppo, 2000). The LPP is largest to negative stimuli when embedded within other positive stimuli, providing a measure of how negative the stimulus is evaluated relative to the other presented stimuli. The LPP may be particularly useful to serve as an index of implicit evaluative responses to individuals of differing social groups. One such evaluative response may be a disgust response to members of derogated groups (e.g., homosexuals; Nussbaum, 2010).

ERP studies have revealed important information about understanding differential processing of social categories based on visually prominent features such as race. However, less is known about attentional and affective processing specific to less easily categorizable groups such as sexual orientation. In order to fill this gap in the literature, the current study sought to accomplish several goals. First, we wanted to examine whether differential attentional capture for out-group relative to in-group targets occurs for sexual orientation during the early stages of person perception using the N1, P2, and N2 ERP components. Second, we assessed the neural evaluative responses to targets of different sexual orientations using the LPP component. A third goal was to explore whether familiarity served as a moderator of the neural processing of out-group homosexual and in-group heterosexual couples. Previous research has shown that racial faces are differentially encoded as a function of out-group familiarity (Walker & Hewstone, 2006; Walker & Tanaka, 2003). In one recent behavioral study, relative implicit attentional allocation to racial out-group versus in-group members was moderated by the number of close out-group friends participants reported having, such that those with more out-group friends showed less attentional differences between in-group and out-group faces (Dickter et al., 2014). These results are reminiscent of findings demonstrating that as individuals become more familiar with out-groups, they express less implicit (Shook & Fazio, 2008) and explicit (e.g., Brewer & Miller, 1984; Pettigrew, 1998; Pettigrew & Tropp, 2008) out-group bias, which is consistent with contact theory (Allport, 1954).

To accomplish these goals, heterosexual college-age participants were presented with pictures of in-group heterosexual and out-group homosexual couples and were asked to rate the images for pleasantness (Meier, Robinson, Gaither, & Heinert, 2006) while their neural activity was recorded using EEG. We chose to examine couples rather than individuals as target stimuli because, although research shows that sexual orientation can be identified in faces at an accuracy rate higher than chance (Rule, Ambady,

Adams, & Macrae, 2008; Tskhay, Feriozzo, & Rule, 2013), we predicted that pictures of couples interacting with one another would more clearly communicate their sexual orientation. Secondly, images of couples rather than group labels or symbolic representations of sexuality were used because we expected that implicit reactions to abstract symbols would be weaker relative to those induced by images of homosexual and heterosexual couples embracing or kissing.

We hypothesized that participants would demonstrate attentional and evaluative biases in the N1, P2, N2, and LPP ERP components and in their behavioral responses toward out-group couples compared to in-group couples. That is, we expected differences in neural processing and behavioral responses between straight and gay couples as well as between straight and lesbian couples. We also expected that participants' reported close contact with out-group individuals would moderate the neural out-group-in-group attentional biases specific to the N1, P2, and N2 components. Although little research has examined whether the LPP component is moderated by familiarity, behavioral research has demonstrated that familiarity with stimuli reduces negative behavioral evaluative responses toward these stimuli (Bornstein, 1989; Fechner, 1876). Thus, we hypothesized that like the other ERP components, the LPP component would also be moderated by familiarity with gay and lesbian couples.

## METHOD

### Participants

Participants were 58 undergraduates (28 male) between the ages of 18 and 30 years ( $M = 19.6$  years,  $SD = 2.2$ ) at a medium-size public liberal arts university in Virginia who participated either for monetary payment or for the partial fulfillment of a course requirement. All participants were right-handed, and none had history of major head injury including stroke or concussion. All procedures were approved by the College of William and Mary Protection of Human Subjects Committee, and a written informed consent was obtained from each participant.

### Materials

#### *Picture stimuli*

Seventy-five images of gay, lesbian, and heterosexual couples previously collected and used in a study by Cunningham, Forestell, and Dickter (2013) were

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used in the current study. The pictures were carefully matched across the three categories in terms of facial expressions, physical appearance, environment, posture/pose, and degree of emotional involvement. Together, these pictures formed 25 sets of corresponding gay, lesbian, and straight images. Each set of pictures depicted the couples engaging in an intimate activity (e.g., kissing, hugging, gazing into each other's eyes, and holding hands). The couples were matched in terms of attractiveness and were all White or of indistinguishable race in order to ensure that differences in responses between pictures were due to the sexual orientation represented rather than other factors. They were also modestly dressed and did not have any unusual features (e.g., unconventional hair styles or piercings). Differences in the images' color and brightness were controlled by making all of the pictures black and white. All images were cropped to show only faces and upper torso.

#### Picture viewing and rating task

Participants completed a picture-viewing and rating task designed to assess implicit levels of discomfort toward homosexuality (Meier et al., 2006) as well as an explicit measure of the pleasantness of the images. In this task, each of the 75 images of gay, lesbian, and heterosexual couples was randomly selected and presented one at a time in the center of a 17" LCD computer monitor using E-Prime software (Psychology Software Tools, Inc., Pittsburgh, PA, USA). Participants were informed that the purpose of this task would be to rate the photos for use in future experiments. They were instructed to take as long as they needed to view each image to ensure an accurate rating and to press the spacebar when they were ready to rate each image. Upon pressing the spacebar, participants were asked to rate the pleasantness of the photo with a rating scale that ranged from 1 (very unpleasant) to 9 (very pleasant). After a rating was selected, a blank screen appeared for an intertrial interval of 500 ms before the next image was presented. The time between presentation of the image and pressing the spacebar served as a measure of viewing time (an implicit measure of the participants' comfort with the images, as defined by Meier et al., 2006).

#### Questionnaires

In addition to completing a demographic questionnaire, in which they indicated their gender, age, and sexual orientation on a scale from 1 (exclusively heterosexual) to 7 (exclusively homosexual) with a

midpoint label of "bisexual", participants also completed the following questionnaires to assess explicit attitudes toward homosexuality and their familiarity with sexual minorities (i.e., gays and lesbians).

