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Action Alters Object Identification: Wielding a Gun Increases The Bias to See Guns

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Stereotypes, expectations, and emotions influence an observer's ability to detect and categorize objects as guns. In light of recent work in action-perception interactions, however, there is another unexplored factor that may be critical: The action choices available to the perceiver. In five experiments, participants determined whether another person was holding a gun or a neutral object. Critically, the participant did this while holding and responding with either a gun or a neutral object. Responding with a gun biased observers to report "gun present" more than did responding with a ball. Thus, by virtue of affording a perceiver the opportunity to use a gun, he or she was more likely to classify objects in a scene as a gun and, as a result, to engage in threat-induced behavior (raising a firearm to shoot). In addition to theoretical implications for event perception and object identification, these findings have practical implications for law enforcement and public safety.

Keywords: object perception, common coding, threat perception, guns

Object recognition is not merely an optical phenomenon. Attentional states, beliefs, expectations, and emotions can all influence an observer's ability to detect and categorize objects. In perhaps their most dramatic form, the confluence of these factors can result in the misidentification of firearms that are absent in a scene (e.g., Correll, Park, Judd, & Goyle, 2002; Eberhardt, Goff, Purdie, & Davies, 2004; Greenwald, Oakes, & Hoffman, 2003; Payne, 2001). Such effects are not limited to the laboratory, however, and, at their extreme, can result in tragic outcomes. Highlighting just one example out of many[1], in 1999, Amidou Diallo, an unarmed African American, was shot 41 times by New York City police officers who perceived him as brandishing a gun rather than showing his wallet. While racial stereotypes and prior expectations regarding criminal guilt may have lowered the perceptual criterion for gun identification, recent work on action-perception interactions suggests another unexplored factor that may be critical in the perception of objects: the action choices available to the perceiver. In our example above, could the mere act of wielding firearms have biased the officers to misperceive Diallo's actions? As we will see, the answer to this question has both practical and theoretical consequences.

One reason to explore a link between actions and object recognition stems from the theory of event coding (Hommel, Musseler, Aschersleben, & Prinz, 2001). This theory posits that both perceptual and action-based representations arise from a common code. Under this view, perception and action planning involve shared processes that can facilitate or inhibit each other. For example, planning or executing directional hand movements influences the perceived directional motion and orientation of an object (Müsseler & Hommel, 1997; Zwickel, Grosjean, & Prinz, 2007). Similarly, the ability to identify tools is disrupted if the motor processes required to act on the tools are otherwise engaged (Witt, Kemmerer, Linkenauger, & Culham, 2010). Critical to the current experiments, if an object is being used to make a response, that object will be incorporated into the action representation and have consequences for perceptual processing (Iriki, Tanaka, & Iwamura, 1996; Miles & Proctor, 2011). Thus far, however, the theory of event coding has been discussed in terms of feature codes and feature dimensions (see Hommel, 2009). Common coding effects have been primarily demonstrated with regard to the perception of orientation, direction, color, and spatial location. It is not known, therefore, whether the mechanisms captured by the theory of event encoding play a role in the determination of object *identity*. We test this possibility here by asking whether planning an action that involves a gun could influence perceptual detection of the presence

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[1] This is not an isolated incident. Other examples where officers shot and killed individuals after mistaking common objects for firearms include Deandre Brunston (Los Angeles, CA, 2003, shoe); Berry Millsap (Tacoma, WA, 2007, cordless drill); Khiel Coppin (New York, NY, 2007, hairbrush); Bernard Monroe (Homer, LA, 2009, drink bottle); Douglas Zerby (Long Beach, CA, 2010, hose nozzle); Flint Farmer (Chicago, IL, 2011, cell phone); Phillip Trimble (Mesa, AZ, 2011, cell phone); and Reed Turner (Kokomo, IN, 2011, cologne bottle).

of other guns, just as planning a directional movement influences perceptual detection of directional stimuli.

