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Tracking the Timecourse of Social Perception: The Effects of Racial Cues on Event-Related Brain Potentials

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Event-related potentials were used to track social perception processes associated with viewing faces of racial ingroup and outgroup members. Activity associated with three distinct processes was detected. First, peaking at approximately 170 ms, faces were distinguished from nonface stimuli. Second, peaking at approximately 250 ms, ingroup members were differentiated from outgroup members, with a larger component suggesting greater attention to ingroup members. This effect may reflect the spontaneous application of a deeper level of processing to ingroup members. Third, peaking at approximately 520 ms, evaluative differentiation of ingroup and outgroup members occurred, with greater ingroup bias displayed by those with higher levels of prejudice on an explicit measure. Together, the results demonstrate the promise of using neural processes to track the presence, timing, and degree of activation of components relevant to social perception, prejudice, and stereotyping.

Keywords: *racial prejudice; implicit prejudice; face processing; social neuroscience*

The study of racial prejudice has benefited greatly from investigations of implicit processes (e.g., Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997; Fazio, Jackson, Dunton, & Williams, 1995; Greenwald, McGhee, & Schwartz, 1998; Wittenbrink, Judd, & Park, 1997). Among the implications of this research is the ease with which racial bias occurs and that racial bias can be composed of multiple components. Although not currently well-integrated with the study of prejudice, research on the neural mechanisms underlying person perception also should be informative for understanding racial prejudice. Adolphs (2003), for instance, has drawn from research on humans and nonhuman primates to suggest that social cognition is based on a distributed set of neural mechanisms for perceiving, recognizing, and evaluating stimuli, which are then used to construct complex central representations of the social environment. For prejudice, the importance of these types of integrative models is their demonstration of the broad range of component processes involved in social cognition. Both research that focuses on a single aspect of the process (e.g., evaluation) as well as research more sensitive to multiple components of the process should be beneficial. Neuroscience measures, while differing from more traditional approaches to prejudice, may provide a particularly beneficial perspective for understanding its multifaceted nature.

A second advantage to examining the neural correlates of prejudice is the ability to examine the timecourse

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of processing. This can be done with event-related brain potentials (ERPs), which reflect brain electrical activity in response to discrete stimuli. Multiple components of the ERP waveform can be assessed in response to a single stimulus, with different components representing different types of processing. Coupled with the sensitive temporal resolution of ERPs (on the order of ms), this allows for measurement of multiple responses to the same stimulus, ranging from more spontaneous to more deliberate. Drawing on these advantages, the goal of the present article is to examine the broad range of processes that occur when people perceive racial ingroup and outgroup members using ERPs to assess the timecourse of processing. Links will then be made between the information gained from such a perspective and more traditional research on person perception.

ERPS AND STAGES OF RACIAL PROCESSING

It is clear that the perception of people from different racial groups can activate different types of evaluations and cognitions, but in addition to evaluative response, other processes may be important to understanding how members of different racial groups are perceived. One potentially relevant factor is depth of processing. The robust tendency to remember racial ingroup members better, especially among White perceivers, is an indication of deeper, more individuated processing of the ingroup (Levin, 2000). Factors such as increased salience for the dimensions that differentiate ingroup faces from each other based on greater experience with the ingroup (MacLin & Malpass, 2001), and a focus on the salient social category distinction that differentiates outgroup members from the ingroup at the expense of more individuating information (Levin, 2000), are thought to produce these processing differences.

These findings demonstrate that the faces of ingroup and outgroup members are eventually subject to different processing, but when this differentiation occurs is less clear. A component of the ERP that is labeled either the vertex positive potential (VPP) or the N170[1] and is sensitive to face processing can address these issues. The VPP/N170 peaks around 170 ms and is typically larger to human faces than objects and nonhuman faces (Bentin, Allison, Puce, Perez, & McCarthy, 1996; Jeffreys, 1989). These findings have led to the conclusion that the VPP/N170 reflects an early structural encoding stage that is sensitive to features indicating faceness but not to more complex processes that allow for differentiation among faces.

There have been few investigations of how social category membership effects the structural encoding of faces (but see Caldara et al., 2003), but there is reason to expect race to modulate early encoding. Recent research showing an N170-like component to nonface stimuli about which participants are expert suggests that the VPP/N170 represents a domain-general encoding mechanism. Such a mechanism has been described as responding to faces, about which humans are normally assumed to be expert, as well as categories about which people are idiosyncratically expert (e.g., in differentiating birds) (Tanaka & Curran, 2001). Given that people are often more familiar with ingroup than outgroup faces, the expertise results suggest that the VPP/N170 will be larger for faces belonging to ingroup than outgroup members.

Alternatively, the VPP/N170 has been viewed as reflecting a face-specific structural encoding mechanism, which presumably does not differentiate between ingroup and outgroup faces. In studies comparing responses to strangers and acquaintances or people who are famous, the N170 was insensitive to familiarity effects (Bentin & Deouell, 2000; Eimer, 2000). From this perspective, the VPP/N170 should be insensitive to ingroup status, and differential processing effects for ingroup and outgroup faces would be expected after the structural encoding processes indicated by the VPP/N170.

Whether social category membership has effects in the VPP/N170 or subsequent components, a large body of research shows that once activated, this information directly activates evaluative responses. Although there have been no ERP components linked to social category-based evaluative judgments within the context of viewing faces, a number of studies have identified a late-positive potential (LPP) that is sensitive to non-face-related evaluative judgments (Cacioppo, Crites, Berntson, & Coles, 1993; Cacioppo, Crites, Gardner, & Berntson, 1994; Crites, Cacioppo, Gardner, & Berntson, 1995; Ito & Cacioppo, 2000; Ito, Larsen, Smith, & Cacioppo, 1998). More specifically, the LPP is sensitive to changes in evaluation. For instance, if participants are shown pictures of positive objects such as appetizing foods and cute animals and are then presented with a negative picture such as a dead animal, the change from positive to negative results in an enhanced LPP (relative to presentation of another positive item). Similarly, a positive item embedded within negative items results in an enhanced LPP relative to responses to another negative item. The magnitude of the response provides a graded index of the degree to which a target stimulus differs evaluatively from the preceding context, ceteris paribus. That is, extremely negative items embedded within extremely positive items elicit a larger LPP than moderately negative items, which in turn elicit larger responses than moderately positive items even when all three categories are equally rare within the extremely positive context (Cacioppo et al., 1994).

