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Stereotypic Vision: How Stereotypes Disambiguate Visual Stimuli

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Three studies examined how participants use race to disambiguate visual stimuli. Participants performed a first-person-shooter task in which Black and White targets appeared holding either a gun or an innocuous object (e.g., a wallet). In Study 1, diffusion analysis (Ratcliff, 1978) showed that participants rapidly acquired information about a gun when it appeared in the hands of a Black target, and about an innocuous object in the hands of a White target. For counterstereotypic pairings (armed Whites, unarmed Blacks), participants acquired information more slowly. In Study 2, eye tracking showed that participants relied on more ambiguous information (measured by visual angle from fovea) when responding to stereotypic targets; for counterstereotypic targets, they achieved greater clarity before responding. In Study 3, participants were briefly exposed to targets (limiting access to visual information) but had unlimited time to respond. In spite of their slow, deliberative responses, they showed racial bias. This pattern is inconsistent with control failure and suggests that stereotypes influenced identification of the object. All 3 studies show that race affects visual processing by supplementing objective information.

Keywords: danger, construal, visual attention, weapon, stereotype

Interpretation depends on the schemata that people apply to the objects of their perception (Bartlett, 1932; Bruner, 1957). Stereotypes, for instance, can ease the processing of consistent information (Stern, Marrs, Millar, & Cole, 1984), guide attention to particular aspects of input (Bodenhausen, 1988), add input that is not actually present (Cantor & Mischel, 1977), and ultimately yield a different construal of the same stimulus. A playful push becomes a hostile shove if the actor is Black rather than White (Duncan, 1976; Sagar & Schofield, 1980), and "Carlos Ramirez" seems more likely to be guilty than "Robert Johnson" (Bodenhausen & Lichtenstein, 1987).

We investigated the influence of race and racial stereotypes on visual perception in the context of a first-person-shooter task (FPST), which presents a series of male targets, either Black or White, holding weapons or innocuous objects. In this task, participants attempt to shoot armed targets but avoid shooting unarmed targets. Tasks like this typically reveal a pronounced bias, such that participants shoot more quickly and more frequently if the target is Black rather than White (Correll, Park, Judd, & Wittenbrink, 2002; Correll et al., 2007b; Payne, 2001, 2006; Plant & Peruche, 2005). This bias seems to reflect an association between Black people and the concept of danger (one component of stereotypes about Blacks) (Correll, Park, Judd, & Wittenbrink, 2007a). In the present work, we examine the prospect that racial stereotypes may actually shape visual perception, potentially leading participants to "see" different objects as a function of the target's race.

The majority of research on stereotype-driven interpretation has focused on judgments of abstract, verbal information. For example, Bodenhausen and Lichtenstein (1987) asked participants to read a description of a court case, and described the defendant as either Latino or White. Kunda and Sherman-Williams (1993) presented participants with descriptions of behavior attributed to different actors (e.g., a construction worker hit someone who annoyed him vs. a housewife hit someone who annoyed her). In both cases, social categories shaped participants' interpretation of the events, such that the Latino defendant was more likely to be judged guilty, and the construction worker's behavior was thought to be more aggressive.

Though the effect of stereotypes on these abstract interpretations offers valuable insights, the present research examines a different question. We test the possibility that stereotypes shape the perception and identification of visual stimuli, actually changing the process by which we make sense of objective visual information. Though there have been efforts to explore related questions, there is little direct work on this issue. Duncan (1976) presented a videotaped encounter where an actor (either Black or White) shoves another person. This work showed that the interpretation of that action depended on the actor's race, seeming more aggressive

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when the actor was Black (cf. Hastorf & Cantril, 1954). However, these data offer no evidence that race affected visual processing per se. In essence, this study shows that the actor's race influenced judgments about the *intention* behind the shove.

Of course, the general idea that expectations impact people's perception of their environment has a long tradition in psychology. More than a century ago, Helmholtz (1866) noted that perception is the result of both sensory input and cognitive influences. Later, "New Look" researchers suggested that as perceivers we "go beyond the information given" (Bruner, 1957). Supporting experimental evidence has followed these early proposals. For example, stimuli are detected faster when they appear in expected locations (Posner, Snyder, & Davidson, 1980), or when they contain expected attributes (e.g., color, shape; Corbetta, Miezin, Dobmeyer, Schulman, & Petersen, 1990). Likewise, expectations have been found to modulate whether stimuli trigger spontaneous attention (Egeth & Yantis, 1997).

However, much of this empirical evidence is based on experiments with highly simplified stimulus arrays (e.g., dots) and relatively simple expectations (e.g., color) that readily map onto the available stimulus attributes. In contrast, few studies have explored the effects of expectations on visual perception and identification with more complex and potentially ambiguous stimuli. In one such study, Balcetis and Dale (2007), presented participants with an ambiguous image, which could be viewed as either a horse or a seal. When participants had been primed with a story about farm animals (rather than sea animals), they were more likely to identify the image as a horse.

The two studies that bear most closely on the present research come from Jennifer Eberhardt (Eberhardt, Goff, Purdie, & Davies, 2004) and Keith Payne (Payne, Shimizu, & Jacoby, 2005). Eberhardt subliminally primed participants with either a series of Black faces or a series of White faces. She then showed them a series of images of an object that, initially, was severely degraded by the addition of pixilated noise. From one image to the next, noise was removed. As the image gradually resolved into clarity, participants were asked to identify the object in question. Eberhardt found that participants who had been primed with Black faces were able to identify crime-related objects (e.g., a gun or a pair of handcuffs) more quickly than participants primed with White faces. Although the image was still grainy and unclear, the prime seemed to help these participants "see" the hidden picture.

The pattern of stereotype-guided vision reported by Eberhardt Goff, Purdie, and Davies (2004) stands in contrast to the results obtained by Payne, Shimizu, and Jacoby (2005). Payne asked participants to perform a weapon identification task (WIT). The WIT is a sequential priming task. On each trial, a Black or White face appears briefly, followed by either a gun or a tool. In this paradigm, participants typically show bias: When primed with a Black face, they are more likely to incorrectly classify a tool as a gun; White primes have the opposite effect. In the 2005 studies, the object appeared very briefly (200 ms) and was then masked. Participants were asked to categorize the object as either a gun or a tool within 500 ms of stimulus onset. The critical aspect of this study is that on each trial—immediately after their initial speeded response—participants were given a second chance to make the classification, this time with no time pressure. The rationale for this second response is that it eliminates errors that are driven by time pressure. Any second chance response the participants execute should be the response they intend, reflecting their actual beliefs about what they saw. If they think they saw a gun, they should classify the object as a gun. If they think they saw a tool, they should classify it as a tool. If stereotypes guide construal (if a tool *really looks like* a gun when it follows a Black face), participants should therefore show bias even when they have unlimited time to respond. Payne's results were strikingly clear. Participants showed pronounced bias on their initial response, but their second guesses were almost perfect. Moreover, the few errors that did occur were unaffected by the race of the prime. These data suggest that stereotype-driven biases occur because people fail to execute the intended response, not because they misperceive the object. This account receives further support from Amodio et al. (2004), who used the WIT to examine an event-related brain potential called the error-related negativity (ERN), which has been implicated in the control of response conflict. Amodio observed increased ERNs on Black-tool trials for which participants made *gun* responses, indicating that participants were at least partially aware of their mistakes even as they were committing them. In line with Payne's data, these results suggest that the tool was perceived accurately, but that participants executed the wrong response under time pressure.

In light of seemingly contradictory findings, the current research reexamines the prospect that racial stereotypes can guide visual perception. We make use of diverse methodological and analytic strategies. Study 1 reexamines reaction time (RT) data from a previously published study (Correll et al., 2007b, Study 2) through the lens of Ratcliff's diffusion model (Ratcliff, 1978; Voss & Voss, 2007). The diffusion model allows us to examine a variety of conceptually distinct factors that influence decision-making, including the accumulation of evidence from a visual array. Study 2 employs eye tracking to examine visual angle (the angle between the fovea and the object) at the time participants execute a decision, allowing us to assess the degree to which participants rely on more or less ambiguous visual information when making decisions. In both of these studies, we suggest that stereotypes can supplement visual perception. We predict that participants will (a) acquire evidence more quickly, and (b) require less objective clarity before responding when targets conform to stereotypes (i.e., armed Blacks and unarmed Whites). By contrast, when targets deviate from stereotypes (i.e., unarmed Blacks and armed Whites), participants should require more time and greater visual clarity before initiating a response. Both of these patterns are consistent with the idea that stereotypes help participants "see" the object. After demonstrating basic support for the idea that stereotypes can guide visual construal, Study 3 directly pits the construal account against a response-execution account. In particular, we examine whether object perception in the FPST is subject to misconstrual. Parallel to Payne et al. (2005), we examine whether participants show bias in their errors when they have unlimited time to respond.

Study 1

This study involves an analysis of data originally reported in an article by Correll et al. (2007b). A sample of lay people completed the FPST. The original analysis showed clear evidence of racial bias in both response times and error rates (which were analyzed with signal detection theory [SDT]). Participants shot more quickly if an armed target was Black rather than White, but indicated *don't shoot* more quickly if an unarmed target was White rather than Black. In addition, participants used a more lenient or trigger-happy criterion when targets were Black and a more stringent, conservative criterion when targets were White. Although this type of analysis, in which latencies and errors are analyzed separately, is common in the field of social psychology, additional information may be gleaned by analyzing both response errors and latencies in an integrated fashion.