*Attitudes toward lesbians and gay men scale* (ATLG; Herek, 1988). The short form of the ATLG was used to assess attitudes toward homosexual individuals. This scale consists of 10 items, with half assessing attitudes toward gay men and half assessing attitudes toward lesbian women. Participants reported the degree to which they agreed with statements such as "Homosexual behavior between two men is just wrong" and "Lesbians just can't fit into our society" using a 7-point scale from 1 (strongly disagree) to 7 (strongly agree). This scale has been shown to have adequate internal consistency ( $\alpha = .97$ ), and in the present study internal consistency was similar to that previously reported ( $\alpha = .94$ ). Responses were reverse-coded where necessary and summed, with higher scores indicating more negative attitudes toward homosexuality.

*Feelings thermometer task* (Esses, Haddock, & Zanna, 1993). In the feelings thermometer task, participants were asked to indicate their feelings toward gay men and lesbian women with a sliding scale from 0 (cold) to 100 (warm), with a neutral midpoint at 50.

*Familiarity with sexual minorities.* To assess close contact with sexual minority group members, participants provided the initials of up to 20 close friends and then subsequently identified the sexual orientation of those individuals. This measure was previously used by Dickter et al. (2014) and Greenwald et al. (1998) to covertly identify close friendships with individuals of different social groups. Proportions were computed for the number of gay and lesbian friends by dividing these by the total number of friends.

Participants also completed Walker, Silvert, Hewstone, and Nobre's (2008) social contact measure ( $\alpha = 0.87$ ; modeled after Voci & Hewstone, 2003) to assess individuating experiences with gay and lesbian individuals. This measure includes questions such as "How often do you spend time with gay friends at their place?" and "How often have you received advice from a gay person when you are having a personal problem?" Questions were answered separately for gay and lesbian groups. Participants indicated on a 5-point scale how strongly they agreed with these three statements. Higher scores indicated more current individuating experiences with each group.

Participants were also asked to estimate the proportion of sexual minority individuals they knew during their childhood (i.e., through high school).

## PROCEDURE

365 Upon arriving to the laboratory, participants completed a consent form and were seated in an electrically shielded Faraday chamber approximately 70 cm from a computer monitor. Participants were asked to be as still as possible during the experiment in order to  
 370 reduce the amount of extraneous noise in the EEG recordings. Participants were told that the computer task involved the presentation of a series of 75 trials, each composed of a picture. They were instructed to view the pictures and to rate the pleasantness of each  
 375 by pressing the spacebar to terminate the image, at which point a subsequent screen would appear in which they made their rating. This procedure, which was used by Meier et al. (2006), measures the reaction time to press the spacebar, which is thought to reflect avoidance of the images; i.e., faster reaction times indicate a greater degree of avoidance ~~for the stimuli~~. After completion of the EEG task, participants completed ~~the~~ questionnaires. When finished, they were debriefed ~~and~~ given credit for their participation  
 385 and dismissed. All participants completed the study within an hour.

### Electrophysiological recording and analysis

390 EEG data were recorded using a DBPA-1 Sensorium Bioamplifier (Sensorium Inc., Charlotte, VT) with an analog high-pass filter of 0.01 Hz and a low-pass filter of 500 Hz (four-pole Bessel). The EEG was recorded from 74 Ag-AgCl sintered electrodes in an electrode cap, placed using the expanded International 10–20  
 395 electrode placement system. All electrodes were referenced to the tip of the nose and the ground electrode was placed in the middle of the forehead, slightly above the eyebrows. Eye movement and blinking were recorded from bipolar electrodes placed on the  
 400 lateral canthi and peri-ocular electrodes on the superior and inferior orbits, aligned with the pupils. Before data collection was initiated, all impedances were adjusted to within 0–20 k $\Omega$ . EEG was recorded continuously throughout the computer task and was analyzed  
 405 offline using EMSE software (Source Signal Imaging, San Diego, CA). Data were undersampled at 500 Hz. The data were corrected for eye movement artifacts, using independent component analysis (Jung

et al., 2000). Individual trials with voltages outside a  $-100$  to  $100$   $\mu$ V range were excluded from analysis. All EEG data were filtered at low pass 20 Hz (Luck, 2005). The data were segmented between 200 ms prior to stimulus onset and 1000 ms post-stimulus onset. After baseline correction over the pre-stimulus interval, segmented data were averaged for each subject in each of the conditions. 410 415

Visual inspection of the grand average waveforms was used to quantify each ERP component. In particular, an electrode variable was included in a repeated-measures analysis of variance along with the conditions of interest. The electrodes that typically present the ERPs of interest in similar past research were examined, and the electrode yielding the highest amplitude for each component was chosen. The N1 component was largest at electrode Fz and was quantified as the largest positive voltage between 60 and 160 ms at electrode Fz. P2 was quantified as the largest positive voltage between 130 and 240 ms at electrode Pz. The N2 component was quantified as the largest negative voltage between 160 and 300 ms at electrode Fz. Finally, the LPP component was quantified as the largest positive voltage from 400 to 850 ms at Pz. 420 425 430