To date, research on the LPP has examined responses to general attitude items (Cacioppo et al., 1993) and affective processes (Cacioppo et al., 1994; Ito et al., 1998) but it is reasonable to assume that the LPP is also sensitive to evaluative judgments of more social stimuli, such as members of different social groups. In fact, the LPP may be particularly useful for measuring evaluative reactions to ingroup and outgroup members. The LPP is more sensitive to the underlying evaluative percept than to response selection or output processes (Crites et al., 1995; Farwell & Donchin, 1991; Rosenfeld, Angell, Johnson, & Qian, 1991). Even when participants are successful in manipulating their overt responses, the LPP is sensitive to the underlying evaluative categorization. For instance, the LPP to a negative item that participants report liking is indistinguishable from a negative item truthfully reported as disliked (Crites et al., 1995). There also is evidence that the LPP is sensitive not only to intentional evaluations but also to spontaneously activated evaluative judgments (Ito & Cacioppo, 2000). Together, these results suggest that ERP-based measures may be useful not only in marking evaluative processes that an individual may not want to report but also in exploring responses not even intended.

Overview of Research

In sum, it is clear that evaluations and cognitions associated with a social category can quickly become activated following exposure to category exemplars (Cunningham, Preacher, & Banaji, 2001; Fazio et al., 1995; Greenwald et al., 1998; Wittenbrink, Judd, & Park, 1997, 2001). In addition, specific ERP components have been linked to aspects of face processing and previous research on the LPP suggests that it may differentiate evaluative reactions to members of different social groups. The goal of the present studies is therefore to integrate these different lines of research using ERPs to study the process by which faces of ingroup and outgroup members are perceived.

The first question of interest is whether the greater experience that Whites typically have interacting with and perceiving other Whites will moderate the VPP/N170. Specifically, we assess whether there are social expertise effects that result in larger responses to ingroup White than outgroup Black faces (consistent with the domain-general view of the VPP/N170) or whether responses at this stage reflect only the structural encoding of faces without sensitivity to other aspects of facial identity (consistent with the domain-specific view). Second, we address whether the LPP, which has been shown to reflect variations in evaluative extremity, will index differential evaluative responses to ingroup and outgroup members. We expect the LPP to relate to the category-based reactions based on prior research showing its sensitivity to the evaluative process evoked by an exemplar from a category (e.g., Cacioppo et al., 1994) even when participants are unwilling (Crites et al., 1995) or unable (Ito & Cacioppo, 2000) to verbally report their feelings. Third, we examine the relation of the ERP responses to explicit evaluative judgments and whether this relation depends on type of explicit response. The two explicit measures collected for this purpose were attitudes toward Blacks as a category and ratings of each individual presented in the stimulus photos.

EXPERIMENT 1

Based on past research showing that the LPP is sensitive to changes in evaluation, we used a modified oddball paradigm in which unpleasant pictures were shown most frequently. We compared responses recorded from White participants to the frequently presented negative pictures and to three other types of pictures that were equally infrequent: (a) positive pictures, (b) pictures of Whites, and (c) pictures of Blacks. Participants viewed three blocks of trials with a different type of infrequent target in each block. To obtain self-reported reactions to the individual targets, participants made liking judgments of what was shown. To obtain category-based reactions, participants completed the Modern Racism Scale (MRS) (McConahay, Hardee, & Batts, 1981). It is likely that our participants have had greater experience interacting with Whites than Blacks. However, to explicitly assess the effects of experience, we also collected information on participants' prior contact with Blacks.

Methods

PARTICIPANTS

Twenty-six students (23 men) from the University of Colorado who identified their ethnicity as White participated for partial class credit.

MATERIALS

Twenty-seven negatively valenced pictures were chosen from the International Affective Picture System (IAPS, Center for the Study of Emotion and Attention, 1995) to serve as the frequently presented context pictures. Pictures were chosen to be similarly arousing and evaluatively extreme; none showed people in them. Two pictures also were selected from each of three additional categories: positive pictures, White male students, and Black male students. The two positive pictures, also from the IAPS, were chosen to be as similar in normative arousal and affective extremity to the mean of the negative pictures. The pictures of the Whites and Blacks were equated on normative attractiveness and arousal ratings and always showed smiling individuals. Finally, two sets of 18 neutral IAPS pictures were selected to serve as filler stimuli.[2]

PROCEDURE

Participants were told that the purpose of the study was to measure electrical activity occurring in the brain when people view pictures. Following procedures used in prior research on evaluative categorization (e.g., Ito et al., 1998), pictures were shown to participants in sequences of five, with each picture presented for 1,000 ms. Participants were instructed to look at the picture for its entire presentation and to think about how much they liked or disliked what it showed. After stimulus offset, participants registered their explicit global evaluation by choosing between the options “like” and “dislike” on an appropriately labeled keypad (order of the labels was counterbalanced between participants). After a 1,000-ms interstimulus interval, the next picture was shown. We stressed to participants that there were no right or wrong evaluations and that we were interested in their first impressions. After the fifth picture in a sequence, the word *pause* was shown on the screen until participants pressed a button to initiate presentation of the next sequence.

A total of 180 five-picture sequences were divided into three equal-length blocks. All blocks contained primarily negative pictures but in half of the sequences either positive pictures, White pictures, or Black pictures (depending on the block) were embedded in the negative context. We refer to these as target pictures. ERPs were recorded during the presentation of the single target picture. In the remaining sequences in each block, all pictures within the sequence were negative and ERP collection occurred during the presentation of one of the five negative pictures. In all sequence types, the picture during which ERPs were collected randomly appeared in either the third, fourth, or fifth position in a sequence, thereby ensuring that it was always preceded by at least two negative pictures and that participants could not easily predict when a nonnegative picture might appear. Block-type order (positive, White, or Black rare target) was randomized. Trial order within a block was random. Participants were not informed of the distinction between pictures during which ERPs were or were not collected, and they evaluated all pictures in a similar fashion.

Participants viewed and made evaluative judgments of the two sets of neutral pictures between the blocks to minimize awareness that responses to Whites and Blacks were being compared.

The MRS and contact measure were completed at the end of the experiment. We operationalized contact as involving both the quality and quantity of outgroup contact (e.g., Britt, Boniecki, Vescio, Biernat, & Brown, 1996; Herek & Capitanio, 1996; Islam & Hewstone, 1993). We therefore asked participants to first list all of their Black acquaintances and then rate each listed acquaintance in terms of how well he or she was known on a 7-point scale with endpoints ranging from *know/knew as only an acquaintance* to *know/knew very well* (Blair, Park, & Bachelor, 2003). Contact was scored as the number of contacts multiplied by the level of contact.