The diffusion model (Ratcliff, 1978; Voss & Voss, 2007) uses both accuracy and latency to represent the decision-making process as it unfolds over time (see Figure 1). Interested readers can find more information about the diffusion model and the software used in the present work (fast-dm) in a series of papers by Voss and colleagues (Voss, Rothermund, & Voss, 2004; Voss & Voss, 2007; see also Ratcliff & Rouder, 1998). In the FPST, participants presumably start with some a priori response tendency (e.g., a mild inclination to shoot). When the target appears, they begin to acquire information about the features of the stimulus (e.g., a dark, thin shape in the target's hand). As participants make sense of the accumulating evidence (perhaps the barrel of a gun?), they gradually approach one of two thresholds: a conclusion that the object is a gun and the corresponding decision to shoot (represented by the upper threshold) or a conclusion that the object is not a gun and the corresponding decision not to shoot (represented by the lower threshold). It is important to note that the diffusion model employs detailed information about the distributions of response time for both correct and incorrect responses to estimate the parameters involved in this process.[1]

1. *Threshold separation* (represented by the variable "a") estimates the distance between the two decision thresholds (shoot vs. don't shoot). Higher estimates represent thresholds that are more distinct from each other, suggesting that participants achieve greater certainty before responding. Greater separation has been associated with both greater accuracy and slower response times.

2. *Starting value* (z) estimates the tendency to favor one decision over another in the absence of accumulated information. For example, if a participant starts the decision process with a bias in favor of shooting (a value of z that is close to the upper threshold), it should take little evidence and little time to reach the *shoot* response, but a great deal of evidence and time to reach the *don't shoot* response. To the extent that racial stereotypes exert influence on decisions via assumptions about the correct response (e.g., leading participants to more strongly favor the shoot response when the target is Black), estimates of z should be higher (and, thus, closer to the shoot threshold) for Black targets than for Whites.

3. *Drift rate* (v) estimates the rate at which participants acquire information about the object. Steep slopes in the direction of the correct threshold suggest that participants rapidly accrue information that leads toward a correct decision, leading to high levels of accuracy and short response times. By contrast, flatter slopes suggest that the visual information is more difficult to parse, leading to more errors and slower responses. Estimates of drift rate are critical for the current study, which is concerned with the prospect that racial stereotypes serve to disambiguate visual stimuli, supplementing the objective information and distorting the accumulation of evidence in a biased fashion. If racial stereotypes bias the acquisition of information, drift rates should be steeper (i.e., indicate faster information acquisition) for stereotypic targets (armed Blacks and unarmed Whites) than for counterstereotypic targets.

4. *Nondecision time* (t_0) represents the time that participants require to perform operations that are not part of the decision-making process itself. For example, once a decision has been made (e.g., that the object is not a gun), it may take participants more time to actually execute the appropriate response if the target is Black rather than White—a pattern consistent with response interference. This variation is captured by t_0.

Diffusion models have been applied successfully to a variety of decision contexts. To demonstrate their flexibility and the diagnosticity of their estimates, Voss (Voss et al., 2004; see also Voss, Rothermund, Gast, & Wentura, 2013) manipulated factors like participants' concern with accuracy, the reward value of a given response, the difficulty of visual discrimination, the difficulty of response execution, and the nature of the task (lexical-decision task or LDT vs. evaluative or semantic categorization). These manipulations affected diffusion model estimates in a predictable fashion. For example, in a color discrimination task, offering a reward for a given response led participants to adopt a starting point (z) closer to the high-value threshold, whereas increasing the perceptual difficulty of the task led to more gradual search slopes (v). In an LDT, priming was evident in the drift rates (v) but not in the nondecision time (t_0); this suggests that associative priming biased the accumulation of evidence. By contrast, in a categorization task, effects were evident in nondecision time, but not drift rates, suggesting that they emerge primarily due to response competition. The estimates derived from diffusion analysis thus seem to be sensitive to different psychological processes. Based on this foundational research, we used the diffusion approach to examine perceptual/interpretational processes in the FPST. We argue that racial cues may bias the interpretation of ambiguous visual information. For example, if a gun looks more like a gun when it appears in the hands of a Black man (rather than a White man), participants should rapidly accumulate information that promotes the decision to shoot. This leads to the prediction that race will affect drift rates in a diffusion analysis, such that stereotype-congruent targets will produce steeper estimates of v, suggesting rapid accumulation of evidence, whereas stereotype incongruent targets produce lower estimates of v, indicative of more gradual slopes and slower accumulation of evidence.

[1] Technically, the algorithm is based on the cumulative distribution function of all trials in a given condition (see Voss & Voss, 2007, for details). Although the diffusion model estimates a large number of parameters, it is identified because the data used to fit it involve much more than simply the four cell means.

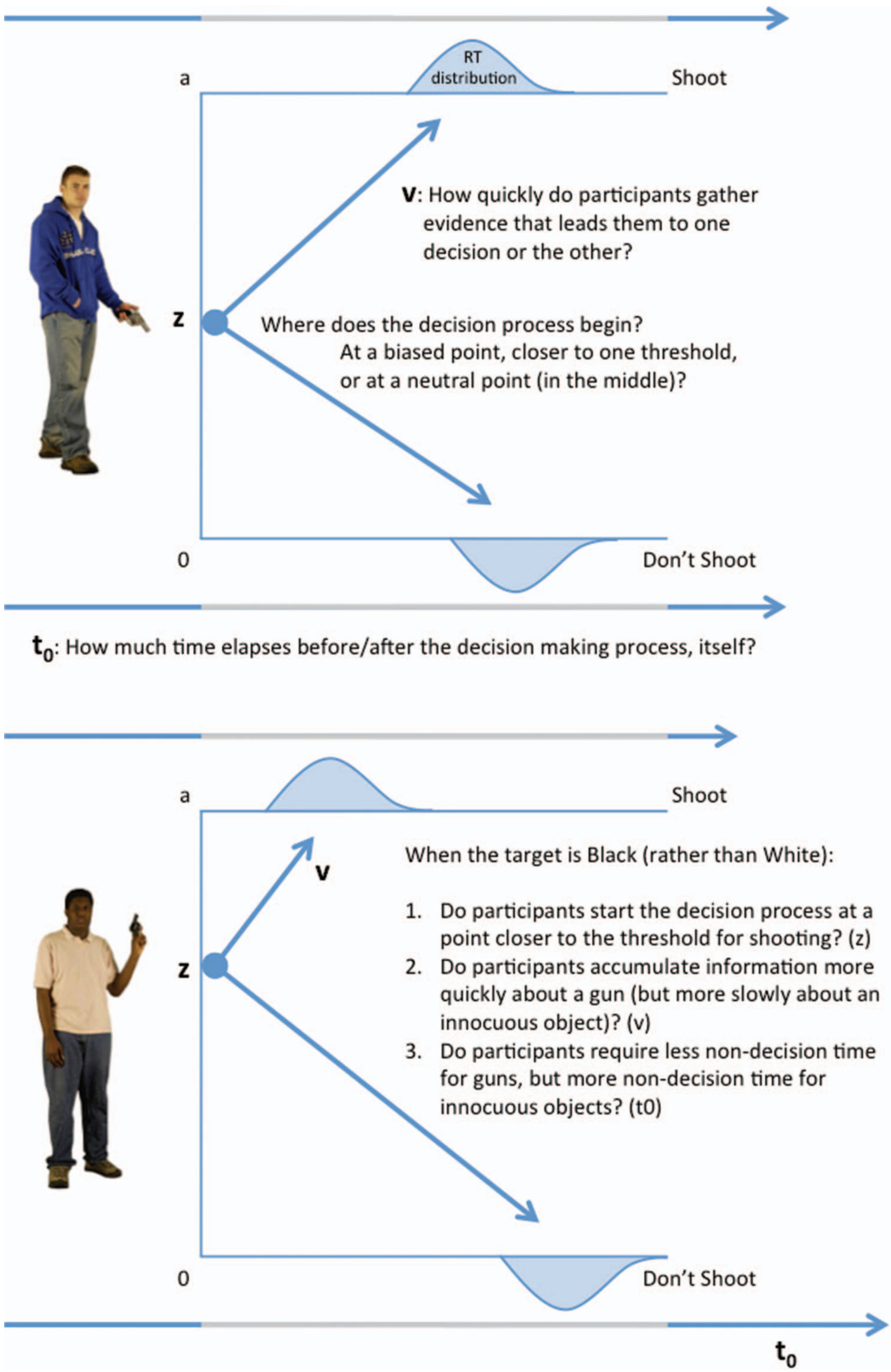

Figure 1. Hypothetical diffusion model for decision making in the context of the first-person shooter task for a White target (top panel) as well as a set of questions concerning how the parameters might change when the target is Black rather than White (bottom panel). Photos are taken from the First-Person Shooter Task (Correll et al., 2007b). See the online article for the color version of this figure.