## RESULTS

### Participant characteristics

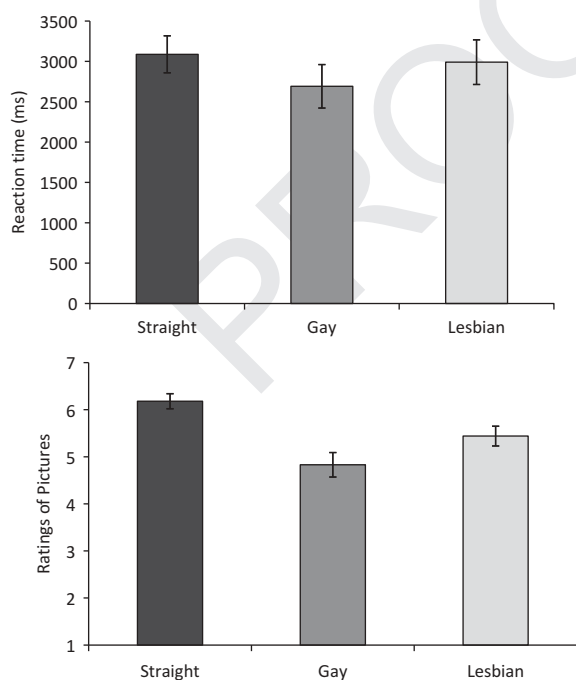
435 Of the 58 participants, 18 were excluded from analyses due to problems with data recording ( $n = 10$ ), errors sending condition codes to recording computer ( $n = 3$ ), excessive EEG artifacts ( $n = 3$ ), because they were ill ( $n = 1$ ) or because they had participated in a previous behavioral study that used the same stimuli ( $n = 1$ ). An additional 4 participants were excluded who indicated that they were not exclusively heterosexual (i.e., their score on the sexual orientation scale was greater than 2;  $n = 2$ ) or they were outliers in terms of their age (i.e., older than 27 years;  $n = 2$ ). The remaining 36 participants (17 males) were between the ages of 18 and 22 years ( $M = 19.08$  years,  $SE = 0.21$ ), and 67% reported their race as White, 8% Black, 22% Asian, 3% as multiracial. Of these, 6% indicated that they were of Hispanic or Latino descent. 440 445 450

Overall scores on the ATLG scale were similar for men ( $M = 3.85$ ,  $SE = 0.40$ ) and women ( $M = 5.14$ ,  $SE = 0.60$ ),  $t(34) = 1.75$ , *ns*. However, relative to women, men indicated that they had a higher proportion of gay friends ( $M = 0.06$ ,  $SE = 0.01$  vs.  $M = 0.02$ ,  $SE = 0.01$ ),  $t(34) = 3.29$ ,  $p < .01$ . No such gender 455 AQZ

460 differences were found for the proportion of lesbian  
friends reported by men and women ( $M = 0.01$ ,  
 $SE = 0.01$  vs.  $M = 0.01$ ,  $SE = 0.01$ ).

## Behavioral results

465 Data for all but one participant were recorded during  
the picture-viewing and rating task. In order to exam-  
ine whether reaction times to and explicit ratings of  
the pictures differed as a function of couple type and  
participant gender, each dependent variable (i.e., reac-  
tion times and ratings) was subjected to two mixed  
analyses of variance with couple type (either gay or  
470 lesbian vs. straight) as the repeated measure. As can  
be seen in Figure 1, results revealed that participants  
dismissed pictures of gay couples more quickly  
( $M = 2691.38$  ms,  $SE = 229.22$ ) than straight couples  
( $M = 3088.03$  ms,  $SE = 276.73$ ),  $F(1, 34) = 19.51$ ,  
475  $p < .001$ ,  $\eta^2 = .365$ . ~~There was no significant differ-~~  
~~ence for reaction times between the lesbian~~  
( $M = 2990.78$  ms,  $SE = 269.63$ ) and straight couples.  
As for participants' ratings of the couples, Figure 1  
480 demonstrates that ratings of gay couples were overall  
more negative ( $M = 4.83$ ,  $SE = 0.26$ ) than straight  
couples ( $M = 6.18$ ,  $SE = 0.16$ ),  $F(1, 34) = 20.83$ ,  
 $p < .001$ ,  $\eta^2 = .380$ . Additionally, for the gay-straight



**Figure 1.** Reaction times to dismiss (top panel) and explicit ratings of (bottom panel) pictures of gay, lesbian, and straight couples. Error bars represent standard error of the mean.

comparison, there was a significant couple type  $\times$   
participant gender interaction,  $F(1, 34) = 7.44$ ,  
 $p < 0.01$ . Simple main effects analyses revealed that  
485 men's ratings of the gay couples ( $M = 5.66$ ,  
 $SE = 0.37$ ) were higher than those of women  
( $M = 4.01$ ,  $SE = 0.37$ ),  $F(1, 34) = 10.14$ ,  $p < 0.03$ .  
For the straight-lesbian comparison, there was only a  
main effect of couple type. As shown in Figure 1,  
490 lesbian couples yielded lower ratings ( $M = 5.44$ ,  
 $SE = .21$ ) than straight couples regardless of partici-  
pant gender,  $F(1, 34) = 11.28$ ,  $p < .002$ . Participants'  
ATLG scores correlated significantly with their ratings  
of lesbian ( $r = -.42$ ,  $p < .01$ ), gay ( $r = -.77$ ,  $p < .01$ ),  
495 but not straight ( $r = 0.11$ ,  $p = 0.53$ ) couples.

## Psychophysiological results

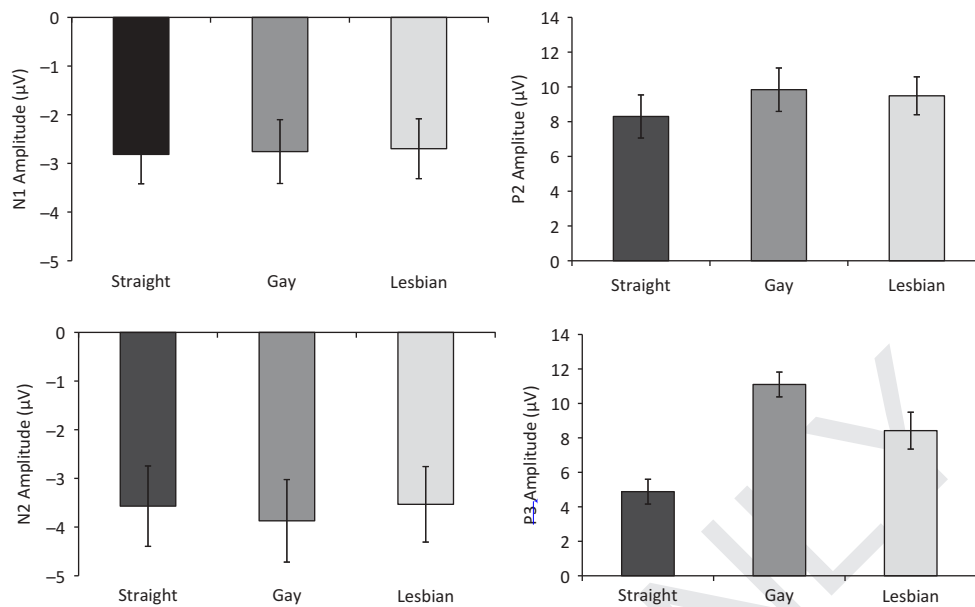
For the ERP components, preliminary analyses  
showed that there were no main effects of participant  
gender, nor did this factor interact with couple type, so  
analyses below are reported collapsing over gender.  
For each ERP component, the effect of couple type on  
ERP amplitude was assessed with dependent samples  
 $t$ -tests comparing amplitudes to straight couples first  
to gay couples and then to lesbian couples. Figures 2  
and 3 depict the results of the analyses reported below.