ERP data collection and reduction. Data were recorded at sites over midline frontal (Fz), central (Cz), and parietal (Pz) areas using tin electrodes sewn into an elastic cap (Electro-Cap International, Eaton, OH). Additional tin electrodes also were placed over the left and right mastoid, above and below the left eye, and on the outer canthus of each eye. Electrode impedances were below 5 KΩ at all sites. ERP recordings were amplified with a gain of 500 by NeuroScan Synamps model amplifiers with a bandpass of .1-30 Hz (12-dB roll-off) and digitized at 1,000 Hz. Data recording began 128 ms before picture onset and continued throughout the 1,000-ms picture presentation.

Active scalp sites were referenced on-line to the left mastoid, then re-referenced off-line to a computed average of the left and right mastoids. EEG data were submitted to a regression procedure to remove the effects of vertical eye movements from the EEG (Semlitsch, Anderer, Schuster, & Presslich, 1986) and then corrected to the mean voltage of the 128-ms prestimulus recording period. We next visually inspected the EEG data and deleted any trials with remaining ocular or other artifact (e.g., due to movement).

Ensemble averages were constructed by aggregating for each participant at each scalp site the electrical activity associated with the evaluation of (a) rare positive targets, (b) negative context targets in the positive block, (c) White targets, (d) negative context targets in the White block, (e) Black targets, and (f) negative context targets in the Black block. One set of ensemble averages, calculated without further filtering of the data, was used to evaluate the shorter latency components (e.g., the VPP), whereas another set of average waveforms constructed on data that was first filtered with a 9-Hz low pass filter was used to evaluate the longer latency LPP component. The use of different filtering parameters was chosen as the best way to extract different types of signal (i.e., short latency vs. long latency components) from the background EEG noise (cf. Scheffers & Coles, 2000).

Following past research (e.g., Ito & Cacioppo, 2000), the amplitude of the LPP was quantified by locating within each ensemble average the largest positive-going potential at Pz between 350-700 ms after stimulus onset. The amplitude of the LPP at other sites was scored as the peak amplitude of the largest positive-going potential that occurred within ±100 ms of the LPP at Pz.

Given (a) that the peak quantification method used to score the LPP is most appropriate when a priori scalp distributions and latency windows can be specified for a component, (b) that we were interested in identifying all components that varied as a function of face race, and (c) the possibility of component overlap, we also used principal components analysis (PCA) to identify additional sources of variance early in our waveforms.

Ensemble-averaged waveforms submitted to a PCA (derived from the covariance matrix) with varimax rotation produce component loadings that indicate orthogonal sources of amplitude variation in the waveform (Donchin & Heffley, 1978; van Boxtel, 1998). More specifically, PCA performed on ERP waveforms produces two output matrices. The first is a matrix of component loadings that represent for each extracted component its degree of association with each time point. Examination of the component loadings reveals the point in time at which the component is most active. The second matrix of interest contains a single component score for each waveform indicating the degree to which the component varies in that particular waveform. Said differently, the component loadings indicate where in time the variability exists and the component scores indicate the degree of variability. The latter can be analyzed in a manner similar to peak-amplitude measures.

Six principal components that accounted for 91% of the variance were extracted. The number of components extracted was determined based on (a) cumulative variance explained and increments in explained variance associated with extracting additional components, (b) theoretical meaningfulness of extracted components, and (c) consistency in component structure across experiments. The extraction of six components also is consistent with past research showing that most variance in ERP data is accounted for by six to eight components (Donchin & Heffley, 1978). Of the six extracted components, two showed variation with variables of theoretical interest and are reported here.[3]

Results

SELF-REPORT RESPONSES

The mean MRS score was 2.03 (SD = 0.48), with a range of 1.33-3.00. The mean contact index was 27.55 (SD = 20.52), with a range of 6-79 (possible range = 0-140).

To analyze the dichotomous like/dislike judgments participants made about each picture, we computed the proportion of trials on which the “like” option was chosen. The proportion of liking responses to the positive, White, and Black pictures (M = 0.66) exceeded those to the negative pictures (M = 0.18), $F(1, 16) = 61.43$, $p < .001$.[4] Judgments about the Whites (M = .49) and Blacks (M = .60) did not differ significantly, $F < 1$. Liking was not moderated by either MRS or contact scores.

VPP

The latency and scalp distribution of one of the PCA-extracted components corresponded to the VPP, with a Cz-maximum distribution and a mean peak latency of 160 ms. For this component as well as all others, responses to positive, White, and Black target pictures were compared to responses to negative context pictures from the relevant block. Including the responses to context pictures as a comparison controls for variability among participants in general ERP responsivity. Responses to Whites and Blacks were compared to assess ingroup bias, which follows prior research in conceptualizing responses to racial groups in a relative sense as the degree to which outgroup members are reacted to differently than ingroup members. Results are presented as the degree to which responses to a given target (e.g., Blacks) differ from responses to another type of target (e.g., Whites) when each is compared to responses to relevant context pictures (e.g., negative pictures from the Black block and negative pictures from the White block, respectively). Data were analyzed in a 2 (picture type: negative context, rare target) × 3 (block: positive, White, Black) × 3 (scalp site: Fz, Cz, Pz) repeated-measures analysis of covariance (ANCOVA) for each component. MRS and level of contact were the covariates, and treatment by covariate interactions were assessed to determine if these individual differences affected processing of the faces (Judd, Kenny, & McClelland, 2001).[5]

Difference waveforms created by subtracting responses to the three rare target stimuli from responses to the corresponding negative context are shown in panel A of Figure 1. In the VPP, responses were larger to the infrequent positive, White, and Black pictures (M = .18) as opposed to the frequently presented negative pictures (M = –.23), $F(1, 21) = 15.74$, $p < .001$.[6] This was moderated by site and whether the infrequent pictures were of faces. The responses to faces of Whites and Blacks, as compared to the frequently presented negative pictures, were significantly larger than those to equally infrequent positive pictures at both Fz and Cz, Fs(1, 21) = 6.98 and 4.78, ps < .05. Thus, as in past research, this component was differentiating faces from nonfaces.

In contrast with an expertise interpretation of the VPP, this component was not larger for White than Black faces (and if anything, responses were larger to Blacks). Moreover, the size of the VPP was uncorrelated with participants’ self-reported level of prejudice and prior contact with Blacks.

Responses at Cz (M = .12) did not differ from those at Fz (M = .09) but tended to be larger than those at Pz (M = –.11), $F(1, 21) = 3.02$, $p = .099$.

