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Event-related potentials and the decision to shoot: The role of threat perception and cognitive control ☆

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Abstract

Participants played a videogame in which they were required to make speeded shoot/don't-shoot decisions in response to armed and unarmed targets, half of whom were Black, half of whom were White. Event-related brain potentials (ERPs), recorded during the game, assessed attentional processes related to target race and object type. Early ERP components (i.e., the P200 and N200) differentiated between Black and White targets, as well as between armed and unarmed targets. Explicitly measured cultural stereotypes predicted both this racial ERP differentiation and racial bias in the game. Most importantly, the degree of racial differentiation in the early ERP components predicted behavioral bias in the videogame and mediated the relationship between cultural stereotypes and bias.
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The recent deaths of unarmed Black men, shot by police, have raised speculation that officers use race when making the decision to shoot. Indeed, several recent studies have shown that participants identify handguns as weapons more quickly and more accurately after seeing a Black face, but classify objects like tools as non-weapons more quickly and accurately after seeing a White face (Amodio et al., 2004; Judd, Blair, & Chapleau, 2004; Payne, 2001; Payne, Lambert, & Jacoby, 2002). Additional work showed a similar bias in the decision to "shoot" (Correll, Park, Judd, & Wittenbrink,

2002; see also Greenwald, Oakes, & Hoffman, 2003). In a videogame simulation, participants were instructed to "shoot" anyone holding a gun (by pressing one button), but not to shoot targets carrying anything else (a decision indicated by pressing a second button). It is important to note that race was technically irrelevant to this task. The correct response depended solely on the object being held. Nonetheless, participants shot armed targets more quickly and more frequently when those targets were Black, rather than White, but decided not to shoot unarmed targets more quickly and more frequently when they were White, rather than Black. Correll et al. termed this pattern *shooter bias.*

Correll et al. (2002) suggested that bias reflects the operation of racial stereotypes, which link Blacks to danger. They proposed that, in the shoot/don't-shoot game, a Black target (whether armed or unarmed) should activate the idea of danger and create a predisposition to shoot (see Fig. 1). When the target is, in fact, armed, this stereotypic predisposition is congruent with the correct response (i.e., to shoot) and should facilitate

Categorization of target race	Stereotypic association	Automatic response tendency	Discrimination of object	Consequence for correct response
White	Low threat ($\downarrow$ P200)	Inhibit "Shoot" response ($\uparrow$ N200)	if Non-gun	Facilitation
			if Gun	Inhibition
Black	High threat ($\uparrow$ P200)	"Shoot" response ($\downarrow$ N200)	if Non-gun	Inhibition
			if Gun	Faciliation

Fig. 1. Racial stereotypes influence threat perception and response tendencies, facilitating responses to stereotype-congruent targets (unarmed Whites and armed Blacks) but inhibiting responses to stereotype-incongruent targets (armed Whites and unarmed Blacks).

it. When the target is unarmed, however, the predisposition is incongruent with the correct response (i.e., to not shoot) and should interfere with it. In support of this idea, the researchers found that participants with greater knowledge of cultural stereotypes showed more pronounced shooter bias.

This prediction is consistent with recent models of automatic processing, such as the *Quadruple Process Model* (Conrey, Sherman, Gawronski, Hugenberg, & Groom, in press). This model suggests that, initially, a stimulus (e.g., a Black male) may activate a given association (threat). The likelihood of this activation is thought to reflect the strength of the association, in this case, the stereotype. Once activated, this association prompts consistent behavior (a shoot response). But, an individual can moderate this biased response if he or she has access to discriminable diagnostic cues (the presence/absence of a weapon), as well as the necessary cognitive capacity and motivation. That is, when diagnostic cues are available, the individual may override the bias and implement a more deliberate response. Given enough time, an individual who accurately perceives a Black target to be unarmed may successfully inhibit the stereotype-driven shoot response. (Of course, if the target is armed, such inhibition is unnecessary: the biased response tendency and the deliberative response will both prompt a decision to shoot.)

The goal of the current study was to examine the manner in which these stereotypes influence behavior online by examining event-related brain potentials (ERPs). ERPs are fluctuations in the electrical activity of the brain that occur in response to specific stimuli. Methodologically, they are valuable because they provide high temporal resolution, allowing researchers to distinguish between processing operations that occur quickly and in rapid succession after stimulus onset. Our particular interest was to examine ERPs related to two processes specified by the preceding analysis as critical to the shoot/don't-shoot decision, namely, threat detection and cognitive control.