N1. Results indicated that neither the difference in  
peak amplitude between straight and gay couples nor  
the difference between straight and lesbian couples  
was significant, all  $p$  values  $> .50$ .

P2. This component was quantified for all but one  
participant. Results indicated that gay couples  
( $M = 9.84$ ,  $SE = 1.25$ ) yielded more positive peak am-  
plitudes than straight couples ( $M = 8.30$ ,  $SE = 1.24$ ),  
 $t(35) = -2.11$ ,  $p < .05$ . However, there was no sig-  
495 nificant difference between lesbian ( $M = 9.49$ ,  
 $SE = 1.09$ ) and straight couples,  $t(35) = -1.62$ ,  
 $p > .10$ . These results suggest that there was greater  
early attention to the gay than to the straight couples.

N2. Results indicated that neither the peak ampli-  
490 tude between straight and gay couples nor the differ-  
ence between straight and lesbian couples was  
significant, all  $p$  values  $> .40$ .

LPP. Analyses demonstrated that gay couples  
( $M = 11.10$ ,  $SE = 0.72$ ) yielded significantly higher  
495 amplitudes than the straight couples ( $M = 4.88$ ,  
 $SE = 0.72$ ),  $t(36) = -5.58$ ,  $p < 0.001$ . Activation in  
response to the lesbian couples ( $M = 8.42$ ,  $SE = 1.07$ )  
was also larger than that to the straight couples,  
 $t(36) = -3.54$ ,  $p < .01$ . These findings suggest that  
500 ~~both~~ the gay couples and the lesbian couples may  
have been more motivationally significant for partici-  
pants than the straight couples.



**Figure 2.** ERP amplitudes in response to pictures of straight, gay, and lesbian couples. The N1 and N2 ERPs are plotted at Fz. The P2 and LPP ERPs are plotted at Pz. Error bars represent standard errors. Note differences in y-axis range for positive and negative components.

## Relationships among variables

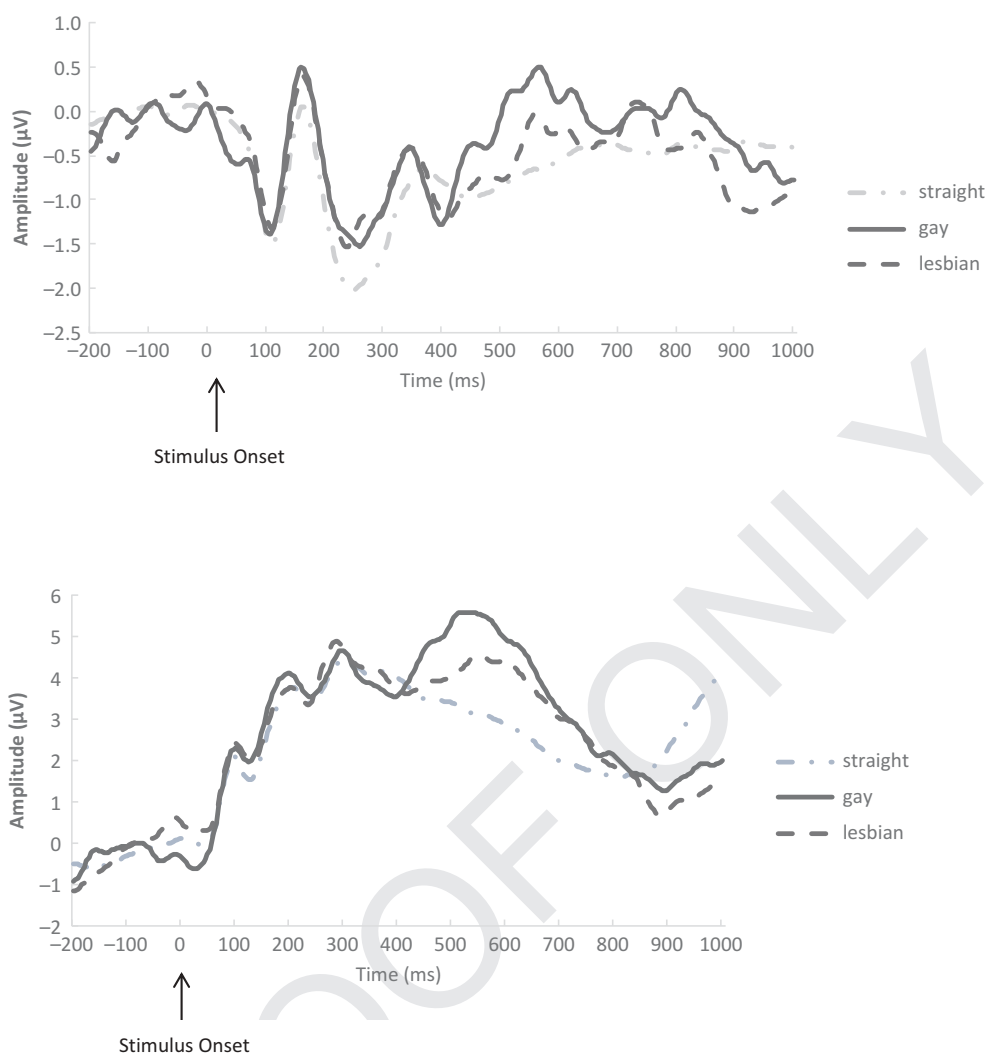
535 In order to examine the relationships among variables, correlational analyses were conducted. Difference scores for RTs and ratings of the pictures were calculated by subtracting scores for lesbian and gay couples from those for straight couples. As a result, positive  
540 difference scores indicated a bias against homosexual couples relative to heterosexual couples. Results of these analyses revealed that RT biases were not correlated with ATLG, feelings thermometers, or any of the familiarity measures. However, rating biases for  
545 straight-gay couples were correlated with ATLG scores,  $r = .75, p < .001$ . Straight-lesbian rating biases were also correlated with ATLG scores,  $r = .51, p < .002$ . Both the straight-gay rating difference and the straight-lesbian rating difference were correlated  
550 with contact with homosexuals,  $r = .61, p < .001$ , and  $r = .36, p < .04$ , respectively. Straight-gay ratings were negatively correlated with the gay feeling thermometer measure,  $r = .58, p < .001$ , as well as social contact with gay people,  $r = .44, p < .008$ , and  
555 individuating experiences with gay men. The straight-lesbian rating difference score was correlated with social contact with lesbians,  $r = .34, p < .05$ .