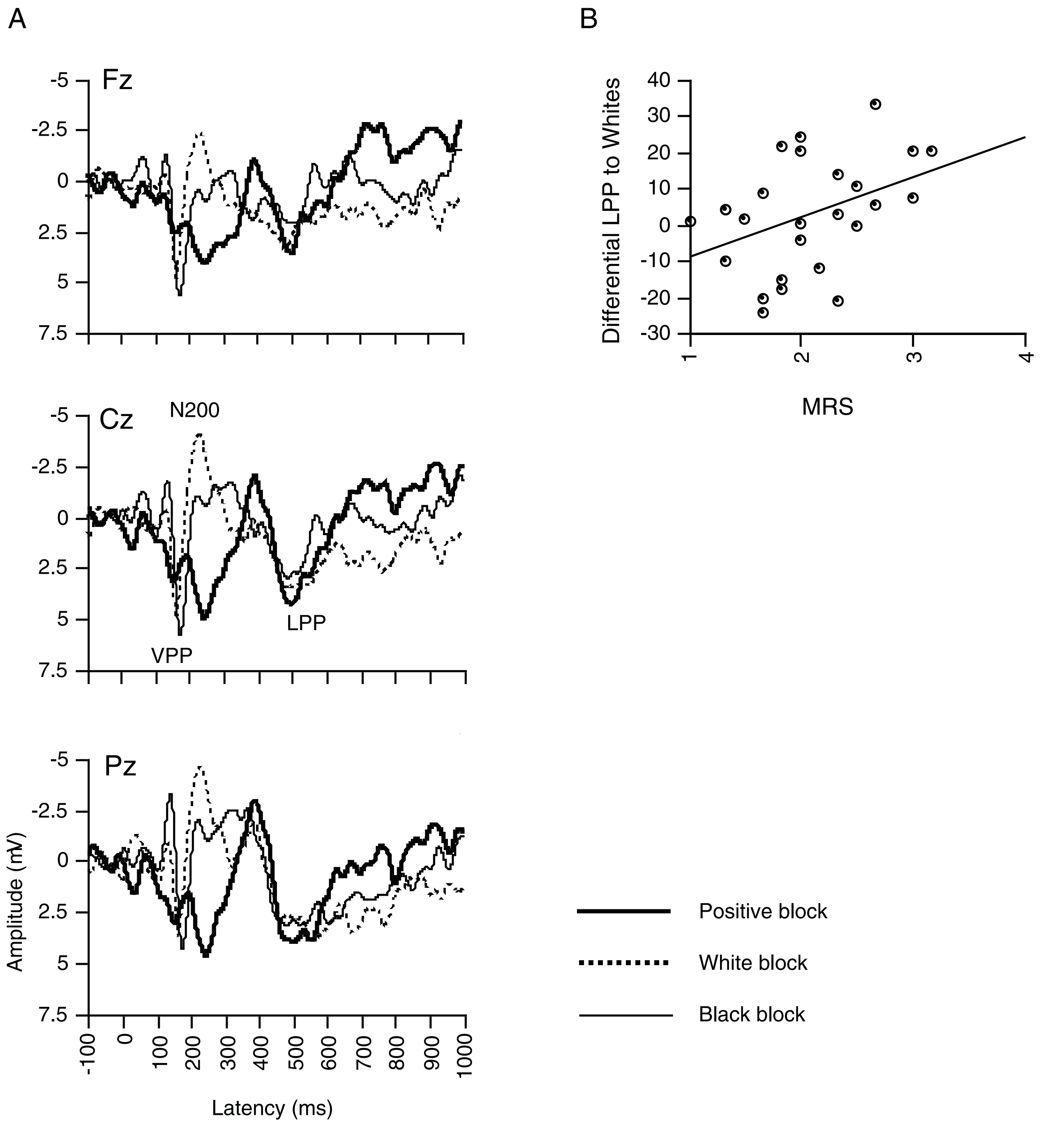

Figure 1A Difference waveforms of ERPs elicited by positive, White, and Black pictures (with each compared to their relevant negative context pictures).
NOTE: ERP = event-related brain potential, VPP = vertex positive potential, LPP = late-positive potential.

Figure 1B Relation between MRS and the degree to which LPP responses were larger to Whites than Blacks.
NOTE: LPP = late-positive potential, MRS = Modern Racism Scale.

N200

The PCA also revealed a negative-going component that peaked at 244 ms that was more negative at Cz (M = –.13) and Fz (M = –12) than at Pz (M = .32), Fs(1, 21) = 28.28 and 10.87, ps < .005, respectively (panel A, Figure 1). As with the VPP, the difference in responses between the negative context pictures and the rare target pictures was larger in the blocks with people in them, F(1, 21) = 46.61, p < .001. The difference between frequent negative and rare positive pictures was .82 but the difference between negative pictures and the rare people pictures was –.78 (because this is a negative-going component, more negative scores indicate a larger effect).

We next compared the size of the infrequent-context difference in the White versus Black block, which revealed a significant difference. Although race did not moderate the VPP, the predicted race effects showing deeper processing for the ingroup were apparent slightly later in the N200. The degree to which responses to Whites exceeded negative context pictures was larger ($M = –.78$) than the degree to which responses to Blacks exceeded negative context pictures ($M = –.19$), $F(1, 21) = 5.84$, $p < .05$. The difference in responses to Whites compared to Blacks did not vary as a function of MRS or contact.

LPP

To examine the hypothesis that ingroup and outgroup faces would elicit different evaluative reactions, peak LPP amplitudes were examined. Consistent with past research on evaluative responses, LPPs to evaluatively inconsistent positive pictures ($M = 7.02$ μV) were larger than those to negative context pictures ($M = 4.93$ μV), $F(1, 21) = 8.84$, $p < .005$. Of greater theoretical interest were LPPs in the blocks in which Whites and Blacks were shown. The deflections visible in the difference waveforms (Figure 1, panel A) at approximately 500 ms show that White and Black targets elicited larger LPPs ($M = 6.76$ μV) than their corresponding negative context ($M = 4.75$ μV), $F(1, 21) = 12.10$, $p < .005$. This effect is consistent with past research in which pictures of people embedded within context pictures not depicting people elicited larger LPPs than context pictures (Ito & Cacioppo, 2000). More important, though, we can compare responses to Whites and Blacks, which holds constant any increase in LPP amplitude due to differences in the targets and context as a function of presence of people. Bias would be indicated if Whites are seen as more evaluatively discrepant than Blacks. There was no mean difference in LPPs to Whites and Blacks. However, responses to Whites and Blacks were moderated by MRS scores: Picture Type × Block × MRS interaction, $F(1, 21) = 5.33$, $p < .05$. The nature of this interaction is shown in panel B of Figure 1. The abscissa represents ingroup bias, computed as the degree to which Whites differ from the negative context compared to the degree to which Blacks differ from the negative context (i.e., $[LPP_{White} - LPP_{negative\ in\ White\ block}] - [LPP_{Black} - LPP_{negative\ in\ Black\ block}]$). Larger scores indicate greater preferences for the ingroup. As can be seen, ingroup bias as measured with the LPP increased as MRS scores increased. The simple correlation between MRS and the index of bias in the LPP was $r = .47$, $p < .05$. None of these effects were moderated by level of contact.