Processing that occurs relatively early (e.g., within 300 ms of stimulus onset) has been associated with covert orienting to stimuli with evolutionary significance (Halgren & Marinkovic, 1995; LeDoux, 1998; Ohman, Lundqvist, & Esteves, 2001). For example, threatening images, like fierce dogs or angry human faces, enhance responses to an ERP component called the P200[1] (Carretie, Martin-Loeches, Hinojosa, & Mercado, 2001; Carretie, Mercado, Tapia, & Hinojosa, 2001; Eimer, Holmes, & McGlone, 2003). Interestingly, the P200 is also sensitive to race. Ito and Urland (2003) showed that Black faces evoke larger P200s than Whites, consistent with the idea that Blacks were perceived as threatening by their White participants. This P200 race difference occurs even when tasks direct attention away from race (e.g., requiring attention to non-social features; Ito & Urland, 2005). Detection of threat, including race-cued threat, is particularly relevant to the present study, which involves the identification of potentially hostile Black and White targets. If the P200 indexes threat perception, we predict that larger deflections should facilitate decisions to shoot but inhibit decisions not to shoot.

A slightly later component, the N200, has been linked to cognitive control processes (Kopp, Rist, & Mattler, 1996; Ritter, Simson, Vaughan, & Friedman, 1979). The N200 may reflect activity in the anterior cingulate cortex (ACC), which plays a critical role in the detection of conflict (Nieuwenhuis, Yeung, Van Den Wildenberg, & Ridderinkhof, 2003; Van Veen & Carter, 2002), including the inhibition of a prepotent response (Swainson et al., 2003). Response inhibition is also critical to performance in the current study. The design, instructions and reward structure of the videogame make shooting the dominant response, and participants are typically faster and more accurate in decisions to shoot than in decisions not to shoot. Initiation of executive control may therefore be required to inhibit this general tendency. As a precursor to response inhibition, larger N200s should therefore facilitate decisions *not* to shoot.

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[1] Components are commonly referred to by the direction of their voltage deflection (positive/negative) and their time course. For example, the P200 is a positive-going component that typically reaches a peak 200 ms after stimulus onset.

Because threat perception (P200) and conflict detection (N200) should influence shoot/don't-shoot decisions, we hypothesized that differential engagement in these processes, as a function of race, should promote shooter bias. As can be seen in Fig. 1, if Black targets are seen as threatening, and if they create a predisposition to shoot (Correll et al., 2002), we hypothesize that Black targets should evoke larger P200s (reflecting increased perception of threat, H_{1A}); and smaller N200s (reflecting congruence with the "shoot" response, H_{1B}), relative to Whites. Of course, participants may vary in the degree to which they (and their ERPs) differentiate targets by race. A participant who perceives Black targets as much more dangerous than Whites should show greater ERP differentiation than one who perceives Blacks and Whites as equally threatening. If the mental operations reflected by these components guide behavior, each participant's idiosyncratic sensitivity to race should predict performance in the game. To the extent that an individual differentiates targets, such that Blacks seem more threatening (P200) and evoke less conflict with the shoot response (N200), a stronger pattern of shooter bias should emerge (H_2).

Methods

Participants

Forty right-handed students (24 males) from the University of Colorado participated for class credit. Thirty-one identified their race as White (19 males), 5 as Asian (1 male), 2 as Hispanic (2 males), and one each as Black[2] (male) and Arabic (male).

Procedure

A videogame presented Black and White men, half carrying pistols and half carrying objects like cell phones or wallets (see Correll et al., 2002, for details). Participants were instructed to shoot armed targets by pressing a button labeled *shoot*, and to press a button labeled *don't shoot* to indicate a decision not to shoot unarmed targets. The game consisted of 80 randomly ordered trials, 20 in each of four cells reflecting the 2 (Target Race) by 2 (Object Type) repeated-measures design of the game.

On each trial, a fixation cross was followed by 1–4 scenes, presented for a randomly determined period of time (500–1000 ms). A target person appeared in the final scene. Participants had 850 ms to respond. Points were awarded/deducted according to performance. Not shooting an unarmed target earned 5 points, but shoot-

ing cost 20. Shooting an armed target earned 10 points, deciding not to shoot cost 40. This reward structure reflects an effort to mirror the contingencies of a police officer, who avoids shooting innocent people, but suffers most by failing to neutralize a threat. This structure also creates a bias to shoot: shooting indiscriminately yields an average penalty of 5 points per trial, whereas not shooting yields a penalty of 17.5. Failure to respond within 850 ms resulted in a penalty of 10 points. The top three performers received cash bonuses of $30, $15, and $10.