Method

Participants and design. We reanalyzed data from Correll et al. (2007b, Study 2) in which 45 members of the Denver community completed the FPST in return for $20.[2] The current experiment employed a 2 (Target Race: Black vs. White) × 2 (Object Type: gun vs. nongun) repeated-measures design.

First-person-shooter task. The FPST presents a series of Black and White male targets, half carrying handguns, half carrying innocuous objects like cell phones or wallets. Participants were instructed to shoot armed targets by pressing a button labeled *shoot*, and to press a second button, labeled *don't shoot*, for decisions not to shoot unarmed targets. Each trial started with a fixation point followed by one to four background scenes, each appearing for a randomly determined duration (500 ms to 1,000 ms). The final background image was ultimately replaced with an image of a target situated in that background, leaving the impression that the target popped up in the scene. The task consisted of 16 practice trials and 100 test trials, 25 in each of four cells of the Race × Object design. Participants were required to respond within 630 ms, and to motivate accuracy, points were awarded/deducted according to performance (see Correll et al., 2007b, for details).

Results and Discussion

Error rates. The basic analysis of these data was reported elsewhere (Correll et al., 2007b). We recapitulate that analysis briefly, here, to provide context for the diffusion model analysis that follows, but for a more detailed analysis, see the original article. We submitted participants' error rates (number of errors divided by the total number of valid trials) to a 2 (Target Race: Black vs. White) × 2 (Object Type: gun vs. nongun) repeated measures analysis of variance. We observed a main effect of object, $F(1, 44) = 30.11$, $p = .0001$, $\eta^2 = .406$, such that participants made fewer errors to armed targets than to unarmed targets. The main effect of race was not evident, $F(1, 44) = 0.18$, $p = .68$, $\eta^2 = .004$, but racial bias in the decision to shoot, as tested by the Race × Object interaction, was significant, $F(1, 44) = 5.45$, $p = .025$, $\eta^2 = .110$. Simple effects tests showed that, when the target was armed, participants made *don't shoot* decisions somewhat (but not significantly) more often if he was White rather than Black, $F(1, 44) = 2.58$, $p = .12$, $\eta^2 = .055$. When the target was unarmed, participants showed a weak trend to shoot him more often if he was Black rather than White, $F(1, 53) = 2.60$, $p = .12$, $\eta^2 = .056$.

Signal detection analysis. SDT assumes that targets can be represented along some judgment-relevant continuum, like perceived threat. In general, armed targets should be perceived as more threatening than unarmed targets. To the extent that this differentiation exists, a participant should be able to discriminate between the two classes of stimuli, shooting armed targets but choosing not to shoot unarmed targets. We use the statistic d' to assess this sensitivity to object type. In addition, SDT assumes that participants choose a point along the threat continuum at which they open fire. Targets exceeding this criterion will be shot, whereas targets falling below the criterion will prompt a don't-shoot response. We used the statistic c to index this criterion. A low value of c indicates a willingness to shoot relatively nonthreatening targets (i.e., a lenient or trigger-happy criterion). As c increases, it suggests that participants become more conservative, firing only on the most threatening targets.

For each participant, we computed the proportion of correct and incorrect decisions to shoot (hits and false alarms, respectively) when the target was Black, and again when the target was White. We then calculated estimates of sensitivity and criterion from these data. There was no evidence that d' differed for Black ($M = 1.39$) versus White ($M = 1.47$) targets, $t(44) = .062$, $p = .54$, $\eta^2 = .000$. However, the criterion did depend on target race, suggesting that participants employed a more lenient criterion for Black targets ($M = -0.30$) and a more conservative criterion for Whites ($M = -0.19$), $t(44) = 2.09$ $p = .042$, $\eta^2 = .090$.

Diffusion model analysis. A diffusion model analysis was conducted using Voss and Voss's (2007) *fast-dm* software. The program requires the user to specify the relationship between parameters and factors in the design of the study. For example, one might specify that drift rate should vary as a function of race (but not object), object (but not race), or both race and object. The other parameters must similarly be specified. Based on previous research (Voss et al., 2013) as well as the advice of Andreas Voss (personal communication, August 9, 2012), we estimated a model for each participant in which threshold separation (a) was held constant across all cells of the design, start point (z) was estimated once for White targets and once for Black targets, and both drift rate (v) and nondecision time (t_0) were estimated separately for each cell of the Race × Object design. By allowing drift rate to vary across all four trial types, this parameterization allows us to examine the extent to which construal processes impact decision making. But, we deliberately chose a model that also allows us to detect processes that are not related to construal. For instance, typically, threshold separation and start point are held constant across a block of trials. However, by allowing separate start points for Black and White targets, we allow for the possibility that quick interpretation of the target's race can bias the position at which the decision process about the object begins. Racial differences in start point would capture a bias that affects the likelihood of a decision to shoot—not due to differential accumulation of information about the object, but rather to a race-based assumption. For example, a participant might show a bias in start point such that less information is needed to shoot a Black target. In addition, by allowing nondecision time to vary across all four trial types, the model allows for effects that are driven by response competition rather than construal. For example, regardless of the decision-making process, a participant may show a bias in behavioral tendencies, such that Black targets facilitate the motor response associated with shooting (Payne et al., 2005; Voss et al., 2013). This parameterization was adopted for all three studies, but it is important to note that results do not differ appreciably with other parameterizations (e.g., if we allow racial differences in threshold separation or constrain the model by holding start point constant across race).

The fast-dm program relies on the Kolmogorov–Smirnov test (Kolmogorov, 1941). This approach has a clear advantage in the present context in that it avoids binning trial-level data and is thus

[2] We have conducted diffusion analyses on several existing datasets with similar results. This dataset, however, uses both the same timing parameters as Studies 2 and 3, and the same stimulus set as Study 3. It thus provides a better comparison for the current work than other existing data.

more appropriate for tasks with fewer trials (Voss et al., 2004).[3] The Kolmogorov–Smirnov test also provides indices of fit, which reflect the degree to which the theoretical model can account for the observed data. These indices are essentially probability (*p*) values, with smaller values suggesting poorer fit. The overall fit statistic for each participant is computed as the product of the *p* values that represent fit for each of the four conditions in our paradigm. We can therefore compute an adjusted fit statistic by raising the fit to the reciprocal of the number of conditions (adjusted fit = $p^{[1/4]}$), which captures something akin to the typical *p* value across condition (see Voss & Voss, 2007). These adjusted values are reported in Table 1. Adjusted fit was relatively high (~0.9) across all studies.

Sample means for each parameter are presented in Figure 2 and Table 1. The estimates were submitted to repeated-measures analyses, examining start point as a function of Target Race, and drift rate and nondecision time as a function of Race × Object. In all subsequent treatments of starting point, we analyzed the *relative starting point* or the ratio, z/a. This estimate corrects for individual differences in threshold separation (see Voss et al., 2004). This means that a value for this ratio of .5 would indicate a start point that is unbiased—falling exactly in the middle of the decision space—whereas a value between 0.5 and 1.0 would indicate a bias to shoot, and a value between 0 and 0.5 would indicate a bias not to shoot. In our analysis of drift rate, we reverse scored the estimates of v for unarmed targets, taking $(-1 \times v)$ as our measure. The drift rates for unarmed targets tend to be negative (sloping down to the lower threshold); by reverse scoring those estimates, we can ask questions about the overall magnitude (steepness vs. flatness) of the drift rate, which reflects the speed of information accumulation, for both armed and unarmed targets.

Starting point (z/a). In general the mean starting point (0.46) was less than 0.5, suggesting a general tendency *not* to shoot, $F(1, 44) = 24.21$, $p < .0001$, $\eta^2 = .355$. This finding is somewhat surprising given that the SDT analysis of these data (and prior studies, e.g., Correll et al., 2002) reveal a negative criterion, suggesting that participants favor the *shoot* response over the *don't shoot* response (but see nondecision time, below). We found no evidence that the starting point differed as a function of target race, $F(1, 44) = 0.61$, $p = .45$, $\eta^2 = .014$. Thus, there was no indication that participants adopted a higher starting point when the target was Black. In fact, the means were slightly higher for White targets. These data suggest that racial bias in behavior arises through a different process.

Nondecision time (t_0). Nondecision time differed as a function of object type, $F(1, 44) = 54.01$, $p < .0001$, $\eta^2 = .551$, but showed no dependence on race or the Race × Object interaction, $Fs(1,44) = 1.11, 1.49$, $ps = 0.30, 0.23$, η^2s = .025, .033, respectively. The results suggest that the average time required to respond to an armed target was significantly shorter than the time required for unarmed targets. Thus, although the estimates of z suggest that participants initiate the decision process at a point closer to the *don't shoot* threshold, the estimates of t_0 nicely account for evidence that, behaviorally, participants favor the decision to shoot. Again, t_0 does not involve the process of evaluating evidence and reaching a decision, per se. Rather, it captures aspects of perception or physical response execution. For example, although participants begin every trial with one finger on the shoot button and one finger on the don't shoot button, they may favor the shoot button, facilitating the physical movement required for a shoot response. These data thus suggest a clear behavioral predisposition to press the shoot button (however, they do *not* suggest that this response tendency depends on target race).