Another reason to suppose that wielding a firearm might influence object categorization stems from the action-specific account of perception which argues that people perceive their surrounding environment in terms of their ability to perform an intended action (Witt, 2011). For example, people with broader shoulders perceived doorways to be narrower (Stefanucci & Geuss, 2009), softball players with higher batting averages perceived the ball to be bigger (Witt & Proffitt, 2005), and targets presented well beyond reach looked closer when observers could interact with them using a laser pointer (Davoli, Brockmole, & Witt, 2012). Even observing other individuals perform actions affects one's perception of distance and speed (Bloesch, Davoli, Roth, Brockmole, & Abrams, in press; Witt, Sugovic, & Taylor, in press). According to this account, then, individual variability in body type (Linkenauger, Witt, Bakdash, Stefanucci, & Proffitt, 2009; Linkenauger, Witt, & Proffitt, 2011; Stefanucci & Geuss, 2009), performance ability (Cañal-Bruland & Van der Kamp, 2009; Witt & Sugovic, 2010), and intended behavior (Bekkering & Neggers, 2002; Vishton et al., 2009; Witt, Proffitt, & Epstein, 2004, 2005, 2010) scale optical information related to an object's distance, size, orientation, and speed. However, as with the theory of event encoding, it is not known whether action abilities influence the perception of an object's identity. If effects like those described above extend beyond basic psychophysical judgments to higher-order visual tasks such as object categorization, then people holding guns may view the world as a shooter, with optical information biased toward perceiving potential threats. As a result, the criteria used to classify objects could be altered, leading to a bias to identify firearms in a scene.

Although the theory of event encoding and the action-specific account of perception provide a theoretical basis upon which one can ask whether action influences object recognition, the theories, in their present form, have not made strong claims about this relationship. Hence, the first theoretical goal of this study was to determine whether action does indeed influence object recognition. Finding this to be the case, our second theoretical goal was to determine which account best explains these effects. The theory of event encoding predicts that the mere act of using an object should have consequences on perception whereas the action-specific account argues that it is not enough to use an object; instead, perception would only be altered to the extent that an object modifies an observer's action capabilities. In the experiments that follow, we contrast these two accounts.

Experiment 1

In Experiment 1 we asked whether observers holding guns adopt different criteria for categorizing objects in the visual field. Participants determined whether a person in a photograph held a gun or a neutral object. They did the task while also holding a gun or a neutral object, and made their response with the held object. We examined if the object used to respond influenced their ability to detect guns.

Method

Participants. Thirty-four students at Purdue University were recruited through the participant pool and awarded credit for their participation. Each provided informed consent.

Stimuli and apparatus. Stimuli were taken from Correll et al. (2002) and depicted people holding guns or neutral objects. The pictures depicted scenes from 20 different locations. For each location, multiple stimuli were created. A background version did not contain a person. Four target versions contained either a White or a Black person holding either a gun or a neutral object. The person always held the object to one side, and never pointed it at the camera. Stimuli were presented on a 19" monitor. Responses were made by raising or lowering a Nintendo Wii Magnum Gun or a foam ball (12 cm in diameter) from a single-button mouse. The mouse was mounted to an incline plane so that movements were unrestricted in either direction (see Figure 1).

Procedure. Participants were randomly assigned to either the hold-gun or the hold-ball condition. Those in the hold-gun condition were given the Wii gun, and those in the hold-ball condition were given the foam ball. Participants were instructed to hold the object in their dominant hand. On each trial, participants stood in front of the display and positioned the object they were holding on the mouse to initiate the trial. A fixation cross then appeared, and after a random delay ranging from 200−800 ms, a background image was presented. Following a random presentation duration ranging from 300−500 ms, the background image was replaced by the target image that contained a person holding a gun or a neutral object. If participants perceived a gun, they were instructed to raise their object and point at the screen. If participants perceived a neutral object, they were instructed to lower their object and point at the floor. The time to respond was registered by virtue of the mouse button being released when the held object was moved. The target image was presented until participants made a response or for a maximal duration of 850 ms. An experimenter watched and recorded participants' movements as "up," "down," or "hesitation." Hesitation movements occurred when participants changed their direction of motion during the movement and were coded as