A subset of participants ($n = 31$) completed a mass-testing questionnaire at the beginning of the semester, which assessed personal views of Blacks and Whites as aggressive, violent, and dangerous. We also measured perceptions of the cultural stereotype of Blacks and Whites as aggressive, violent, and dangerous. Personal and cultural stereotypes for each race were computed by averaging the three items. Difference scores reflected the degree to which dangerous traits were more strongly associated with Blacks than Whites at both personal and cultural levels.

Psychophysiological data collection and reduction

ERP data were recorded from 28 sites using tin electrodes sewn into an elastic cap (Electro-Cap International, Eaton, OH). Miniature tin electrodes were also placed over the left and right mastoid. Active scalp sites were referenced on-line to the left mastoid. Additional electrodes were placed above and below the left eye, and on the outer canthus of each eye to monitor vertical and horizontal eye movements, respectively. Electrode impedances were below $10\,K\Omega$ 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 1000 Hz.

Off-line, data were re-referenced to a computed average of the left and right mastoids and submitted to a regression procedure to remove the effects of vertical eye movements, which can distort scalp measurements (Semlitsch, Anderer, Schuster, & Presslich, 1986). Epochs beginning 100 ms before stimulus onset and continuing for 1000 ms were created, then corrected to the mean voltage of the pre-stimulus recording period. We visually inspected the ERP data and deleted any trials with ocular or other artifact (e.g., due to movement). Data from all sites for that trial were eliminated from analysis if artifact was detected at any of the scalp sites. Epochs were then filtered with a 12 Hz low pass filter (96 dB, zero-phase shift).

Four ensemble averages were created for each participant, averaging across correct responses of the four trial types. Visual inspection of these condition averages revealed five distinct deflections at more frontal scalp sites, as seen in Fig. 2. Based on polarity and latency, we refer to these components as N100 (mean

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[2] Exclusion of this participant does not affect the significance of the results.
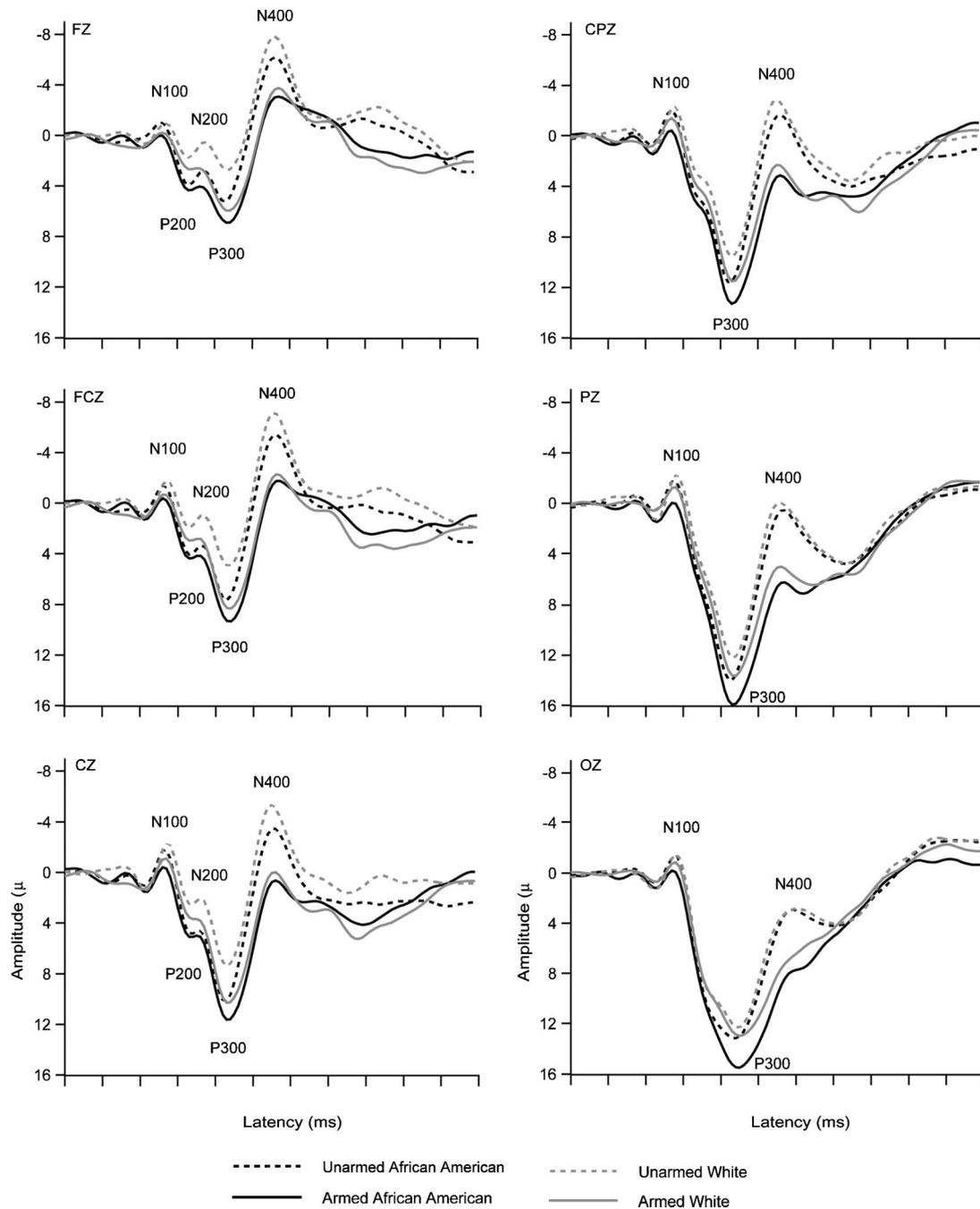
Fig. 2. Grand average waveforms as a function of target race and object type shown separately at each midline electrode.