Responses at Pz ($M = 8.90$ μV) were significantly larger than responses at Cz ($M = 5.41$ μV) or Fz ($M = 3.63$ μV), Fs$(1, 21) = 49.94$ and 28.24, respectively, ps $< .001$.

Discussion

Results from this experiment reveal an interesting timecourse of social perception. The VPP results are consistent with past research showing that faces are differentiated from nonfaces by about 170 ms (160 ms in this experiment). Of interest, this initial stage of encoding did not differentiate between ingroup and outgroup faces, which is contrary to predictions of a domain-general view of the VPP/N170 and the likelihood that our participants had greater experience and practice perceiving Whites than Blacks. Moreover, the larger responses to faces than nonfaces occurred regardless of the level of prejudice or prior contact our White participants had with Blacks. Despite the absence of face race effects in the VPP, race did modulate the N200, with larger responses to Whites than Blacks. Of interest, although this effect is consistent with deeper processing of the group with which participants were more familiar, the effect was not moderated by level of prejudice or amount of prior contact with Blacks.

Social group membership also affected LPP responses. In past research, the size of the LPP has increased as a function of the evaluative distance between a target and the surrounding context. To capitalize on this, a negative evaluative context was created in this experiment and the size of LPPs to Whites and Blacks relative to the negative evaluative context was used to assess bias. A more negative attitude toward Blacks would manifest as a smaller evaluative distance between Blacks and the negative context than between Whites and the negative context. Although there was no such mean level of bias, there was a correlation between bias as measured in the LPP and MRS scores. Higher scores on the MRS were associated with greater evaluative differentiation in the LPP

Experiment 1 used a blocked design to maximize the difference in responses to ingroup and outgroup members. Although beneficial from this perspective, blocked presentation may have an unintended effect of facilitating different processing strategies across the blocks. For instance, the absence of ingroup/outgroup effects in the VPP could be due to the implementation of different processing strategies across blocks that manifested in similar scalp-recorded potentials. To address this, a second experiment was conducted in which stimuli were intermixed in a single block. A second experiment also was warranted to examine the degree to which results from Experiment 1 were dependent on the use of the negative evaluative context.

EXPERIMENT 2

Participants in Experiment 2 were shown positive pictures most frequently. Responses to the positive context pictures were compared to responses to equally improbable ingroup and outgroup pictures, whose presentation was intermixed within a single block. Because they were not of theoretical interest, rare, valenced, nonpeople target pictures (in this case, negative pictures) were omitted from this experiment. Participants also completed the MRS and a measure of prior contact with Blacks.

Methods

PARTICIPANTS

Sixteen students (10 men) from the University of Colorado participated for partial class credit. All identified their ethnicity as White.

MATERIALS AND PROCEDURE

Thirty-nine positively valenced pictures from the IAPS and six new pictures each of White men and Black men were selected with the same constraints as Experiment 1.

Participants viewed 90 five-picture sequences presented in a single block. Positive pictures were shown most frequently; 30 sequences contained only positive pictures and 30 each contained a single White or Black target. To ensure that the absence of contact effects in Experiment 1 was not due to the particular contact measure used, we employed a five-item measure that separately assessed (a) number of Blacks in the neighborhood where participants grew up, (b) number of Black friends growing up, (c) number of Black students in their high school, (d) number of current Black friends, and (e) how often Blacks are encountered in current typical daily interactions. All were rated on 7-point scales. The first three items were combined into a single index of past contact ($\alpha = .53$), whereas the last two items were used separately to assess different aspects of current contact. All other aspects of data collection were identical to Experiment 1. PCA analyses extracted six components that accounted for 89% of the variance.

Results

SELF-REPORT RESPONSES

The mean MRS score was 2.61 ($SD = 1.02$). Mean contact ratings on the dimensions of past contact, current friends, and daily contact were 2.25, 2.63, and 2.19, respectively (*SD*s of 0.85, 1.41, and 1.11, respectively).

Positive pictures received a significantly higher proportion of liking responses ($M = .82$) than White and Black pictures ($M = .40$), $F(1, 9) = 55.14$, $p < .001$.[7] Directionally, Blacks received a higher proportion of liking ($M = .45$) responses than Whites ($M = .35$), but the difference was not reliable, $F(1, 9) = 2.86$, $p = .125$. Liking responses were not moderated by self-reported prejudice or any of the contact measures.

VPP

Because positive, White, and Black stimuli were presented within a single block, we analyzed the data with separate 3 (picture type: frequent positive, rare White, rare Black) × 3 (scalp site: Fz, Cz, Pz) repeated-measures ANCOVAs for each component. MRS and the three separate aspects of contact served as covariates. Ensemble average waveforms to all three pictures types are shown in panel A of Figure 2.

Our first analyses were on the VPP component, which the PCA identified with a mean latency of 180 ms. As in Experiment 1, the VPP revealed only differentiation between faces and nonfaces. VPP responses were significantly larger to pictures of both Whites and Blacks ($M = .25$) than to positive, nonpeople pictures ($M = -.22$), $F(1, 10) = 13.08$, $p = .005$. Responses were actually directionally larger to Black than White faces, although this difference was not reliable, $F < 1$. As in Experiment 1, neither MRS nor prior contact with Blacks moderated these effects.

VPP responses were significantly larger at Fz and Cz ($M = .27$) than at Pz ($M = -.25$), $F(1, 10) = 48.67$. Responses at Fz and Cz did not differ, $F < 1$.

N200

The PCA also revealed a negative-going component that peaked at 287 ms. This component was significantly larger to pictures of people ($M = -0.70$) than to nonpeople pictures ($M = .39$), $F(1, 10) = 16.33$, $p < .005$. A comparison of the responses to Whites and Blacks replicates Experiment 1, showing larger responses to Whites ($M = -.21$) than Blacks ($M = .07$), $F(1, 10) = 4.62$, $p = .057$. As in Experiment 1, this effect was not moderated by MRS or contact.

This component was significantly larger (more negative) at Cz ($M = -.28$) than at Fz ($M = -.07$) or Pz ($M = .60$), *F*s $(1, 10) = 7.20$ and 53.77, respectively, *p*s $< .05$.