Drift rate (v). Most importantly for our argument, we examined the drift rates. If stereotypes augment visual information (helping participants interpret visual stimuli) drift rates for stereotype-congruent targets (armed Blacks and unarmed Whites) should be steeper than drift rates for counterstereotypic targets (unarmed Blacks and armed Whites). This prediction is tested by the interaction between target race and object type. The analysis of the drift rates revealed a pronounced main effect of object type, $F(1, 44) = 32.36$, $p < .0001$, $\eta^2 = .424$, suggesting that evidence accumulation was faster when the object was a gun rather than a nongun. We found no evidence of a main effect for race, $F(1, 44) = 0.02$, $p = .89$, $\eta^2 = .000$. However, the critical Race × Object interaction was significant, $F(1, 44) = 9.13$, $p = .005$, $\eta^2 = .172$. To make sense of this pattern, we examined armed and unarmed targets separately. For armed targets, participants accumulated evidence promoting the decision to shoot more quickly if the target was Black rather than White, $F(1, 44) = 6.46$, $p = .015$, $\eta^2 = .128$. By contrast, for unarmed targets, participants accumulated evidence favoring the decision not to shoot marginally more quickly if the target was White rather than Black, $F(1, 44) = 3.09$, $p = .09$, $\eta^2 = .066$. The results suggest that participants accumulated evidence more rapidly when the target conformed to stereotypes, leading them to arrive at the correct conclusion more quickly. By contrast, when the target was incongruent with stereotypes, (e.g., a White target holding a gun), participants acquired information more slowly.

We also computed two indices to capture individual variation in drift rates, one reflecting the overall speed with which participants accumulate information, and one reflecting the magnitude of racial bias in that accumulation. *Mean drift rate*, or the speed with which participants accumulate information regardless of race and object, was computed as the simple average of the four estimates of drift rate. *Stereotypic drift rate*, which represents the relative advantage in drift rate for stereotype congruent targets, was computed as $(v_{\text{armed Black}} - v_{\text{armed White}}) - (v_{\text{unarmed Black}} - v_{\text{unarmed White}})$. We then examined the correlations between these diffusion model indices and indices based on the signal detection estimates, focusing on mean sensitivity $[(d'_{\text{White}} + d'_{\text{Black}})/2]$, race-based differences in sensitivity $[d'_{\text{White}} - d'_{\text{Black}}]$, mean criterion $[(c_{\text{White}} + c_{\text{Black}})/2]$, and race-based differences in the criterion, which reflect bias in the decision to shoot $[c_{\text{White}} - c_{\text{Black}}]$. Mean drift rate was strongly and positively correlated with both mean sensitivity and mean criterion, $rs = 0.95, 0.42$, $ps < .0001, .005$, respectively. Not surprisingly, the speed with which participants accumulated information (estimated by the diffusion model) was closely related to their overall ability to differentiate between armed and unarmed targets. What is perhaps more interesting is that participants who acquired information more quickly also set a stricter criterion on average—they were generally less inclined to shoot.

[3] Given the relatively low number of trials, it is possible that the diffusion model estimates are disproportionately influenced by a few odd responses. Although this kind of overfitting may take place at the level of the participant, it should only add error to our analysis and weaken the reported effects.

Table 1
Diffusion Model Estimates for Each Parameter in Studies 1, 2, and 3

	Study 1 (n = 45)		Study 2 (n = 39)		Study 3 (n = 54)	
	Mean	StDev	Mean	StDev	Mean	StDev
Adjusted fit ($p^{1/4}$)	0.927	0.046	0.874	0.080	0.903	0.073
Threshold separation (a)	0.637	0.080	0.698	0.081	0.664	0.079
Relative start point (z/a)						
White	0.466	0.070	0.441	0.068	0.492	0.067
Black	0.453	0.086	0.461	0.074	0.497	0.061
Nondecision time (t_0)						
No gun						
White	0.455	0.054	0.506	0.045	0.383	0.063
Black	0.455	0.052	0.499	0.042	0.387	0.064
Gun						
White	0.412	0.044	0.466	0.043	0.353	0.052
Black	0.419	0.048	0.458	0.040	0.361	0.055
Drift rate (v)						
No gun						
White	1.860	2.082	2.252	1.513	0.880	1.992
Black	1.335	1.958	1.822	1.309	0.482	2.195
Gun						
White	2.617	1.340	2.962	1.266	1.722	1.379
Black	3.197	1.394	3.420	1.070	2.286	1.422

The stereotypic drift rate index was strongly related to racial bias in the criteria to shoot, $r(43) = .85$, $p < .0001$. In as much as the error rates contribute to both the diffusion model analysis and the signal detection analysis, this correlation presents an intuitive (not surprising) confirmation of expectations: participants who gathered evidence in a more stereotypic fashion made more biased decisions. In the subsequent studies, we will use the stereotypic drift rate index to test more interesting extensions of this logic. Overall, then, the results from diffusion model analysis suggest that participants accumulate evidence more quickly when targets "fit" prevalent stereotypes, but more slowly or gradually when targets violate those stereotypes. This pattern suggests that the target's race may guide visual interpretation of the object, perhaps by offering supplemental information. Moreover, the magnitude of this biased accumulation is strongly related to racial bias in the decision to shoot.

Study 2

Study 1 employed a sophisticated but relatively indirect analytic technique, using RTs and error rates to make inferences about how stereotypes impact the processing of visual information in the FPST. Study 2 turns to a more direct measurement approach: eye tracking. Here, we examine how target race impacts visual search. We have argued that racial cues may bias the interpretation of ambiguous visual information and the results of Study 1 demonstrate that participants more rapidly accumulate information on stereotype-congruent trials. Thus, a gun more readily looks like a gun when it appears in the hands of a Black man (rather than a White man). But if participants gather evidence more quickly on stereotype-congruent trials it stands to reason that participants should also terminate their visual search more quickly. If race augments the available visual information on these trials, participants should require less of the available *objective* information. By contrast, on counterstereotypic trials, race may retard the accumulation of evidence. If a gun in the hands of a White man somehow looks less readily like a gun, participants should accrue information more gradually (as shown in Study 1) and, as a consequence, they should seek greater clarity through an extended visual search. In essence, they may require more concrete, clearer objective information due to the fact that race impairs subjective interpretation. In Study 2 we sought to directly test these differences in the use of available information by tracking participants' eye gaze during the shooter task.

With the use of the eye tracker, it is possible to measure where on a computer screen the participant is looking, and thus to calculate the distance between an area of interest on the screen (i.e., the object held in the target's hand) and the direction of the participant's gaze (i.e., the center of the retina). This distance can be assessed in terms of visual angle. Small visual angles indicate that the participant is looking directly at or near the object. Larger visual angles indicate that the participant is looking elsewhere. Objects within 1° of the retina center fall onto the highest density of cones, which provides the greatest level of visual acuity. As visual angle increases, visual acuity decreases dramatically. To achieve the greatest objective clarity about the nature of the object, participants must therefore fixate directly on it, yielding a negligible angle.

When partially resolved visual information about the object is congruent with stereotypes, race may help disambiguate the stimulus, leading to premature responses based on lower-quality visual information (Bar, 2003). By contrast, when partially resolved information about the object conflicts with racial stereotypes, participants may seek greater clarity—resolving the ambiguity through more careful visual processing (rather than schema-driven inferences, Von Hippel, Jonides, Hilton, & Narayan, 1993). The Black target holding a cell phone and the White target holding a Beretta may therefore prompt a more exhaustive visual search, as participants strive to interpret the conflicting input. This kind of top-down, stereotype driven interpretation should yield an interaction between target race and object type on visual angle.

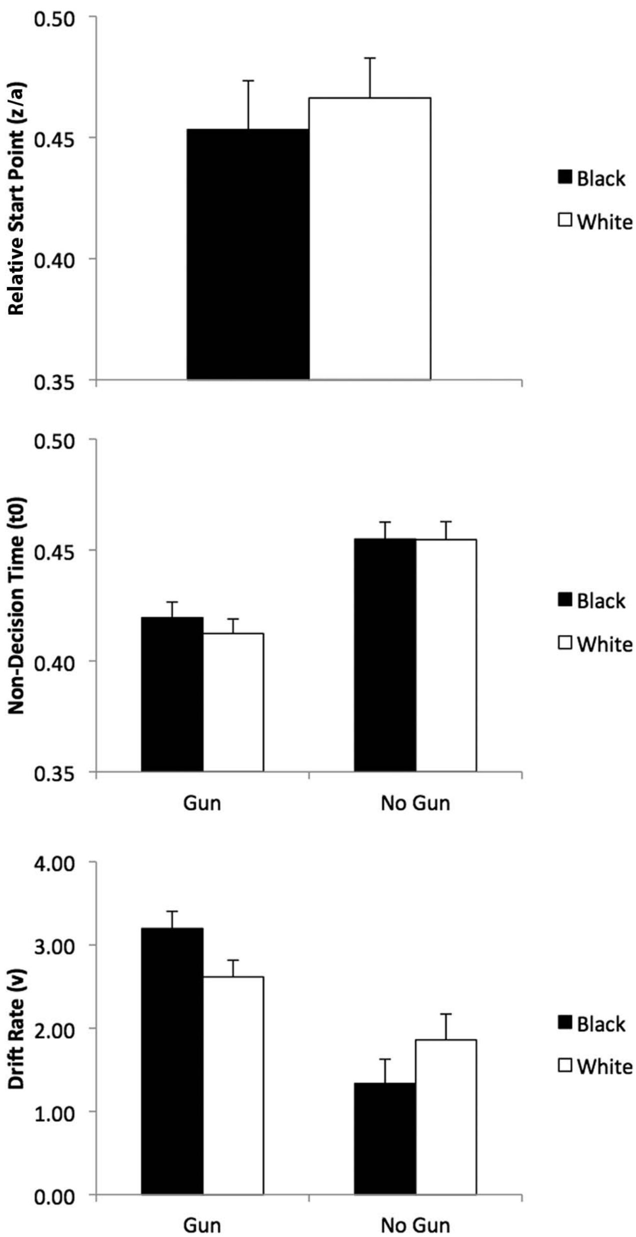

Figure 2. Mean (±SEM) of diffusion model estimates: relative start point (z/a) by Target Race (top panel); nondecision time (t_0) by Target Race and Object Type (middle panel); and drift rate (v) by Target Race and Object Type (bottom panel; Study 1).