latency $= 159$ ms), P200 (mean latency $= 219$ ms), N200 (mean latency $= 273$ ms), P300 (mean latency $= 345$ ms), and N400 (mean latency $= 475$ ms).[3] Peak amplitudes were scored for each participant by locating the largest negative-going deflections between 75 and 225 ms (N100), 200 and 350 ms (N200), and 350 and 600 ms

(N400) and the largest positive-going deflections between 175 and 300 ms (P200) and 250 and 500 ms (P300). At more parietal sites, the P200 and N200 were less distinct, perhaps masked by the relatively large P300 at these sites. As a result, the P200 and N200 were not scored at more parietal regions, starting with central-parietal and temporal-parietal sites. Preliminary analyses revealed similar effects of experimental conditions at midline and left- and right-lateralized scalp sites. For brevity, we present results at only midline scalp sites. N100, P300, and N400 were analyzed with separate

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[3] The N400 was the only component in which a significant latency effect occurred involving variables of interest. N400s to White targets peaked earlier ($M = 470$ ms) than those to Black targets ($M = 481$ ms), $F(1, 39) = 4.18$, $p < .05$.

2 (Target Race: Black, White) $\times$ 2 (Object Type: gun, no gun) $\times$ 6 (Sagittal Site: Fz, FCz, Cz, CPz, Pz, and Oz) repeated-measures analyses. For P200 and N200, the Sagittal Site factor contained three levels (Fz, FCz, and Cz).

Results

Behavioral data

We averaged log-transformed latencies from correct trials for the four target types (armed Black $M = 547.85$ ms, armed White $M = 554.46$ ms, unarmed Black $M = 630.18$ ms, and unarmed White $M = 617.08$ ms).[4] Participants shot armed targets more quickly than they decided not to shoot unarmed targets, $F(1, 39) = 276.22$, $p < .0001$. This finding replicates previous work (Correll et al., 2002) and supports the argument that, in the context of the game, "shoot" is the prepotent response. Shooter bias was calculated as the degree to which participants shot armed targets more quickly if they were Black (rather than White) and indicated "don't shoot" more quickly if unarmed targets were White (rather than Black). This index represents the interaction of Target Race and Object Type, $F(1, 39) = 16.89$, $p < .005$.

ERP effects

Fig. 2 shows ERP waveforms recorded during correct responses at each electrode. Two general effects can be seen. First, armed and unarmed targets were differentiated early in processing, beginning in the N100. This effect took the form of a negative displacement of the waveforms for unarmed targets (seen as an upward shift in the waves), producing larger negative-going but smaller positive-going components for unarmed targets. Second, ERPs differed as a function of race beginning in the P200, in the form of a negative displacement for White targets, producing larger negative-going but smaller positive-going components for Whites.