LPP

As in Experiment 1, LPPs were larger to the pictures of Whites and Blacks ($M = 8.65$ μV) than to the frequently presented positive pictures ($M = 5.38$ μV), $F(1, 10) = 10.46$, $p < .01$. The size of the LPP elicited by Whites and Blacks did not differ at the mean level ($F < 1$), but responses to Whites and Blacks were moderated by MRS scores, $F(1, 10) = 6.05$, $p < .05$. The interaction with MRS, which is shown in Panel B of Figure 2, replicates Experiment 1 in showing greater evaluative differentiation in

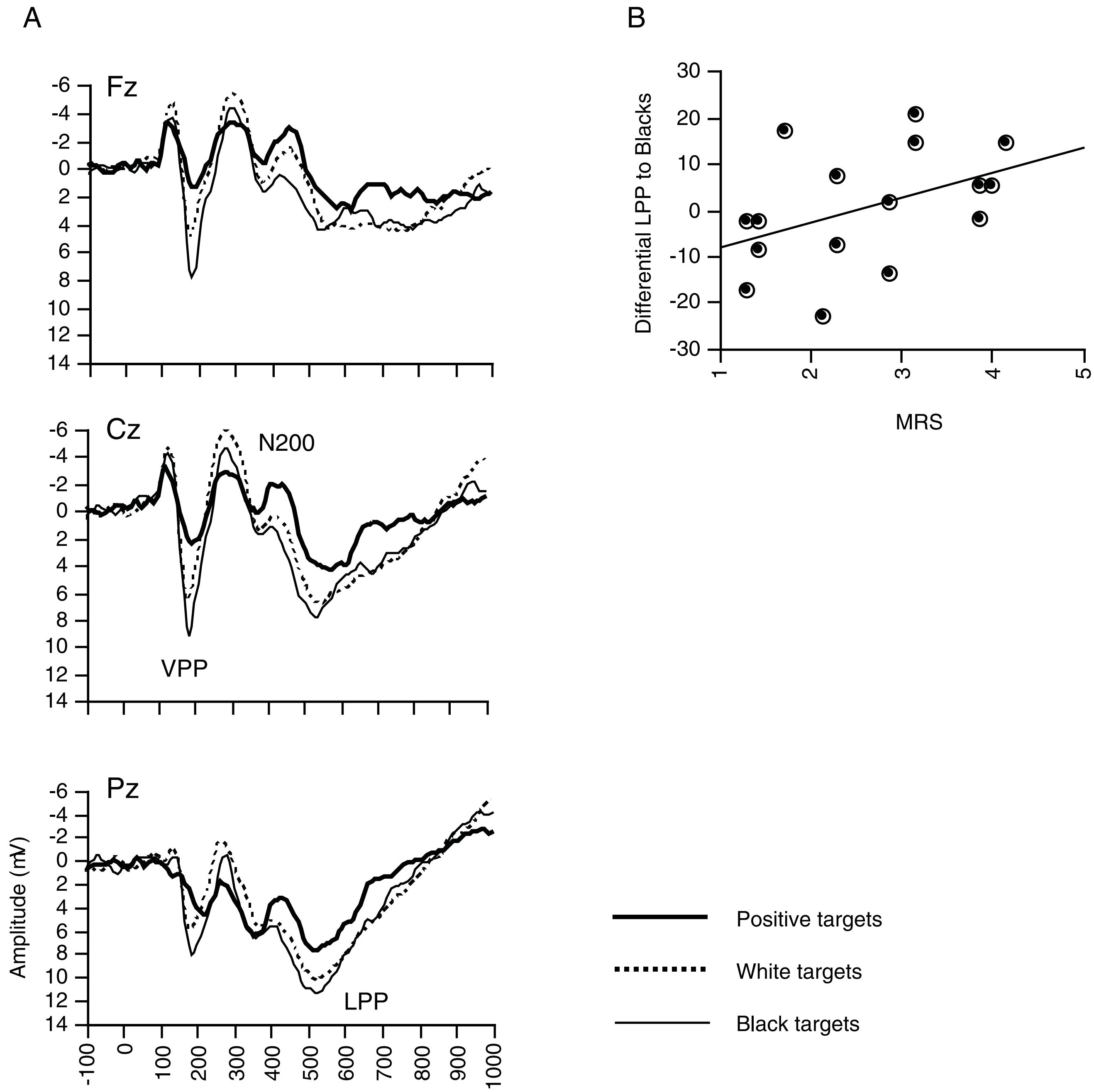

Figure 2A Waveforms to positive, White, and Black pictures.
NOTE: LPP = late-positive potential, VPP = vertex positive potential.

Figure 2B Relation between MRS and the degree to which LPP responses were larger to Blacks than Whites.
NOTE: LPP = late-positive potential, MRS = Modern Racism Scale.

favor of the ingroup as MRS scores increase. An index of ingroup bias computed as the degree to which LPP amplitude to Blacks exceeds that to Whites is plotted on the abscissa. The simple correlation between MRS and the index of bias in the LPP was $r = .44$, $p = .08$. The degree to which LPPs differed to Black and White targets was not moderated by any of the measures of contact.

The LPP was larger at Pz (M = 11.05 μV) than at Cz (M = 7.21 μV) and at Fz (M = 4.42 μV), Fs(1, 10) = 35.50 and 48.98, participants < .001.

GENERAL DISCUSSION

Using a somewhat different approach to the study of social perception, we have gained the following information about the broader process of impression formation. When faces are perceived in a heterogeneous context that reflects many everyday perception experiences, at least four discrete information-processing operations can occur. First, faces are differentiated from nonfaces by about 170 ms, as shown in a component previously associated with the structural encoding of faces (Bentin et al., 1996). Neither face race, self-reported prejudice, nor level of interracial contact had an effect at this point, suggesting that, at least when the encoding of faces occurs in a heterogeneous context that includes nonfaces, initial encoding is insensitive to factors associated with category membership. Models of impression formation argue that category membership is quickly and effortlessly encoded (Brewer, 1988; Fiske & Neuberg, 1990). Our results do not contradict this assumption, but they do point out that when perceiving faces intermixed with nonfaces, other, more superordinate features are encoded first.

Whereas the race with which participants were more expert and practiced did not affect initial structural encoding of the face, White faces did elicit larger N200 responses than Black faces. The direction of this effect suggests greater attention toward White targets, consistent with behavioral indications of deeper, more differentiated processing of ingroup members (Levin, 2000). The mean latencies of the N200 suggest that this greater attention to ingroup members occurred by approximately 250 ms after stimulus onset.

Next, the LPP effects suggest that the application of category-based affective reactions occurred by approximately 500 ms. After stimulus offset, when participants were required to explicitly report their evaluations, they displayed an absence of ingroup bias. This indicates that not long after the arousal of evaluative bias (as seen in the LPP), other processes that shape explicit evaluative responses can have an influence.