Method

Participants and design. Forty-two non-Black undergraduates participated in return for course credit. The current experiment employed the same 2 (Target Race: Black vs. White) × 2 (Object Type: gun vs. nongun) repeated-measures design as Study 1. Three participants were excluded from analysis due to either excessively high error rates ($N = 1$) or time out rates ($N = 2$), leaving 39 participants for analysis.

Apparatus. The recording of eye movements was obtained via the use of eye-tracker equipment (EyeLink-1000 Tower Mount Head Supported System; SR Research Ltd., Ontario, Canada). This is a video based system that measures both the pupil and the corneal reflection (recorded from the left eye in the current experiment) via an infrared camera, allowing the location of fixation to be obtained. Spatial resolution is extremely high: 0.01° of visual angle. Instructions and stimuli were presented via the integrated programming software (SR Research Experiment Builder, version 1.4.128 RC). The software was run on a Dell 3-GHz Pentium D computer and stimuli were displayed on a 2100 monitor at a resolution of 1,024 × 768 pixels and with a refresh rate of 60 Hz. Distance between the eyes and the monitor was maintained at 57 cm with the use of chin and forehead rests.

Procedure. Participants were run individually. Upon being seated at the tower mount, the experimenter explained how eye tracking worked and adjusted the height of the rests so that the participant could sit upright comfortably at the proper distance from the monitor. The experimenter then completed a calibration procedure to ensure accuracy. Following these initial procedural details, the FPST was introduced.

First-person-shooter task. The task for this experiment was the same as that used in Study 1 with the following exceptions. First, the current experiment included 120 trials consisting of 30 trials of each type, randomly presented in two blocks of 60. Second, the stimuli were adjusted so that the location of the object for each target was equidistant from the central fixation point. Finally, the current experiment used a Zalman FG1000 FPS Gun Gaming Mouse rather than a button box. This mouse has a pistol-style grip with two buttons on the front. Buttons were counterbalanced so that half of the participants used the top button to shoot and the other half used the lower button to shoot. The nonshoot button was described as the safety. Because the gun mouse is designed for right-handed individuals, all participants were right-handed, and had normal or corrected-to-normal vision. After completion of the task, participants were debriefed, thanked, and dismissed.

Results and Discussion

Error rates. Error rates were submitted to a 2 (Target Race: Black vs. White) × 2 (Object Type: gun vs. nongun) repeated-measures analysis. This analysis revealed a significant main effect of object, $F(1, 38) = 11.86$, $p = .001$, $\eta^2 = .24$, such that participants made fewer errors in response to armed targets ($M = 9.66\%$) than to unarmed targets ($M = 14.50\%$). This main effect, however, was subsumed by a significant interaction between race and object, $F(1, 38) = 11.73$, $p = .002$, $\eta^2 = .23$. Participants were more likely to shoot an unarmed target if he was Black ($M = 16.42\%$) rather than White ($M = 12.57\%$), $t(38) = -2.32$, $p = .026$, $\eta^2 = 0.12$. For armed targets, this pattern was reversed. Participants were more likely to choose *don't shoot* if an armed target was White ($M = 12.00\%$) rather than Black ($M = 9.23\%$), $t(38) = 2.21$, $p = .033$, $\eta^2 = 0.11$.

Signal detection analysis. We also calculated estimates of sensitivity (d') and criterion (c) from these data. We observed no effect of target race on d', $t(38) < 1$. However, the criterion did depend on race, such that participants set a lower, more lenient criterion for Black targets ($M = -.24$) compared with White targets ($M = .014$) targets, $t(38) = 5.15$, $p = .01$, $\eta^2 = 0.41$. This replicates the typical pattern of bias, such that participants were more likely to shoot Black rather than White targets.

Visual angle from fovea. For each trial, we measured the distance between the location of the participant's gaze and the center of the interest area (i.e., the gun or the nonweapon object) in pixels. The true distance in millimeters (D_r) was calculated by multiplying the pixel distance (D_p) with the quotient of the width (T = 4,000 mm) divided by the horizontal resolution (R = 1,024) of the screen (i.e., $D_r = D_p(T/R)$). Visual angle (α) is then calculated: $\alpha = arctan(D_r/D_{oe})^*(180/\pi)$ where D_{oe} represents the distance from the eye to the screen (5,700 mm). Within roughly 1° of the exact center of the retina is the foveola. The high density of cones in this area provides the eye with its highest resolution. As the visual angle increases, cone density decreases and the resolution of the image suffers. Specifically, the ability to discriminate fine detail shows a dramatic drop in the 2°-10° range (i.e., parafovea).

The mean visual angle between the object and fovea at the time of the response was calculated for each target type (see Figure 3). These means were submitted to a 2 (Target Race: Black vs. White) × 2 (Object Type: gun vs. nongun) repeated-measures analysis. We observed a pronounced (and entirely unanticipated) effect of target race ($F(1, 38) = 23.23$, $p = .001$, $\eta^2 = .38$) indicating greater visual angle when the target was Black (M = 2.08°) than when the target was White (M = 1.59°). In other words, the response (shooting or not shooting) for a Black target was made at a point in time when participants had poorer resolution regarding the most relevant information (i.e., the object in the hand); whereas, for White targets, participants generally achieved greater acuity before responding. The analysis also revealed a marginally significant effect of object, indicating that visual angle tended to be smaller for guns (M = 1.72°) than for other objects (M = 1.95°), $F(1, 38) = 3.56$, $p = .067$, $\eta^2 = .08$.

We have argued that visual resolution should be less critical for stereotypic targets because participants employ race-based schemata to disambiguate the stimulus. Accordingly, we predicted that participants would be more likely to respond prior to obtaining clear objective information on stereotype-congruent trials but would wait to achieve more complete resolution on stereotype-incongruent trials, for which race-based stereotypes and partially processed information about the object conflict. This question is tested by the Race × Object interaction, which was significant, $F(1, 38) = 5.20$, $p = .028$, $\eta^2 = .12$. As predicted, mean visual angle was larger for stereotypic targets and smaller for counterstereotypic targets. We decomposed this interaction by examining the simple effects of race for each level of object. Unfortunately, the simple effects are difficult to interpret due to the main effect of race and object (described above): visual angle is generally smaller for trials involving White targets and guns. However, the simple effects show that, when the target was armed, visual angle was much greater for Black targets (M = 2.03°) than for White targets (M = 1.41°), $t(38) = 5.329$, $p = .001$, $\eta^2 = .428$. This difference suggests that participants shot Blacks with relatively low visual resolution or clarity concerning the object, whereas they achieved much greater visual resolution before shooting an armed White. For unarmed targets, race had a smaller (but still significant) effect on visual angle, $t(38) = 2.858$, $p = .01$, $\eta^2 = .177$ (M_{White} = 1.78° vs. M_{Black} = 2.11°). This smaller effect may reflect the countervailing influences of stereotype-driven construal and the general tendency in this sample to respond with lower resolution for Black (rather than White) targets.

Recall that our measure of visual angle reflects the direction of the eyes at the moment in time when the participants responded. We acknowledge that it is possible that participants initially foveated the object, but that their eye gaze subsequently drifted away from the object prior to the response. To address this concern, we examined the visual angle of the fixation *prior to* the response. On fewer than 1% of the trials was the visual angle of the prior/penultimate fixation smaller (suggesting that gaze was thus closer to the object) than the visual angle of the fixation when the response was made. Given the relatively fast response times and the fact that the time between saccades is on the order of 200 ms, this clearly suggests that fixations were still moving toward the object when the response occurred. Thus, the visual angle at time of response is almost certainly the minimum visual angle achieved by the participant.

Interestingly, the main effect of target race is congruent with research showing that Black *faces* tend to capture and hold visual attention (Donders, Correll, & Wittenbrink, 2008), which may prevent participants from disengaging from the faces of Black targets to seek information about the object. However, we did not predict this effect a priori, and we are hesitant about overinterpreting it. In any case, these data support the prediction that race exerts a top-down influence on visual processing during the FPST such that, on average, participants responded to stereotypic targets (M = 1.91°) before attaining the visual clarity they achieved for counterstereotypic targets (M = 1.76°). Presumably, stereotype-driven inferences provided participants with a sense of clarity not warranted by objective visual information.