N100

Analyses revealed sensitivity only to Object Type, with larger (more negative) N100s to targets who were unarmed ($M = -2.97 \mu V$) rather than armed ($M = -2.10 \mu V$), $F(1, 39) = 11.11$, $p < .005$.

P200

Object Type continued to affect processing in the P200, with larger (more positive) P200s to armed ($M = 5.56 \mu V$) than unarmed targets ($M = 4.53 \mu V$),

$F(1, 39) = 6.50$, $p < .05$. As predicted (H_{1A}), P200s were larger for Blacks ($M = 5.82 \mu V$) than Whites ($M = 4.27 \mu V$), $F(1, 39) = 10.18$, $p < .005$, suggesting that Blacks were perceived as more threatening. The Target Race $\times$ Object Type interaction was not significant, $F < 1$.

N200

Although the N200 is a negative-going component, this component exhibited a general positive shift, so the values of the peaks were positive in polarity. Smaller positive values therefore indicate larger N200s. N200s were larger to unarmed ($M = 0.64 \mu V$) than armed targets ($M = 1.83 \mu V$), $F(1, 39) = 6.66$, $p < .05$. As predicted (H_{1B}), N200s were larger to Whites ($M = 0.32 \mu V$) than Blacks ($M = 2.15 \mu V$), $F(1, 39) = 16.05$, $p < .001$, suggesting that Whites induced greater conflict with the "shoot" response. The interaction was not significant, $F < 2$.

P300

P300s were larger to Blacks ($M = 13.06 \mu V$) than Whites ($M = 11.31 \mu V$), $F(1, 39) = 20.71$, $p < .0001$, and to armed ($M = 13.31 \mu V$) than unarmed targets ($M = 11.06 \mu V$), $F(1, 39) = 32.82$, $p < .0001$. Again, the interaction was not significant, $F < 1$.

N400

N400s were larger to Whites ($M = -2.44 \mu V$) than Blacks ($M = -1.61 \mu V$) and to unarmed ($M = -4.17 \mu V$) than armed targets ($M = 0.12 \mu V$), F's$(1, 39) = 4.77$ and 110.58, p's $< .05$ and .0001, respectively. There was also a marginally significant interaction between Target Race, Object Type, and Sagittal Site, $F(5, 35) = 2.11$, $p = .09$. Simple effects tests showed that, at more frontal sites (Fz, FCz, and Cz), N400s were larger to unarmed Whites ($M = -8.11 \mu V$) than to unarmed Blacks ($M = -6.49 \mu V$; $F(1, 39) = 10.04$, $p < .005$), but responses to armed Whites ($M = -3.34 \mu V$) and Blacks ($M = -3.17 \mu V$) did not differ. At more parietal sites (CPz, Pz, and Oz), responses were larger to unarmed targets ($M = -1.10$ versus $3.37 \mu V$; $F(1.39) = 138.87$, $p < .0001$), but there were no target race effects within either object type.[5]

Summary of ERP effects

Consistent with the N100's sensitivity to task factors (e.g., Hillyard & Munte, 1984), results show that processing was modulated by the object toward which partici-

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[4] Consistent with Correll et al. (2002), participants made few errors in the task ($M = 4.3\%$). Errors were not predicted by the Race $\times$ Object interaction, $F < 0.6$.

[5] There was an Object Type $\times$ Sagittal interaction in the N400. The object effect was larger more parietally, $F(5, 35) = 3.42$, $p < .05$. The only other sagittal effects were main effects. In the N100, amplitudes at CPz ($M = -3.02 \mu V$) were larger than Fz ($M = -1.91 \mu V$) and Pz ($M = -2.67 \mu V$), F's$(1, 39) = 14.53$ and 4.88, p's $< .05$. In the P300, amplitudes increased linearly from anterior to posterior sites, $F(1, 39) = 109.17$, $p < .0001$. P300s were largest at Pz ($M = 15.66 \mu V$) and Oz ($M = 15.59 \mu V$).

pants were instructed to attend by 160 ms. Modulation as a function of object type continued throughout subsequent processing, affecting all components: unarmed targets consistently evoked more negative potentials than armed targets. Race also modulated processing, even though it was not task relevant. Race effects emerged in the P200 and in all subsequent components: Whites evoked more negative potentials than Blacks.