The difference in evaluative responses as shown in the LPP and explicit liking responses may at first seem unusual given that both were measured in response to the same exemplar, but they are sensible from the perspective of social judgability. This work shows that when relatively little information beside category information is known, perceivers may not feel entitled to use category-based expectancies to judge a target (Yzerbyt, Schadron, Leyens, & Rocher, 1994; cf. Darley & Gross, 1983). We believe that this occurred with the explicit liking judgments, a relatively public declaration of liking for strangers about whom very little other than race was known. At the same time, another self-report measure, the MRS, was related to the LPP responses. Although category-based expectations may not be judged as appropriate sources of influence on the self-reported judgment of an individual's likability, they are the very reactions that are assessed by the MRS. Moreover, stereotypes and prejudice may be more freely expressed on a measure about an entire group because they can be justified as being true for at least some members. The group-level response also makes the expression of any bias less personally directed toward an individual (cf. Sears, 1983). The reactions indexed by the LPP appear to have been more sensitive to these category-based reactions as opposed to the factors influencing the liking reports.

Because liking judgments were measured on a less variable scale than the MRS or the LPP, the lack of concordance between liking and the other two measures could reflect a restriction of range in the liking judgments. Simple liking scales were chosen so participants would be able to easily and quickly form and register an opinion in the context of the large number of judgments being made and the importance of not having deliberation or execution of the response carry over into the ERPs associated with the next picture. A measure with more response options may have revealed larger differences in responding to ingroup and outgroup targets. However, it is worth noting that the liking responses, even given the restricted response options, were always in the (nonsignificant) direction of greater liking for Blacks. Thus, a more variable scale might have revealed more variability in responding, but indications were that participants would not have used this variability to express preference for their ingroup, in which case a dissociation between the liking and LPP responses still would have existed.

The absence of outgroup contact effects may indicate that prior contact does not affect the cognitive and affective processes assessed here. It is the case, though, that the type of contact assessed focused on interactions with friends and acquaintances. More global factors, such as the much greater representation of Whites in the media, provide another important source of familiarity differences, and this may influence the types of processes assessed here.

Relation Between Cognitive and Evaluative Aspects of Face Processing

Although we think the different effects we obtained are interesting in isolation, knowing the way in which these processes influence each other is also of interest. To examine this, we performed ancillary regression analyses in both experiments in which we assessed the temporal dependencies between a response and all temporally preceding effects. This was done with separate regression analyses in which self-reported liking, LPP, and N200 race effects were predicted by temporally preceding race or face effects as well as all factors in the original analyses (e.g., MRS, level of contact). For instance, in the case of the LPP, this analysis would add the degree to which N200s were larger to Whites than Blacks and the degree to which VPPs were larger to faces than nonfaces as predictors. Although race did not significantly moderate liking judgments, the criterion on the liking analysis was the degree to which greater liking was reported toward Blacks, which reflects the direction of the liking effects.

In both experiments, the self-reported liking and LPP effects were unchanged by the addition of the temporally preceding effects, and none of the temporally preceding effects were significant predictors. For liking, these results indicate that what participants were willing to report as their explicit liking judgment was not affected by the earlier evaluative response indexed by the LPP, a conclusion consistent with the different pattern of responses in the two measures discussed earlier. Moreover, the liking judgments were not influenced by any other form of processing we assessed, such as structural face encoding or differences in depth of processing.

For the LPP, these ancillary analyses address the degree to which evaluative responses are influenced by preceding cognitive operations. There is evidence addressing effects in the other direction—that prejudice influences more cognitive operations. For instance, the speed with which social categorization decisions are made has been shown to vary as a function of prejudice and ingroup identification (Blascovich, Wyer, Swart, & Kibler, 1997; Castano, Yzerbyt, & Bourguignon, 2001). Theoretical accounts focus on the effect that these chronic motivational states have on more cognitive operations such as categorization. The absence of N200 and VPP effects in the ancillary LPP analyses indicate, however, that the degree to which participants displayed bias against individual racial outgroup members was not dependent on basic structural encoding of individual faces or the degree to which deeper processing occurred for the ingroup. This may indicate that our participants' evaluative responses were determined more by general factors such as evaluative associations with the entire category rather than biased perceptual encoding of individual group members.

The only place in which a temporally preceding effect had an effect was in the N200. In Experiment 1, N200s to Whites and Blacks were no longer significantly different when the degree to which faces elicited larger VPPs was entered as a predictor. However, in Experiment 2, the N200 effect remained even when the VPP effect was included. In Experiment 1, this indicates that an earlier sensitivity to faces (but not face race) accounts for a subsequent differentiation as a function of race in the N200. We think this is due to the blocked presentation used in Experiment 1 but not Experiment 2. The face/nonface distinction covaried with race in Experiment 1. Blacks and Whites were presented in the same block in Experiment 2, and in that context, noticing faceness in the VPP did not account for differentiation as a function of race in the N200. Because the N200 effect is still significant in Experiment 2, we do not think the elimination of the N200 effect in Experiment 1 indicates that the face/nonface operation is necessary to the N200 effect. Instead, we think it indicates that when a superordinate and subordinate level of classification overlap, processing at the superordinate level (what is indexed in the VPP) aids processing at the subordinate level (what is indexed by the N200).

Relation to Other Implicit Prejudice Measures

Our measures are in many ways quite different from other implicit prejudice measures. The latter tend to disguise their measurement interest (e.g., by presenting stimuli subliminally or saying the task is about word judgment; Dovidio et al., 1997; Fazio et al., 1995; Wittenbrink et al., 1997), whereas our participants had plenty of time to view the pictures and knew we were interested in their evaluations. However, to the degree that implicit measures try to indirectly assess perceivers' responses in a way that minimizes social desirability concerns (Fazio & Olson, 2003), we think our ERP responses are more implicit. Participants' presumed lack of awareness of our interest in and the meaning of the different ERP components, the LPP's prior sensitivity to unintended evaluative reactions (Ito & Cacioppo, 2000), and the LPP's dissociation with explicit liking judgments in these studies argue that the ERP components were reflecting more spontaneous reactions.

If we are assessing more implicit responses, how can the consistent correlation between the LPP and MRS be reconciled with the many prior demonstrations of dissociations between implicit and explicit prejudice measures (Blair, 2001; Dovidio, Kawakami, & Gaertner, 2002; Fazio et al., 1995; Greenwald et al., 1998)? First, Cunningham et al. (2001) showed that when scale reliability is taken into account, implicit and explicit prejudice measures do appear to reflect a common latent construct. Nevertheless, task factors are still likely to influence the degree of observed concordance. Wittenbrink et al. (2001) showed that implicit measures encouraging a more conceptual task (whether a letter string is or is not a word) correlate more strongly with the MRS than do implicit measures that encourage an evaluative task. This was explained as reflecting the three-component view of attitudes. Both the conceptual judgment task and the MRS were argued to more strongly reflect cognitive aspects of attitudes toward Blacks than the evaluative judgment task.