Diffusion model analysis. We submitted the response data to a diffusion model analysis. The effects closely paralleled Study 1. We again observed no evidence of a race effect on estimates of the starting point, $F(1, 38) = 1.26$, $p = .27$, $\eta^2 = .032$. Regarding nondecision time, we observed an effect of race (which we did not find in Study 1), $F(1, 38) = 8.45$, $p = .007$, $\eta^2 = .182$. However, the pattern of results was otherwise extremely similar: we obtained

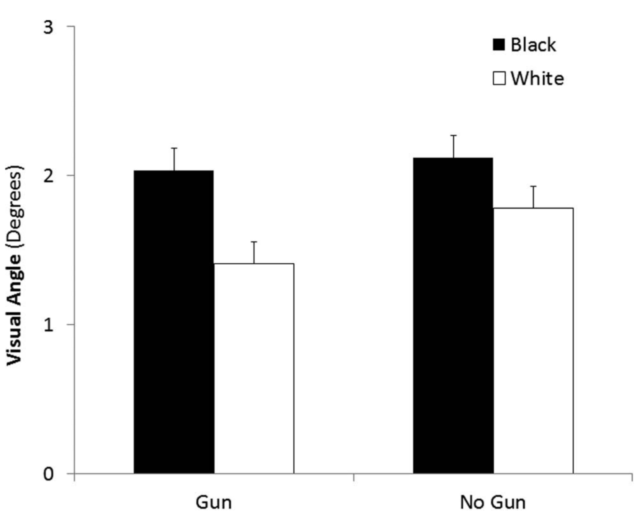

Figure 3. Mean (±SEM) of visual angle by Target Race and Object Type (Study 2).

a pronounced effect of object, $F(1, 38) = 160.12$, $p < .0001$, $\eta^2 = .808$, and as in Study 1, the interaction between race and object was not significant, $F(1, 38) = 0.02$, $p = .89$, $\eta^2 = .001$. Most importantly for our argument, the analysis of drift rate cleanly replicated Study 1. We again observed a pronounced effect of object, $F(1, 38) = 32.58$, $p < .0001$, $\eta^2 = .462$, as well as the critical Race × Object interaction, $F(1, 38) = 9.03$, $p = .0005$, $\eta^2 = .192$. The interaction reflects the fact that participants acquired information more quickly for armed Black targets than for armed White targets, $F(1, 38) = 4.62$, $p = .039$, $\eta^2 = .108$, and marginally more quickly for unarmed Whites than for unarmed Blacks, $F(1, 38) = 3.77$, $p = .06$, $\eta^2 = .090$. As in Study 1, the effect of race was not significant, $F(1, 38) = 0.01$, $p = .94$, $\eta^2 = .000$.

Finally, we tested the relationship between the magnitude of bias in drift rates and the bias in visual angle. To examine this question, we again computed an index representing the Race × Object interaction in drift rates (the stereotypic drift rate index), and a similar index for visual angle: $(\text{visualangle}_{\text{armed Black}} - \text{visualangle}_{\text{armed White}}) - (\text{visualangle}_{\text{unarmed Black}} - \text{visualangle}_{\text{unarmed White}})$. The two indices were correlated, $r = .345$, $p = .032$. This finding suggests that participants who demonstrated more pronounced racial bias in drift rate (more rapidly accruing information on stereotypic than counter-stereotypic targets) also tended to terminate their visual search earlier and with less clear visual information for stereotypic targets. This is exactly the pattern we would predict if racial stereotypes augment visual processing, leading participants to more quickly interpret ambiguous evidence, such that they reach a stereotypic decision more quickly (as measured by the drift rate index) and so require less fine-grained information (as measured by the visual angle index).

Study 3

Rather than the analytical or measurement strategies involved in Studies 1 and 2, our final test of stereotype-guided visual processing involves a methodological innovation developed by Payne et al. (2005, described briefly in the introduction). These authors tested two accounts of bias: a *construal* account and an *executive failure* account. In line with the current proposal, the construal account posits that racial stereotypes promote misperception—objects in the hands of a Black target actually look more like guns than the same objects in the hands of a White target. By contrast, an executive failure account argues that participants perceive the objects accurately, but that racial cues interfere with the responses they execute. The assumption behind the executive failure account is that there are multiple influences, each of which may guide behavior under some circumstances. So, for a Black target holding a cell phone, the object might promote a nonhostile response while the target's race promotes a hostile response. To the extent that participants effectively exercise control over their behavior, they should be able to implement the correct response, basing their actions on the appropriate object information. But when control fails, racial stereotypes may lead participants to shoot even though they know full well that the object is harmless. In their studies, Payne and colleagues briefly presented a White or a Black face followed by a gun or a tool. Participants made an initial speeded response followed by a second, delayed response. The data showed pronounced bias on the first response—but because the first response involved time pressure, bias might reflect either misconstrual or executive failure. The deliberative second response is more diagnostic. On the second response, participants had plenty of time to respond, so executive failure should be extremely unlikely. The only reason that participants should shoot is if they actually believe they saw a gun. On the second responses, performance was virtually perfect, and participants showed no evidence of racial bias. This suggests that they accurately perceived the objects, and that bias on the speeded response was due only to executive failure.

Payne's (Payne et al., 2005) results are surprising in light of Eberhardt's work (Eberhardt et al., 2004) and the results of Studies 1 and 2 in the current article, which suggest that racial cues can actually alter the acquisition and resulting construal of visual information. To make sense of the divergent results, it is perhaps important to note certain details that differentiate the tasks used in the studies. First, the WIT's priming methodology used by Payne and colleagues separates stereotype/person information and object information into two temporally and functionally distinct events. Moreover, the objects are presented against a plain background at a relatively large scale (5.3 cm × 4 cm; see Figure 4, bottom panel). As Payne and his colleagues observe, the procedure yields visual displays that are fairly unambiguous (Payne et al., 2005, p.

Figure 4. Example stimuli from the first-person-shooter task (top panel) and the weapon identification task (bottom panel). Photos are taken from the First-Person Shooter Task (Correll et al., 2007b; top panel) and from Keith Payne's stimulus set (Payne et al., 2005; bottom panel). See the online article for the color version of this figure.

46). This is a crucial point. Using verbal stimuli, studies have shown that a lack of ambiguity limits the capacity of stereotypes to guide construal (Kunda & Sherman-Williams, 1993). It seems plausible that visual processing operates similarly. Construal effects may be more prominent in situations where information concerning the object is ambiguous. Notably, Eberhardt's results were observed with severely degraded stimuli, and the FPST uses images of Black and White people holding relatively small objects, situated in complex, naturalistic backgrounds. We suspect that, with more ambiguous stimuli, race may directly affect construal, such that participants genuinely misperceive the target object.

Study 3 investigates this possibility using the same approach as Payne et al. (2005). We test whether stereotypic biases persist when participants have the time and resources to execute their intended response. Participants performed an FPST with two modifications. First, the target image remained visible for a very short duration to preclude extensive visual processing. Second, after an initial speeded response, participants were given a second chance to make their shoot/don't shoot decision. On this second response, there was no pressure to respond quickly. Thus, the present study was a close replication of Payne's study. The critical difference was that we used complex stimuli in which race and object appeared simultaneously rather than sequential priming with simple stimuli. We expected that these complex stimuli would yield stereotypic construal effects that would persist even though participants were not pressured for a rash decision.

Method

Participants and design. Fifty-eight non-Black participants (eight Asian, five Latino, 44 White; 36 female; one who did not report race or gender) were recruited for paid participation ($10) in a psychology experiment. Two additional participants emerged as outliers in the analysis reported below (Cook's D = .215 and .124, the next highest value was 0.056[4]) and were excluded, though their inclusion does not substantively change the results. Participants played a simplified videogame, in which they responded to Black and White targets who were either armed or unarmed. On each trial, participants made both a speeded and a nonspeeded response. This resulted in a 2 (Target Race: Black vs. White) × 2 (Object Type: gun vs. nongun) × 2 (Response Order: first vs. second) within-subject design.

First-person-shooter task. The FPST consisted of a modified version of the task used in Study 1. For the purpose of the present study, the final target image was displayed for only 175 ms and immediately replaced by another background scene, which served as a mask. Initially, participants made a speeded decision, indicating either *shoot* or *don't shoot* within 630 ms of target onset. After the initial response, the computer presented the message, "Actually shoot or don't shoot?" (see Payne et al., 2005). Participants then made a second response at their own pace—no deadline was imposed. Following the latter response, participants received visual and auditory feedback as well as a running tally of their points.

Procedure. The experiment was conducted with groups of one to three participants. Upon arrival, participants were met by a female Caucasian experimenter who described the study as an investigation of perceptual vigilance. Detailed instructions for the task and a set of 16 practice trials followed. Participants then performed the FPST. Finally, participants were thanked and debriefed.

Results and Discussion

We typically exclude participants who fail to respond within the time window on an excessive number of trials (e.g., Correll et al., 2002, 2007b). The timing parameters of the current task, however, dramatically increased the number of timeouts during the speeded judgment. Application of our standard criteria would result in the exclusion of roughly 50% of our sample. Accordingly, we adopted more lenient criteria, excluding only participants who timed out on more than a third of the trials ($n = 4$). However, the results reported below hold even if we apply the more stringent criteria we normally use.