560 For each ERP component, two difference scores were calculated: one between peak amplitudes to the straight and lesbian couples and another between peak amplitudes to the straight and gay couples. For both of these calculations, amplitudes to homosexual couples

were subtracted from straight couples. This bias score was thus an indication of relative attention for the heterosexual and homosexual couples such that larger  
565 difference scores indicated greater bias between the two types of couples. Correlational analyses were then conducted between each component and RT, rating bias, percent childhood sexual minority experience, individuating experiences with gay/lesbian individuals, proportion of sexual minority friends, ATLG, and the feeling thermometers. Only significant or  
570 marginally significant correlations are reported below.

N1. There were no significant correlations between  
575 straight-gay difference score and any of the variables. There was a significant negative correlation between the straight-lesbian difference score for the N1 component and individuating experiences with lesbians,  $r(36) = -.35, p < .04$ . Marginal correlations were found between N1 amplitude and the proportion of  
580 sexual minority friends,  $r(36) = .31, p < .07$ , and the percent of childhood experiences with sexual minorities,  $r(36) = .29, p < .09$ . These results demonstrate that those with a higher proportion of current sexual minority friends and peers and more contact with  
585 lesbians have smaller differences in N1 amplitude to straight versus lesbian couples (i.e., a smaller bias).

P2. No significant correlations were found for  
590 straight-gay difference scores with any variable. For straight-lesbian difference scores, there was a significant correlation with the proportion of sexual minority friends participants currently have,  $r(36) = .42$ ,



**Figure 3.** ERP amplitudes in response to pictures of straight, gay, and lesbian couples. The top waveform is plotted at electrode FZ. The bottom waveform is plotted at electrode PZ.

$p < 0.02$ , revealing that the greater the proportion of friends, the less ERP bias.

595 N2. No significant correlations were found between the bias scores for the N2 component and any of the other variables.

LPP. No significant correlations were found between the bias scored for the P3/LPP component and any of the other variables.

## DISCUSSION

This study is the first to examine heterosexual individuals' neural processing of pictures of in-group straight and out-group gay and lesbian couples. This

study demonstrates that, similar to work on racial categorization, early neural attention in the P2 and later neural evaluative responses in the LPP are enhanced to out-group compared to in-group couples based on sexual orientation. Moreover, the amount of bias demonstrated for lesbian versus straight couples in the early ERP components appears to be related to participants' reports of their familiarity with this out-group. These findings were further supported by behavioral findings, in that participants were faster to dismiss images of gay relative to straight couples, and ratings were lower for gay and lesbian couples relative to straight couples. Similar to the neural results, further inspection of the rating bias scores revealed that they were related to participants' contact with

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620 gays and lesbians and their feelings of warmth toward  
these groups.

625 Although there were no significant in-group-out-  
group differences in the N1 ERP component, differ-  
ences emerged in the P2 component. For the P2 com-  
ponent, larger amplitudes were observed to out-group  
630 gay relative to in-group straight couples, suggesting  
greater out-group attentional capture. These findings  
are in line with the investigations of race, which have  
revealed that racial out-group targets elicit enhanced P2  
635 amplitudes (e.g., Dickter & Bartholow, 2007; Ito &  
Urland, 2003). The current study suggests that gay  
couples, but not lesbian couples, are being processed  
as out-group members in a similar fashion to racial out-  
groups. The fact that individuals can encode contextual  
640 information, such as romantic involvement, from sti-  
muli that are more ostensibly complex (i.e., pictures of  
two people) than a single face of a certain race, is  
consistent with previous work demonstrating that pre-  
ferential attention to nuanced characteristics can occur  
645 as early as 200 ms during social categorization. These  
results provide important insight into the social cate-  
gorization that occurs as a result of perceived sexual  
orientation. Although not significant, visual inspection  
of the ERP plot from the present study reveals that in-  
group couples yield somewhat larger N2 amplitudes  
650 than out-group couples. Research typically shows that  
racial in-group targets elicit larger N2 amplitudes than  
racial out-group targets.

Our results also revealed differences in processing  
655 between out-group couples and in-group couples later  
in the LPP. Greater activation was observed to out-  
group gay compared to in-group straight couples as  
well as to out-group lesbian compared to in-group  
straight couples. This pattern is consistent with pre-  
660 vious work in the race literature showing greater  
amplitudes in LPP are associated with out-group pro-  
cessing (e.g., Dickter & Bartholow, 2007). Because  
the LPP is associated with the processing of more  
motivationally significant stimuli and with negative  
665 implicit evaluative judgments (Cacioppo et al., 1993;  
Crites et al., 1995; Ito & Cacioppo, 2000), it may be  
the case that our findings reflect general negative  
affective responses to couples who represent a differ-  
ent sexual orientation from the perceivers.