Although only the N400 showed an interaction involving race and object type, Fig. 2 clearly suggests that, as early as the P200, processing of unarmed Whites diverged from both types of armed targets and from unarmed Blacks as well. Responses to unarmed Whites are shifted in a negative direction. To examine this effect, we examined two post hoc contrasts, first assessing whether responses to unarmed Whites differed from responses to all other types of targets, and then whether unarmed Blacks were differentiated from armed Blacks and Whites. In the P200 and N200, the first contrast was significant. Responses to unarmed Whites ($M_{P200} = 3.59\,\mu V$, $M_{N200} = -0.54\,\mu V$) differed from responses to armed Whites, armed Blacks, and unarmed Blacks ($M_{P200} = 5.53\,\mu V$, $M_{N200} = 1.83\,\mu V$), $F(1,39) = 12.25$ and 31.92, respectively, p's < .001. By contrast, unarmed Blacks ($M_{P200} = 5.47\,\mu V$, $M_{N200} = 1.82\,\mu V$) were not differentiated from armed Blacks and Whites ($M_{P200} = 5.56\,\mu V$, $M_{N200} = 1.83\,\mu V$), F's < 1.[6]

Relation between ERPs, behavior and questionnaires

Table 1 shows correlations between the ERP contrasts, shooter bias, and the self-reported stereotype measures (for participants for whom these data were available). For each ERP component, we computed contrast scores that represent the Target Race and Object Type main effects, as well as their interaction. To maximize sensitivity, contrasts were computed at the electrode at which the component was maximal.[7]

In line with Correll et al. (2002), participants who reported that American society associates violence with Blacks (more than Whites) showed greater behavioral bias. Interestingly, personal and cultural stereotypes also correlated with racial differentiation in the P200 and N200. These effects show that even in a task that does not explicitly require processing in terms of race, stereotypes about Blacks and Whites predict differential attention to race.

Our most critical hypothesis suggested that racial differentiation in ERPs should exacerbate shooter bias (H₂). As predicted, participants who exhibited larger

Table 1
Correlations among ERP effects, behavioral shooter bias, and stereotypes

	Shooter bias (latency) ($n = 40$)	Personal stereotype ($n = 31$)	Cultural stereotype ($n = 31$)
Shooter bias		.18	.38*
ERP Race main effect			
N100	.27[b]	.29	.30
P200	.33*	.43*	.32[b]
N200	.35*	.42*	.41*
P300	.10	.28	.10
N400	.05	.20	.14
ERP Object Type main effect			
N100	.16	−.23	−.17
P200	−.13	−.07	−.25
N200	.02	.08	−.11
P300	−.29	.31	−.10
N400	−.14	−.16	−.23
ERP Race × Object interaction			
N100	−.13	−.06	−.12
P200	.30[a]	.15	.14
N200	.13	.09	.13
P300	−.10	.09	.11
N400	.05	.04	−.09

[a] $p < .06$.
[b] $p < .09$.
* $p < .05$.

P200s (greater threat), and smaller N200s (reduced response inhibition), for Blacks, relative to Whites, showed greater bias. The magnitude of the race effect in the N100 also exhibited a marginal correlation with bias. (In the case of the N100, target race effects were not significant when averaged across participants. Nevertheless, the correlation indicates that individuals differed in their attention to race as early as 160 ms, and that these individual differences predicted subsequent bias.)

Additional analyses examined the relation of shooter bias and the significant P200 and N200 contrasts reflecting differentiation of unarmed Whites from the other three types of target. The degree to which unarmed Whites were processed differently in both the P200 and N200 correlated with bias, r's(40) = .31, .31, p's = .05, .06, respectively. This relationship primarily reflected the correlation between bias and the simple ERP race effect among unarmed targets, r's(40) = .40, .39, respectively, p's < .05. In neither case did differential ERPs to armed targets, as a function of race, correlate with bias. Similar results were obtained for the N100. The degree to which N100s differed to unarmed Whites, as compared to the other three types of target, was correlated with bias, $r(40) = .33$, $p < .05$, reflecting the correlation between bias and the simple race effect among unarmed targets, $r(40) = .42$, $p < .05$.

Mediational analyses

To recapitulate, cultural stereotypes predicted both racial differentiation in ERPs and shooter bias. Further,

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[6] Neither contrast was significant in the P300. Instead, participants tended to differentially process armed Blacks ($M = 14.20\,\mu V$) as compared to the other targets ($M = 11.52\,\mu V$), $F(1,39) = 33.85$, $p < .0001$.