Of interest, our participants were explicitly performing an evaluative task, and reactions to the targets nevertheless varied as a function of MRS scores. We think the difference between our results and those of Wittenbrink et al. (2001) lies in the scope of the processing induced by the social category targets. In Wittenbrink et al., category responses were primed with names stereotypical of Whites and Blacks that were shown for 15 ms, followed by a masking stimulus. Given that the breadth of information that could be activated by the prime is probably attenuated by its presentation outside of awareness, it is not surprising that the nature of the task participants were required to perform with respect to the subsequent imperative stimulus was an important determinant of the type of associations activated by the prime. By contrast, our task asked participants to engage in impression formation more globally with presentation parameters that allowed for longer processing of the target. Even though participants were explicitly making evaluative judgments, different types of processing also were occurring (e.g., as evidenced by the VPP and N200 results). In this context, it appears that participants activated not only information that allowed them to make the evaluative judgment but also more belief-based information that was correlated with MRS scores. Overall, this suggests that previously identified measurement dimensions used to explain relations among implicit prejudice measures, and between implicit and explicit measures, should be expanded to include a consideration of the breadth of processing of the category-related information that is allowed. A less constrained processing task, as in our experiments, appears to increase the relation to other measures of category-based reactions, even when these measures assess different components of the attitude.

The target of measurement also has been identified as influencing correlations obtained between different types of prejudice measures. Olson and Fazio (in press) recently showed that processing at the level of exemplar versus the category affects intercorrelations among implicit prejudice measures. At the same time, there should be overlapping associations activated by both types of processing. The consistent correlation between LPP and MRS responses here demonstrate this overlap. We think this is also due to the relatively broad processing task performed by our participants, which allowed them to access the category-based reaction even when processing at the level of category exemplar.

Concern about whether different implicit measures of prejudice are intercorrelated has at times implied that there should be a single implicit attitude. Wittenbrink et al. (2001) argued that work on the multicomponent nature of explicit attitudes makes it unsurprising that implicit attitudes also might be multifaceted. Our results address this issue from a slightly different perspective. To the degree that responses to category exemplars are composed of multiple discrete information processing operations, all of which occur in a relatively spontaneous manner, it is inappropriate to think of a single implicit response.

Other Issues

Although race did not modulate responses until the N200, this does not mean that race cannot be encoded before that point. In fact, Ito and Urland (2003) have found target race effects in a component peaking at around 120 ms in studies in which only faces were shown. Other research has shown that likability modulates perception of faces as early as 80-116 ms (Pizzagalli, Regard, & Lehmann, 1999). This suggests that when differentiation of faces from nonfaces is unnecessary because only faces are being seen, early encoding mechanisms can instead be tuned to other dimensions that differentiate the faces.

In the present studies, we chose to present a heterogeneous set of stimuli because doing so allowed for the trial structure optimal for recording the LPP. However, we can ask whether doing so had adverse effects on our ability to detect effects in other components. One possibility is that presentation of a large number of nonface stimuli increased the salience of the face/nonface distinction at the cost of the White face/Black face distinction. Perhaps there is a VPP social expertise effect, but it was obscured by this other difference. We think this unlikely because of the results of Ito and Urland (2003). They presented only faces, with equal numbers of White and Black male and female faces. Thus, race was as salient a distinction as the only other dimension that obviously differentiated the faces (gender). In this context, race modulated a component peaking at around 120 ms. Of importance, though, this early race effect was in the direction of greater attention to Blacks. Greater attention to Whites, possibly reflecting deeper processing of the group with whom participants had greater experience, was not found until the N200, as in the present studies. Overall, then, it may be possible to speed attention to differences in racial or other evaluative cues, but greater attention to Whites did not occur until approximately 250 ms in any of these studies.

Summary

Across all measures, our results suggest that participants vary in the level of explicit prejudice they will report and the amount of contact they have had with outgroup members. Regardless of these differences, structural encoding of faces occurs equally for faces of both races, as shown in the VPP. Face race does moderate N200 responses. Information about target race appears to then feed forward to subsequent evaluative judgments, an effect that is moderated by the extremity of self-reported racial prejudice toward Blacks as a group. Shortly thereafter (about 500 ms later), when participants are asked to report their liking for each individual, no ingroup bias was displayed. These studies highlight the complex nature of social perception. They also provide important timecourse information about these effects that, when coupled with findings using complementary methods (e.g., studies assessing more complex behavioral outcomes), should facilitate a fuller understanding of social cognition.

NOTES

1. The vertex positive potential (VPP) and N170 manifest with a similar latency, respond similarly to experimental manipulations, and may represent positive- and negative-going manifestations of the same electrical dipole. The VPP is maximal at the vertex, whereas the N170 is maximal at temporal areas. In the studies reported here, we analyze midline sites and therefore quantify a positive-going VPP.

2. We recognize that participants were shown a limited number of Black and White exemplars. This was done to equate the number of times individual pictures were shown to each participant. Adding more Black and White pictures would have required adding more pictures in each category to keep the number of presentations equal. At the time, it was not possible to substantially increase the number of negative pictures that otherwise met all our constraints. We do not think our effects are unique to the particular stimuli we chose because we purposely varied the stimuli in Experiment 2 and used a greater number of individual exemplars.

3. None of the remaining components extracted from the principal components analysis (PCA) showed variation as a function of any of the experimental variables of interest. Instead, they showed effects as a function of scalp distribution, a simple target-context difference that did not interact with block or corresponded to the late-positive potential (LPP). We report in the text LPP analyses based on 9 Hz low-pass filtered data rather than the 30 Hz low-pass filtered PCA data because the former filtering is more appropriate for the slower-frequency LPP and is consistent with past research (Cacioppo, Crites, Berntson, & Coles, 1993; Cacioppo, Crites, Gardner, & Berntson, 1994; Crites, Cacioppo, Gardner, & Berntson, 1995; Ito & Cacioppo, 2000; Ito, Larsen, Smith, & Cacioppo, 1998). A graph of the component loadings is available from the first author.

4. Liking responses were unavailable from 5 participants due to computer problems. Analysis of liking responses is therefore based on 21 participants.

5. There were no simple (i.e., noninteractive) effects of the covariates in any of the analyses in either experiment.

6. All values for the VPP and N200 are reported in component score units.

7. Liking responses from 2 participants were unavailable because of computer problems. Analysis of the liking responses is therefore based on data from 14 participants.

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