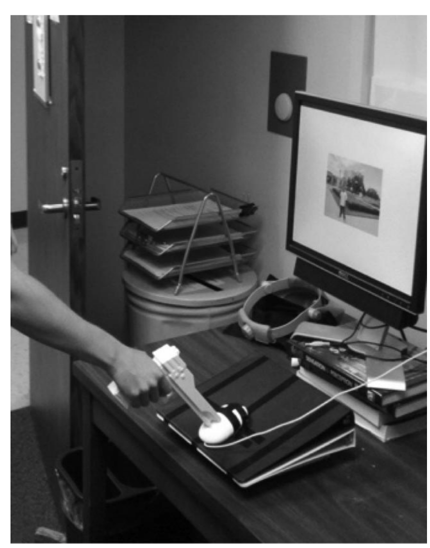

Figure 1. Experimental set-up. Participants positioned a Wii gun (shown) or a rubber ball (not shown) on a mouse. In Experiments 1, 2, and 4 participants responded up if they perceived a gun and down if they perceived a neutral object. In Experiments 3 and 5, participants responded down if they perceived a gun.

errors (<1% of trials). The experimenter could only see the participant, not the display screen, so the experimenter did not know whether each stimulus contained a gun or a neutral object. Participants were instructed to wait until they knew which direction to move and then make the movement without changing directions. If they continued to make hesitation responses, the experimenter reminded them to wait until they knew which direction and then to make the movement without changing directions.

Prior to beginning the experimental trials, participants completed 18 practice trials to familiarize themselves with the task and method of responding. The background image was a rectangle that was blue, red, or green. After the delay, an arrow pointing either up or down appeared on top of the rectangle which signaled which way the participant should move the object in their hand.

Results and Discussion

Gun detection performance was measured using a nonparametric signal detection approach to contrast hit and false alarm rates. Signal discriminability was measured by A′, which ranges from .5 (chance discrimination) to 1 (perfect discrimination). Response bias was measured by B″. In the current study, negatively signed B″ values indicate a bias to respond "gun present" while positively signed values indicate a bias to respond "gun absent." Absolute values of B″ indicate the strength of the bias. B″ could not be calculated for four participants who had perfect accuracy in one of the conditions. These analyses showed that A′ scores did not differ across groups, $t(32) = 1.02$, $p = .32$ (hold-gun: $M = .95$, $SD = .04$; hold-ball: $M = .94$, $SD = .05$). Hence, perceptual sensitivity was the same for those holding a gun and those holding a ball. However, analysis of B″ showed that those wielding the gun exhibited a stronger bias to report "gun present" compared to those holding a ball, $t(32) = 2.36$, $p = .02$ (see Figure 2). From this evidence, then, the categorization of objects held by others is affected by the objects held by observers.

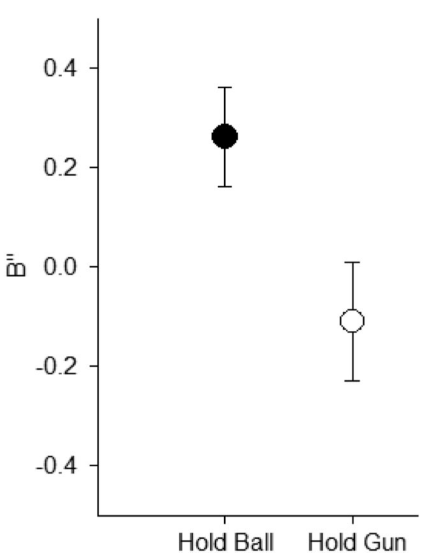

Figure 2. Results from Experiment 1. Bias (as measured by B″) to report "gun present" is plotted as a function of the object held (gun or ball). A lower value indicates a greater bias to report "gun present." Error bars are 1 SEM.