[7] CPz, Cz, Cz, Pz, and Fz for the N100, P200, N200, P300, and N400, respectively.
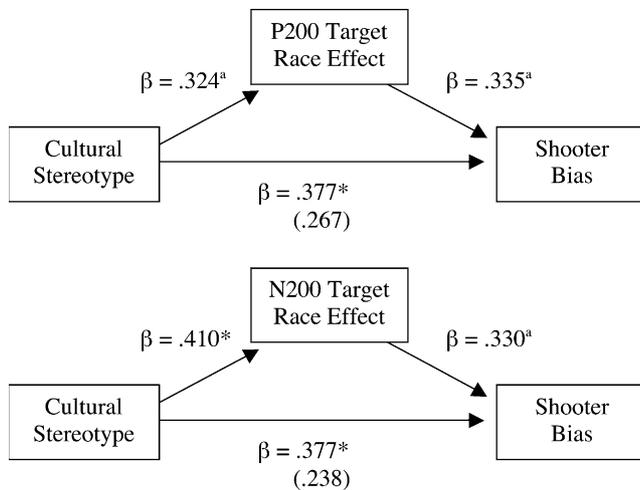
Fig. 3. Differential attention to target race, as indexed by the P200 and N200 (top and bottom panels, respectively) mediate the relationship between cultural stereotypes and shooter bias. In each case, the direct effect of Cultural Stereotype on Shooter Bias was significantly weaker after partialling out the ERP race effect (the partial correlation is shown in parentheses). *$p < .05$. [a] $p < .10$.

ERP differentiation and bias were, themselves, correlated. This pattern raises the intriguing possibility that stereotypes affect behavior in the game, in part, because they prompt racial differences in threat- and conflict-detection processes. To examine this possibility, we conducted mediational analyses following MacKinnon's product coefficient method (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). Separate tests showed that racial differentiation in the P200 and N200 each mediated the effect of cultural stereotypes on shooter bias, z's = 1.36, 1.54, respectively, p's < .02 (see Fig. 3).[8]

Discussion

This study measured ERPs while participants played a simple videogame, deciding whether or not to shoot Black and White targets who were either armed or unarmed. Behavioral data replicated previous findings: participants shot armed Blacks more quickly than armed Whites, and decided not to shoot unarmed Whites more quickly than unarmed Blacks. Participants reporting a stronger association between violence and Blacks at the cultural level displayed especially biased behavior. As predicted, ERPs showed that the P200 and N200 components differentiated targets according to race (H_1). Like bias, this racial differentiation was especially pronounced among individuals with more stereotypic beliefs and knowledge. Crucially, sensitivity to race in the P200 and N200 predicted the magnitude of shooter

bias (H_2), and even mediated the relationship between cultural stereotypes and bias in the videogame. Congruent with the argument advanced by Correll et al. (2002) and with models of implicit processing (Conrey et al., in press), these results indicate that an individual's spontaneous (and technically unnecessary) attention to racial cues may promote bias in split-second decisions.

We believe the current investigation is valuable, in part, because it makes use of three vastly different forms of data. By measuring (a) long-standing stereotypes, (b) nearly instantaneous neural activity related to threat perception and control, and (c) subsequent behavioral responses, we gain insight into the manner in which person and context factors combine to influence behavior. Participants with stronger personal and cultural stereotypes, measured weeks before the ERP session, were especially likely to respond to Blacks as both more threatening and more consistent with a shoot response than Whites. This pattern that was not moderated by the presence/absence of a weapon. The results suggest that people's stable beliefs about groups have the capacity both to influence their perceptions of the threat posed by an individual, and to moderate the predisposition to shoot.[9] These perceptions, in turn, have consequences for behavior. Perception of a target as threatening, and failure to inhibit the dominant "shoot" response, should predispose participants to respond correctly when a target is, in fact, armed. As a consequence, participants should (and do) shoot armed Blacks more quickly than armed Whites. But, the same perceptions should have very different consequences for unarmed targets. If an unarmed target seems threatening, and creates an erroneous predisposition to shoot, the participant must inhibit and overcome that initial response tendency in order to respond correctly. Accordingly, participants should (and do) decide not to shoot unarmed Blacks more slowly than unarmed Whites (see Fig. 1).