665 It is possible that societal associations with homo-  
sexuality and disgust (Nussbaum, 2010) may play a  
role in the negative LPP evaluative response as well  
as the behavioral findings. Research has demonstrated  
670 a relationship between disgust and the evaluation of  
homosexuality (Cunningham et al., 2013; Dasgupta,  
DeSteno, Williams, & Hunsinger, 2009; Inbar,  
Pizarro, & Bloom, 2012; Inbar et al., 2009). While  
previous research demonstrated this relationship using

behavioral measures, the current study demonstrates  
675 that negative affective responses and greater attention  
are seen during the neural processing of homosexual  
compared to heterosexual couples. Whether differ-  
ences in LPP activation are moderated by disgust  
680 sensitivity or manipulations of disgust is a fruitful  
avenue for future work.

Although there were no differences in neural activ-  
ity between the lesbian and straight couples in any of  
the early attentional ERP components, differences in  
activation to these couples were related to some of the  
685 familiarity measures. That is, smaller differences  
between the activation to lesbian and straight couples  
in the early ERP components N1 and P2 were found  
in those participants with more current relationships  
with lesbians and other sexual minority peers. These  
690 results suggest that although there was not a global  
difference in the processing of out-group lesbian ver-  
sus in-group straight couples, processing varied as a  
function of participants' familiarity with these groups.

The relationship between activation and familiarity  
695 reported in this study is consistent with Allport's  
(1954) contact theory which suggests that meaningful  
intergroup contact with out-group members can  
change perceptions of out-group members. Previous  
700 examinations of contact theory demonstrate that close  
friendships that involve self-disclosure and intimacy  
over a sustained time period are particularly effective  
at reducing bias (e.g., Brewer & Miller, 1984; Cook &  
Seltiz, 1955; Pettigrew, 1998; Voci & Hewstone,  
2003). When considered in light of previous work,  
705 which demonstrates that close contact with out-group  
members is associated with smaller attentional differ-  
ences between racial in-group and out-group members  
(Dickter et al., 2014), this work suggests that unfami-  
liarity with social groups may lead to differences in  
710 patterns of attention between the two groups. The  
mechanism responsible for the reduction in attentional  
differences is yet unclear. That is, close relationships  
with out-group members may reduce negative stereo-  
types, reduce the threat that is associated with out-  
715 groups, or reduce the novelty of out-group members  
themselves; work in our lab is currently examining  
mediating variables.

It is important to point out, however, that the  
720 correlations reported herein should be interpreted  
with caution, given that social contact was measured  
and not manipulated; the causal direction of this effect  
is unknown. Moreover, the current study was limited  
in that a relatively small sample size was used.  
725 Although this sample size is quite large compared to  
similar ERP studies, we should be careful in interpret-  
ing correlations between variables with a sample of  
this size.

Because this is the first study to look at neural responses to couples representing different sexual orientations, more work is needed to determine the replicability of these effects. For example, future work could employ more sensitive measures of intergroup contact or employ stimuli depicting individuals whose social category is more ambiguous. Because studies have demonstrated that sexual orientation can be identified in faces at an accuracy rate higher than chance (Rule et al., 2008; Tskhay et al., 2013), it would be interesting to examine whether distinctions in neural processing occur in response to faces of homosexual and heterosexual individuals. Indeed, research is currently being conducted in our lab exploring this very question.

In summary, this work represents an important step in examining the neural processing of social in-groups and out-groups and opens the door to further investigations seeking to understand how homosexual couples are viewed by our society. Although a significant amount of social neuroscience research has focused on understanding early attention and evaluative processing of race, more work needs to be conducted to further understand the cognitive underpinnings involved in processing members of sexual minority groups. As prejudice against homosexuals is still prevalent in our society, understanding how attention to and evaluative processing of sexual minorities is important, as is the examination of other groups that are less easily identifiable.

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## REFERENCES

- Allport, G. W. (1954). *The Nature of Prejudice*. Reading, MA: Addison-Wesley.
- Banse, R., Seise, J., & Zerbes, N. (2001). Implicit attitudes towards homosexuality: Reliability, validity, and controllability of the IAT. *Zeitschrift Für Experimentelle Psychologie*, 48(2), 145–160. doi:10.1026//0949-3946.48.2.145
- Bargh, J. A., Chen, M., & Burrows, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype activation on action. *Journal of Personality and Social Psychology*, 71, 230–244. doi:10.1037/0022-3514.71.2.230
- Bartholow, B. D., & Dickter, C. L. (2008). A response conflict account of the effects of stereotypes on racial categorization. *Social Cognition*, 26(3), 314–332. doi:10.1521/soco.2008.26.3.314
- Bettencourt, B., Dill, K. E., Greathouse, S. A., Charlton, K., & Mulholland, A. (1997). Evaluations of ingroup and outgroup members: The role of category-based expectancy violation. *Journal of Experimental Social Psychology*, 33(3), 244–275. doi:10.1006/jesp.1996.1323
- Bornstein, R. F. (1989). Exposure and affect: Overview and meta-analysis of research, 1968–1987. *Psychological Bulletin*, 106, 265–289. doi:10.1037/0033-2909.106.2.265
- Brewer, M. (1988). A dual process model of impression formation. In T. Srull & R. Wyer Jr. (Eds.), *Advances in social cognition* (Vol. 1, pp. 1–36). Hillsdale, NJ: Lawrence Erlbaum.
- Brewer, M. B., & Miller, N. (1984). Beyond the contact hypothesis: Theoretical perspectives on desegregation. In N. Miller & M. B. Brewer (Eds.), *Groups in contact: The psychology of desegregation* (pp. 281–302). Orlando, FL: Academic Press.
- Brosch, T., & Van Bavel, J. J. (2012). The flexibility of emotional attention: Accessible social identities guide rapid attentional orienting. *Cognition*, 125, 309–316. doi:10.1016/j.cognition.2012.07.007
- Cacioppo, J. T., Crites Jr., S. L., Berntson, G. G., & Coles, M. G. H. (1993). If attitudes affect how stimuli are processed, should they not affect the event-related brain potential? *Psychological Science*, 4, 108–112. doi:10.1111/j.1467-9280.1993.tb00470.x
- Cook, S. W., & Seltiz, C. (1955). Some factors which influence the attitudinal outcome of personal contact. *International Social Science Bulletin*, 7, 51–58.
- Correll, J., Park, B., Judd, C. M., & Wittenbrink, B. (2002). The police officer's dilemma: Using ethnicity to disambiguate potentially threatening individuals. *Journal of Personality and Social Psychology*, 83(6), 1314–1329. doi:10.1037/0022-3514.83.6.1314
- Crites, S. L., Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1995). Bioelectrical echoes from evaluative categorization: II. A late positive brain potential that varies as a function of attitude registration rather than attitude report. *Journal of Personality and Social Psychology*, 68(6), 997–1013. doi:10.1037/0022-3514.68.6.997
- Cunningham, E., Forestell, C. A., & Dickter, C. L. (2013). Induced disgust affects implicit and explicit responses toward gay men and lesbians. *European Journal of Social Psychology*, 43(5), 362–369. doi:10.1002/ejsp.1945
- Darley, J. M., & Gross, P. H. (1983). A hypothesis-confirming bias in labeling effects. *Journal of Personality and Social Psychology*, 44, 20–33. doi:10.1037/0022-3514.44.1.20
- ~~Dasgupta, N. (2004). Implicit ingroup favoritism, outgroup favoritism, and their behavioral manifestations. *Social Justice Research*, 17(2), 143–169. doi:10.1023/B:SORE.0000027407.70241.15~~
- Dasgupta, N., DeSteno, D. A., Williams, L., & Hunsinger, M. (2009). Fanning the flames of prejudice: The influence of specific incidental emotions on implicit prejudice. *Emotion*, 9, 585–591. doi:10.1037/a0015961
- ~~Dasgupta, N., McGhee, D. E., Greenwald, A. G., & Banaji, M. R. (2000). Automatic preference for White Americans: Eliminating the familiarity explanation. *Journal of Experimental Social Psychology*, 36(3), 316–328. doi:10.1006/jesp.1999.1418~~
- Dasgupta, N., & Rivera, L. M. (2006). From automatic antigay prejudice to behavior: The moderating role of conscious beliefs about gender and behavioral control. *Journal of Personality and Social Psychology*, 91(2), 268–280. doi:10.1037/0022-3514.91.2.268