We submitted participants' error rates to a 2 (Target Race: Black vs. White) × 2 (Object Type: gun vs. nongun) × 2 (Response Order: first vs. second) analysis of variance. We observed a number of lower order effects.

We begin by considering the data from the initial, speeded response. Replicating previous findings, we observed a main effect of object, such that participants made more errors in response to unarmed (rather than armed) targets, $F(1, 53) = 29.76, p < .0001, \eta^2 = .360$. This analysis also revealed racial bias, manifested as an interaction between race and object, with significantly more errors for stereotype-inconsistent targets, $F(1, 53) = 8.99, p = .005, \eta^2 = .145$. Tests of the simple effects showed that, when the target was armed, participants mistakenly made *don't shoot* decisions more often if he was White rather than Black, $F(1, 53) = 7.16, p = .01, \eta^2 = .119$. When the target was unarmed, participants showed a weak trend to mistakenly shoot him more often if he was Black rather than White, $F(1, 53) = 2.24, p = .14, \eta^2 = .041$ (see Table 1 and Figure 5 for means).

The critical question in the current study was whether this evidence of racial bias, observed under pressure, also emerges in the absence of pressure. The second, deliberative response distinguishes between the executive failure and construal accounts. If bias emerges due to control failure (i.e., participants correctly perceived the object, but executed the wrong response), we should observe bias only on the initial, speeded response. According to this account, participants clearly perceived the object, so their deliberative responses should be accurate and unbiased. However, if participants actually misperceived the objects in a stereotypic fashion (e.g., if they misconstrued the Black target's cell phone as a gun), they should show bias even when they have more time to respond. To address this question, we examined performance on the second response. Again, we observed a main effect of object, $F(1, 53) = 19.60, p < .0001, \eta^2 = .270$. But critically, even when participants had unlimited time to execute their response (and potentially correct any executive control errors), we observed clear evidence of racial bias: the interaction between race and object persisted, $F(1, 53) = 10.39, p = .003, \eta^2 = .164$. As before, when the target was armed, participants mistakenly made *don't shoot* decisions more often if he was White rather than Black, $F(1, 53) =$

[4] Cook's D quantifies the influence that each observation has on the statistical model of interest. Outliers have much greater influence than other cases, yielding large, diagnostic gaps in ordered values of Cook's D (Judd, McClelland, & Ryan, 2011, p. 305).

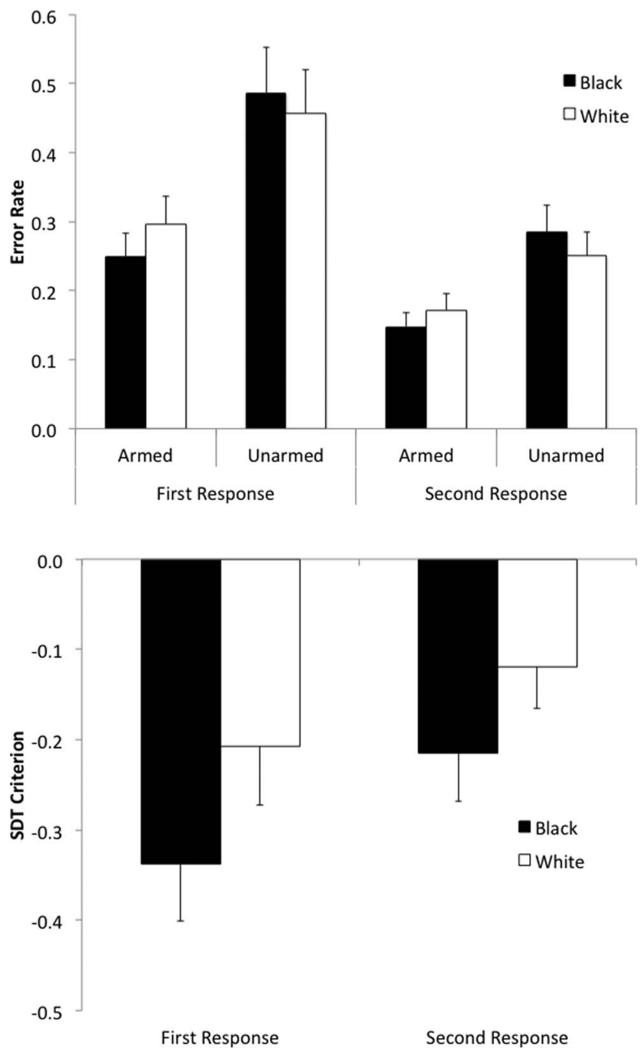

Figure 5. Mean (±SEM) of error rates (top panel) and SDT criteria (bottom panel) by Target Race and Response Order (Study 3).

6.65, $p = .013$, $\eta^2 = .111$. When the target was unarmed, participants mistakenly shot him more often if he was Black rather than White, $F(1, 53) = 4.96$, $p = .031$, $\eta^2 = .086$. (Recall that the simple effect of race among unarmed targets was not significant in the test of the first response, so with respect to this effect, directionally, race is exerting more reliable effects when participants have the chance to deliberate!)

The three-way interaction directly tests the capacity of response order (first vs. second) to moderate racial bias (the Race × Object interaction). The executive failure account predicts that the three-way interaction should be significant, whereas the construal account predicts a null effect. In line with the latter hypothesis, the interaction was not significant, $F(1, 53) = 0.46$, $p = .51$, $\eta^2 = .009$. We do not want to draw conclusions on the basis of a null result (we consider the significant pattern of bias in the second response a more important test of the construal account), but these results show that the Race × Object interaction is approximately as strong for deliberative responses as for speeded responses.

In the full analysis, a main effect of response order also emerged, suggesting that participants were (predictably) more accurate on the second response than on the first, $F(1, 53) = 234.98$, $p < .0001$, $\eta^2 = .816$. We also observed a Response Order × Object interaction, $F(1, 53) = 13.43$, $p = .0006$, $\eta^2 = .202$, suggesting that the effect of object was less pronounced in the second response. These effects offer evidence that some errors were due to control failure, in line with the conclusions of Payne et al. (2005). Nonetheless, the persistent pattern of racial bias in the deliberative response suggests that, whatever control failures occur, they do not fully account for racial bias in the FPST.

Signal detection analysis. As in Studies 1 and 2, we performed an SDT analysis. Parallel to the error rates, the SDT analysis of the first response suggested that participants set a lower criterion to shoot Black targets than White targets, $F(1, 53) = 9.99$, $p = .003$, $\eta^2 = .159$. More importantly, analysis of the second, deliberative response also revealed bias, $F(1, 53) = 9.03$, $p = .004$, $\eta^2 = .146$ (see Figure 5). And, parallel to the analysis of error rates, the capacity of Response Order to reduce this bias (the Response order × Race interaction) was not significant, $F(1, 53) = 0.20$, $p = .66$, $\eta^2 = .004$. The SDT analysis also showed that participants were more conservative and more accurate when given a chance to deliberate. Estimates of both c and d' were higher on the second response than on the first, $Fs(1, 53) > 8.99$, $ps < .005$, $\eta^2 s > .145$.

In the FPST, participants typically shoot unarmed Black targets more frequently than unarmed Whites, and choose not to shoot armed White targets more frequently than armed Blacks (Correll et al., 2002, 2007b). The present study modified the standard procedure to determine whether the effects can be attributed to stereotypic misperceptions of the critical object, or whether they result from failure to execute the intended response. In the present study, participants had ample opportunity to control any unwanted influences and execute whatever response they intended. In addition, we limited exposure to the target stimulus to 175 ms, making it impossible for participants to use the additional time for further scrutiny of visual information. Despite these changes in procedure, participants' responses continued to be influenced by the race of the target and showed clear evidence of bias. Clearly, freedom from time pressure did nothing to eliminate bias in the present experiment. The executive failure hypothesis cannot explain these results.

Although the persistence of stereotype-consistent errors in the absence of time pressure is in clear conflict with the executive failure account, it is consistent with a construal explanation. To the extent that stereotypes shape representation of the percept, additional response time should do little to help participants correct their errors. Participants who mistakenly "see" the cell phone as a gun when it is held by a Black target do not err by incorrectly executing their intended response. Rather, they err by correctly executing an intention that is, itself, incorrect. Such errors in construal of the object cannot be corrected through more careful response execution. They can only be remedied by changes in participants' representation of the object—for example, by additional processing of perceptual information. In the present study, the masking of the target stimulus interfered with such changes in representation. Thus, a construal account of shooter bias predicts precisely the results observed in the present experiment.