It is noteworthy that the race by object interaction was not significant in either the P200 or the N200. Racial cues may be processed automatically and independently of other physical, task-relevant cues (Ito & Urland, 2003, 2005). If race-relevant processing proceeds independently of object in the current paradigm, we may anticipate additive, rather than interactive, effects. Indeed, because the task-relevant objects represent an artificial category, rather than a biologically prepared category (e.g., snakes or spiders), it seems reasonable that social processing should not be strongly influenced by object type.

Nonetheless, an interactive hypothesis can be derived from evolutionary theory. To survive, humans must reli-

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[8] Tests of reverse mediation (i.e., taking stereotypes as the mediator of the relationship between ERPs and shooter bias) were not significant for either component, p's > .6.

[9] In this regard, our argument is similar to behavioral studies showing that racial prejudice and ingroup identity moderate racial categorization, e.g., Blascovich, Wyer, Swart, and Kibler (1997), Castano, Yzerbyt, and Bourguignon (2002).

ably detect threats in their environment (Cacioppo & Berntson, 1994; Ohman et al., 2001). Attentional processes, and consequently ERPs, should therefore differentiate between threatening and innocuous stimuli. In the context of the game, armed targets constitute a threat: they are the "bad guys." But, in light of prevalent cultural stereotypes, even unarmed Blacks may be perceived as threats (Devine & Elliot, 1995; Ito & Urland, 2003). Only unarmed White targets, then, should be perceived as non-threatening (evoking smaller P200s), and only they should unambiguously warrant a don't-shoot response (evoking larger N200s associated with inhibition of the *shoot* response). Focused contrasts for both the P200 and N200 showed that unarmed White targets were, indeed, processed differently than all other targets, whereas unarmed Blacks were processed in a fashion similar to armed targets. However, given the extremely weak interactions in the current data (F's < 2) and the lack of any a priori justification for these focused contrasts, we advance this hypothesis with caution.

Like the P200 and N200, the P300 and N400 showed main effects of both race and object. However, neither the P300 nor the N400 correlated with behavior or with reported stereotypes. We can only speculate about this lack of correlation. Given the later time course of the P300 and N400, they may reflect cognitive processes unrelated to the behavioral decision (e.g., meta-evaluative thoughts of the stimuli, or their controlled integration into the current context, Halgren & Marinkovic, 1995) that neither impacted behavior nor related to systematic differences in stereotyping.

The N100 showed a unique pattern. It was larger to unarmed targets, but showed no significant effect of race. The N100 seems to be sensitive to the nature of the task, and it has recently been suggested that its amplitude is related to processes of discrimination, as opposed to detection (Hopf, Vogel, Woodman, Heinze, & Luck, 2002). That is, the N100 is larger when participants are asked to decide *what kind of stimulus* is present, rather than deciding simply whether or not a stimulus is present. Though our participants were always asked to discriminate guns from other objects, the fact that unarmed targets evoked larger N100s may be seen as consistent with the idea that participants see the videogame principally as an exercise in weapon detection, and that identification of a non-weapon involves more effortful discrimination-based processing.

These results highlight the complex psychological processes that govern the decision to shoot. The data suggest that both threat perception and conflict detection play an important role, and crucially, that racial cues promote biased shooting behavior because (a) Black targets seem more threatening than White targets, and (b) White targets conflict more strongly with the tendency to shoot than do Black targets. This initial insight into the basic psychological mechanisms that underlie shooter bias will,

we hope, promote a better understanding of when and how bias may influence real-world police decisions. For instance, our P200 results imply that the association between threat and Black racial features enhances bias. If so, real-world circumstances that moderate the relation between threat and race should affect bias. Police working in a predominantly minority area, for example, may come to see race as a non-diagnostic cue. If everybody in the neighborhood is Black, the fact that a particular suspect is also Black may seem irrelevant, and bias may be minimized. Moreover, any cue (i.e., not simply race) that implies danger may create a predisposition to shoot. Police in profoundly dangerous circumstances may be disposed to see all suspects, White and Black alike, as threatening. Accordingly, bias should be reduced. Any changes in behavior resulting from these contextual effects should be associated with changes in the neural processes indexing threat, and in attentional systems associated with cognitive control. We feel that our efforts and those of other researchers (e.g., Amodio et al., 2004) who are working to chart the low-level processes that translate racial attitudes into discriminatory behavior have the potential to help our society understand and address important issues, and, in so doing, help realize the tremendous promise of social neuroscience in the Decade of Behavior.

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