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- Dickter, C. L., & Bartholow, B. D. (2007). Racial ingroup and outgroup attention biases revealed by event-related brain potentials. *Social Cognitive and Affective Neuroscience*, 2(3), 189–198. doi:10.1093/scan/nsm012
- 850 Dickter, C. L., & Bartholow, B. D. (2010). Ingroup categorization and response conflict: Interactive effects of target race, flanker compatibility, and infrequency on N2 amplitude. *Psychophysiology*, 47(3), 596–601. doi:10.1111/j.1469-8986.2010.00963.x
- 855 Dickter, C. L., Gagnon, K. T., Gyurovski, I. I., & Brewington, B. S. (2014). Close contact with racial outgroup members moderates attentional allocation towards outgroup versus ingroup faces. *Group Processes and Intergroup Relations*. doi:10.1177/1368430214527854.
- 860 Dickter, C. L., & Gyurovski, I. I. (2012). The effects of expectancy violations on early attention to race in an impression formation paradigm. *Social Neuroscience*, 7, 240–251. doi:10.1080/17470919.2011.609906
- 865 Donders, N. C., Correll, J., & Wittenbrink, B. (2008). Danger stereotypes predict racially biased attentional allocation. *Journal of Experimental Social Psychology*, 44(5), 1328–1333. doi:10.1016/j.jesp.2008.04.002
- 870 Dovidio, J. F., & Gaertner, S. L. (2000). Aversive racism and selection decisions: 1989 and 1999. *Psychological Science*, 11(4), 315–319. doi:10.1111/1467-9280.00262
- Fechner, G. T. (1876). *Vorschule der aesthetik*. Leipzig: Breitkoff & Hartel.
- Fiske, S. T., & Neuberg, S. L. (1990). A continuum of impression formation, from category-based to individuating processes: Influences of information and motivation on attention and interpretation. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 23, pp. 1–74). New York, NY: Academic Press. doi:10.1016/S0065-2601(08)60317-2
- 875 Gabriel, U., Banse, R., & Hug, F. (2007). Predicting private and public helping behaviour by implicit attitudes and the motivation to control prejudiced reactions. *British Journal of Social Psychology*, 46(2), 365–382. doi:10.1348/014466606X120400
- 880 Giner-Sorolla, R., García, M. T., & Bargh, J. A. (1999). The automatic evaluation of pictures. *Social Cognition*, 17(1), 76–96.
- 885 Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology*, 74(6), 1464–1480. doi:10.1037/0022-3514.74.6.1464
- 890 Hehman, E., Stanley, E. M., Gaertner, S. L., & Simons, R. F. (2011). Multiple group membership influences face-recognition: Recall and neurological evidence. *Journal of Experimental Social Psychology*, 47(6), 1262–1268. doi:10.1016/j.jesp.2011.05.014
- 895 Herek, G. M. (1988). Heterosexuals' attitudes toward lesbians and gay men: Correlates and gender differences. *The Journal of Sex Research*, 25(4), 451–477. doi:10.1080/00224498809551476
- 900 Inbar, Y., Pizarro, D. A., & Bloom, P. (2012). Disgusting smells cause decreased liking of gay men. *Emotion*, 12, 23–27. doi:10.1037/a0023984
- 905 Inbar, Y., Pizarro, D. A., Knobe, J., & Bloom, P. (2009). Disgust sensitivity predicts intuitive disapproval of gays. *Emotion*, 9(3), 435–439. doi:10.1037/a0015960
- Ito, T. A., & Bartholow, B. D. (2009). The neural correlates of race. *Trends in Cognitive Sciences*, 13(12), 524–531. doi:10.1016/j.tics.2009.10.002 910
- Ito, T. A., & Cacioppo, J. T. (2000). Electrophysiological evidence of implicit and explicit categorization processes. *Journal of Experimental Social Psychology*, 36, 660–676. doi:10.1006/jesp.2000.1430
- 915 Ito, T. A., Thompson, E., & Cacioppo, J. T. (2004). Tracking the timecourse of social perception: The effects of racial cues on event-related brain potentials. *Personality and Social Psychology Bulletin*, 30(10), 1267–1280. doi:10.1177/0146167204264335
- 920 Ito, T. A., & Urland, G. R. (2003). Race and gender on the brain: Electro-cortical measures of attention to the race and gender of multiply categorizable individuals. *Journal of Personality and Social Psychology*, 85(4), 616–626. doi:10.1037/0022-3514.85.4.616
- 925 Ito, T. A., & Urland, G. R. (2005). The influence of processing objectives on the perception of faces: An ERP study of race and gender perception. *Cognitive, Affective, & Behavioral Neuroscience*, 5(1), 21–36. doi:10.3758/CABN.5.1.21
- Jung, T.-P., Makeig, S., Westerfield, M., Townsend, J., Courchesne, E., & Sejnowski, T. J. (2000). Removal of eye activity artifacts from visual event-related potentials in normal and clinical subjects. *Clinical Neurophysiology*, 111(10), 1745–1758. doi:10.1016/S1388-2457(00)00386-2
- 930 Jussim, L., Palumbo, P., Smith, A., & Madon, S. (2000). Stigma and self-fulfilling prophecies. In T. Heatherton, R. Kleck, M. R. Hebl, & J. G. Hull (Eds.), *The social psychology of stigma* (pp. 374–418). New York, NY: Guilford Press.
- 935 Luck, S. J. (2005). ~~Ten simple rules for designing ERP experiments.~~ In ~~Event-related potentials: A methods handbook.~~ 940
- 940 Macrae, C. N., Milne, A. B., & Bodenhausen, G. V. (1994). Stereotypes as energy-saving devices: A peek inside the cognitive toolbox. *Journal of Personality and Social Psychology*, 66(1), 37–47. doi:10.1037/0022-3514.66.1.37 945
- 945 McConahay, J. B. (1986). Modern racism, ambivalence, and the modern racism scale. In J. F. Dovidio & S. L. Gaertner (Eds.), *Prejudice, discrimination, and racism* (pp. 91–125). San Diego, CA: Academic Press. 950
- 950 Meier, B. P., Robinson, M. D., Gaither, G. A., & Heinert, N. J. (2006). A secret attraction or defensive loathing? Homophobia, defense, and implicit cognition. *Journal of Research in Personality*, 40, 377–394. doi:10.1016/j.jrp.2005.01.007 955
- 955 Nussbaum, M. C. (2010). *From disgust to humanity: Sexual orientation and constitutional law*. Oxford University Press. 960
- 960 Payne, B. K. (2001). Prejudice and perception: The role of automatic and controlled processes in misperceiving a weapon. *Journal of Personality and Social Psychology*, 81(2), 181–192. doi:10.1037/0022-3514.81.2.181
- 965 Pettigrew, T. F. (1998). Intergroup contact theory. *Annual Review of Psychology*, 49, 65–85. doi:10.1146/annurev.psych.49.1.65
- Pettigrew, T. F., & Tropp, L. R. (2008). How does intergroup contact reduce prejudice? Meta-analytic tests of three mediators. *European Journal of Social Psychology*, 38(6), 922–934. doi:10.1002/ejsp.504