Diffusion model analysis. We submitted data from the initial, speeded response to a diffusion model analysis (recall that the diffusion analysis relies on response time distribution, so it makes little sense to apply it to the second, delayed response). The results largely echoed Studies 1 and 2. We observed no effect of race on estimates of the starting point, $F(1, 53) = 0.19$, $p = .67$, $\eta^2 = .004$. There were main effects of race and object on nondecision time, $Fs(1, 53) = 39.26, 6.07$, $ps < .0001, .018$, $\eta^2 = .426, .103$, respectively, but the critical interaction between race and object was not significant, $F(1, 53) = 0.48$, $p = .50$, $\eta^2 = .009$. Turning to drift rate, we found evidence of an object main effect, $F(1, 53) = 23.20$, $p < .0001$, $\eta^2 = .304$, and the predicted Race × Object interaction, $F(1, 53) = 11.30$, $p = .002$, $\eta^2 = .176$ (the main effect of race was not significant, $F(1, 53) = 0.32$, $p = .58$, $\eta^2 = .006$). As in Study 1, participants acquired information more quickly for armed Black targets than for armed White targets, $F(1, 53) = 7.11$, $p = .011$, $\eta^2 = .118$, but they acquired information more quickly for unarmed Whites than for unarmed Blacks, $F(1, 53) = 3.98$, $p = .052$, $\eta^2 = .070$.

Finally, we examined the relationship between the magnitude of the Race × Object interaction for each participant's drift rate estimates (the stereotypic drift rate index) and racial bias in the SDT criteria for both the speeded and the deliberative response. As in Study 1, participants who demonstrated a more stereotypic drift rate showed greater bias in their criteria on the speeded response, $r = .84$, $p < .0001$. This correlation suggests that participants who more rapidly accumulate information for stereotype-congruent targets show more bias in decisions to shoot. This effect may not be particularly surprising because the diffusion model and signal detection estimates both derive from the decision making process during the initial response. It is somewhat more interesting that stereotypic drift rates, which characterize information processing during the initial response, marginally predict racial bias on the subsequent, more deliberative response, $r = .24$, $p = .09$. This trend is in line with the possibility that stereotype-guided visual processing alters the construal of ambiguous stimuli, leading to persistent biases. Overall, Study 3 suggests that, with complex stimuli, genuine misconstrual can occur. Participants seemed to perceive the objects in line with racial stereotypes—connecting the dots in a biased fashion (see Table 2).

General Discussion

In three studies, participants performed a task in which they decided whether or not to shoot Black and White targets who were either armed or unarmed. We were interested in the degree to which the race of the target would influence visual processing by promoting a stereotypic interpretation of the stimulus. In Study 1, we used the diffusion model to examine the speed with which participants accumulated information about the object. Participants gathered evidence more quickly on stereotypic trials than on counterstereotypic trials, supporting the argument that stereotypes can supplement objective information. Study 2 employed eye tracking and found that, on stereotypic trials, participants tended to prematurely terminate their visual search. They were less likely to actually fixate on the object, itself, prior to executing their decision, presumably because race served to augment their interpretation. Finally, in Study 3, participants performed a modified FPST in which they responded twice—once under time pressure and then again, with no pressure. Even on the second response, when participants had unlimited time to respond, they showed a bias to shoot Black targets. Because there was no rush to respond, it is implausible that this bias stems from control failure. On their second, deliberative response, participants should only shoot an unarmed Black target if they actually misperceived the object, and (incorrectly) came to the conclusion that the target was holding a gun. Accordingly, this pattern likely reflects a tendency to genuinely misperceive objects in a stereotype-congruent fashion.

Across all three studies, diffusion model analyses offered evidence that the rate at which participants acquired information about the object was influenced by the target's race. Information about guns accumulated more quickly if the target was Black. Information about cell phones and wallets accumulated marginally more quickly if the target was White. This suggests that stereotypes guided visual processing. However, stereotypic processing did not affect the other critical parameters. We allowed for the possibility that, when trying to reach a decision about the object, quick perception of racial cues would lead participants to adopt a biased starting point, such that the process would start closer to the *shoot* threshold if the target were Black. But we never observed any evidence that start point depended on the target's race. We also tested the possibility that nondecision time might show evidence of stereotypic processing. This pattern might emerge not because participants process visual information in a biased fashion, but rather because stereotypes influence the execution of motor responses (Payne et al., 2005). In all three studies, behavioral tendencies clearly favored the *shoot* response; however, we found no evidence that the magnitude of this bias depended on race. To make sense of the results of our diffusion analyses, it is useful to compare them with other studies examining a variety of processes that affect diffusion model parameters.

Table 2
Mean and Standard Deviation of Error Rates (for Armed and Unarmed Targets), and Signal Detection Estimates (C and d') by Target Race and Response Order (Study 3)

	First response				Second response			
	Black		White		Black		White	
	Mean	StDev	Mean	StDev	Mean	StDev	Mean	StDev
Armed	0.250	0.133	0.297	0.136	0.147	0.085	0.172	0.081
Unarmed	0.487	0.250	0.458	0.240	0.284	0.183	0.250	0.168
C	−0.338	0.441	−0.214	0.470	−0.212	0.391	−0.107	0.340
d'	0.803	0.897	0.743	0.837	1.807	0.723	1.784	0.688

Voss, Rothermund, Gast, and Wentura (2013) conducted a series of studies designed to pit associative priming against response competition effects. Each study involved sequential priming in which participants viewed a prime stimulus followed by a target stimulus. In some studies, participants were asked to perform a categorization task by categorizing the target according to valence or category (e.g., living vs. nonliving). In other studies, they performed a lexical-decision task (LDT), in which the target stimulus was sometimes a word and sometimes a nonword string of letters and participants simply had to indicate whether the target was (or was not) a word. These two tasks differ in an important way (see Wentura & Degner, 2010; Wittenbrink, 2007). In the categorization task, the prime stimulus can promote a tendency that influences responses to the target. For example, a nonliving prime like *bread* may facilitate categorization of other nonliving targets (semantically related like *butter* or unrelated like *pencil*) and inhibit categorization of living targets (e.g., *baker, nurse*). However, in the LDT, this kind of response interference cannot occur. If *bread* facilitates lexical categorization of *butter* and *baker* but not *pencil* or *nurse*, the explanation cannot involve response interference because all four stimuli are real words and therefore require the same response. The LDT can thus provide evidence of interpretive processes (e.g., associative priming) that are unrelated to response execution. In diffusion analyses, Voss and his colleagues consistently showed that interpretive effects were explained by differences in drift rate (but not by nondecision time), whereas response interference was explained by differences in nondecision time (but not by drift rate). In light of this work, the stereotypic drift rates shown in the current studies strongly suggest that race can bias visual processing (not just response execution).

The present data thus strongly suggest that participants can truly *misperceive* simple objects in a manner that is consistent with stereotypic or schematic expectations—that a cell phone or a wallet can actually *look like* a gun in the hands of a Black man (see Eberhardt et al., 2004; Tajfel & Wilkes, 1963). Though this position is congruent with an array of older studies, it seemingly runs contrary to work by Payne et al. (2005). Payne's work suggests that participants *do not misperceive* objects in the WIT.

More than 20 years ago, Bodenhausen and Lichtenstein (1987) showed that perceivers do not rely on stereotypic associations in all situations. The complexity or difficulty of the judgment task and the ambiguity of the available information moderate stereotype application (Darley & Gross, 1983; Kunda & Sherman-Williams, 1993). When the task is complex and the information vague, participants invoke stereotypes to guide interpretation, fostering a more complete (if biased) representation of the situation at hand. The WIT involves stimuli of relatively low complexity. Information that is central to task performance is therefore much more salient. By contrast, in the FPST, the object is small and difficult to see. In our stimuli, the object accounts for roughly 0.2% of the stimulus array and is presented against a complex background (see Figure 4, top panel). The information provided by the target's body and face thus constitutes a much more salient stimulus. To the extent that participants quickly extract racial information but have difficulty apprehending the object, they may employ racial stereotypes to disambiguate the stimulus, "seeing" guns in the hands of Black targets who are actually unarmed. Stereotypes may thus guide visual processing and construal of the information (Bar, 2003). Though we feel these studies offer strong evidence in support of a misconstrual account, it is important to note that misconstrual and control failure are not mutually exclusive. When the object is ambiguous, stereotypes may guide perceptions. But whether or not the object is perceived accurately, stereotypes may influence response tendencies (particularly under time pressure), such that Black stimuli promote more hostile decisions than White stimuli (De Houwer, 2003; Payne et al., 2005).

One important goal of this research in the long run is to understand how processes of perception and response execution unfold for police officers making actual decisions to shoot. One factor that clearly differentiates police from lay people is that officers engage in regular training and qualification in complex shoot/don't shoot scenarios. In their ongoing training, new recruits and officers regularly take part in speeded decision-making drills at the firing range, in video simulations, or even in interactive "house searches" where actors playing criminals actually fire on the trainee using nonlethal (but very painful) ammunition. This training is, of course, intended to improve decision making, and our work with officers suggests that, indeed, officers show less racial bias in the FPST than do untrained community members (Correll et al., 2007b; but see Sim, Correll, & Sadler, 2013, for boundary conditions). The possibility that this reduction reflects training-related changes offers intriguing avenues for future research. For example, we have recently examined officer performance through the lens of the diffusion model, and we find that part of the difference between officers and lay people can be explained by improvements in evidence accumulation on counterstereotypic trials. The implication seems to be that training can help participants more effectively attend to diagnostic information. To the extent that training improves visual processing (Green & Bavelier, 2007), it may offer a powerful tool to reduce the unintended influence of race in law enforcement decisions.

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