- 970 Rowatt, W. C., Tsang, J.-A., Kelly, J., LaMartina, B.,  
McCullers, M., & McKinley, A. (2006). Associations  
between religious personality dimensions and implicit  
homosexual prejudice. *Journal for the Scientific Study  
of Religion*, 45(3), 397–406. doi:10.1111/j.1468-  
975 5906.2006.00314.x
- Rule, N. O., Ambady, N., Adams Jr, R. B., & Macrae, C.  
(2008). Accuracy and awareness in the perception and  
categorization of male sexual orientation. *Journal of  
Personality and Social Psychology*, 95(5), 1019–1028.  
980 doi:10.1037/a0013194
- Sherrill, K., & Yang, A. (2000). From outlaws to in-laws:  
Anti-gay attitudes thaw. *Public Perspective*, 11(1), 20–23.
- Shook, N. J., & Fazio, R. H. (2008). Interracial roommate  
relationships: An experimental field test of the contact  
985 hypothesis. *Psychological Science*, 19(7), 717–723.  
doi:10.1111/j.1467-9280.2008.02147.x
- Steffens, M. C., & Wagner, C. (2004). Attitudes toward  
lesbians, gay men, bisexual women, and bisexual men  
in Germany. *Journal of Sex Research*, 41(2), 137–149.  
990 doi:10.1080/00224490409552222
- Trawalter, S., Todd, A. R., Baird, A. A., & Richeson, J. A.  
(2008). Attending to threat: Race-based patterns of  
selective attention. *Journal of Experimental Social  
Psychology*, 44(5), 1322–1327. doi:10.1016/j.  
jesp.2008.03.006 995
- Tskhay, K. O., Feriozzo, M. M., & Rule, N. O. (2013).  
Facial features influence the categorization of female  
sexual orientation. *Perception*, 42, 1090–1094.  
doi:10.1068/p7575
- Voci, A., & Hewstone, M. (2003). Intergroup contact 1000  
and prejudice toward immigrants in Italy: The  
mediational role of anxiety and the moderational  
role of group salience. *Group Processes & Intergroup  
Relations*, 6(1), 37–54. doi:10.1177/13684302030  
06001011 1005
- Walker, P. M., & Hewstone, M. (2006). A perceptual dis-  
crimination investigation of the own-race effect and  
intergroup experience. *Applied Cognitive Psychology*,  
20(4), 461–475. doi:10.1002/acp.1191
- Walker, P. M., & Tanaka, J. W. (2003). An encoding advantage 1010  
for own-race versus other-race faces. *Perception*,  
32, 1117–1125. doi:10.1068/p5098
- Yang, A. S. (1997). Trends: Attitudes toward homosexuality.  
*The Public Opinion Quarterly*, 61(3), 477–507.  
doi:10.1086/297810 1015