In addition to response biases, we also examined reaction times (RTs) which showed that responses were not, overall, affected by the type of object held by the participants, $F(1, 32) < 1$ (hold-gun: $M = 585$ ms, $SE = 10$; hold-ball: $M = 606$ ms, $SE = 11$). Replicating prior research (e.g., Payne, 2001), however, participants responded faster when a gun was present in a scene ($M = 560$ ms, $SE = 10$) than when it was absent ($M = 634$ ms, $SE = 11$), $t(33) = 16.63$, $p < .001$. However, participants made different movements when they detected a gun (move up) and when they detected a neutral object (move down). To determine if the faster response when a gun was present was due to the presence of a gun and not to difference in the movements, we analyzed RTs during the practice trials for which participants simply moved in response to arrows pointing up or down. We found that participants were faster to move up ($M = 389$ ms, $SE = 8$) in response to arrows than to move down ($M = 418$ ms, $SE = 7$), but the difference between the movements (29 ms) was significantly smaller than the difference when responding to guns compared to neutral stimuli (74 ms), $F(1, 33) = 32.52$, $p < .001$, $\eta_p^2 = .50$. So while there may be inherent differences in the speed with which an observer can initiate an upward movement relative to a downward movement, there seem to also be differences in the speed to respond to guns versus neutral stimuli.

In addition to the above analyses, we took the opportunity to determine whether the bias and RT effects were moderated by race given that the stimulus set we used in this experiment was originally developed to assess the effects of race on the detection of weapons in a scene (Correll et al., 2002). In terms of bias, B″ was not affected by race, $F(1, 28) < 1$ (see Table 1). The interaction between race and held object was also not significant, $F(1, 28) < 1$. In terms of RTs, there was again no main effect of race, $F(1, 32) < 1$. A trend for an interaction between race and the type of object held by the actors did emerge however, with RTs somewhat faster when a gun was held by a black actor and when a neutral object was held by a white actor, $F(1, 32) = 2.85$, $p = .10$, $\eta_p^2 = .08$ (see Table 1). None of the interactions involving the participants' held object were significant, $Fs(1, 32) < 1$. Collectively, these results suggest that the race of the actor in the scenes did not moderate participant's response choices, although it may have affected their response times.

Generally, our finding related to race contrasts with a number of investigations that have shown a bias to perceive Black people as holding a gun (Correll et al., 2002; Eberhardt et al., 2004). It is important to note, however, that these previous investigations have typically used very different methods of responding to those employed in the current study (e.g., press one button to shoot and another button to indicate the choice to not shoot), which may make across-study comparisons difficult as the nature of an observer's response choices have been shown to influence how stimuli are coded (e.g., Hommel et al., 2001). Because issues of race are not central to the current investigation, we will not belabor the point here, but future work should consider the types of response choices available to the perceiver and how that affects the coding of the stimuli with respect to race.

Experiment 2

To ensure the replicability of the findings obtained in Experiment 1, we repeated the experiment with a new stimulus set and a within-subjects design.

Table 1
On the Left, Mean B" are Presented as a Function of Race and Held Object in Experiment 1. A Lower Value Indicates a Greater Bias to Report "Gun present." On the Right, Mean RTs are Presented as a Function of Race and Target Object. Standard Error is Presented in Parentheses

	Held object (B")		Target object (RTs)	
Target race	Gun	Ball	Gun	Neutral
Black	.05 (.15)	.18 (.13)	557 (10)	637 (12)
White	−.02 (.16)	.26 (.14)	560 (11)	629 (11)

Method

Participants. Thirty-eight students at Purdue University received course credit in exchange for participation. All provided informed consent.

Stimuli and apparatus. Photographs of a person wearing a black ski mask and holding a gun or a shoe at 19 locations were presented (see Figure 3). The person always pointed the object at the camera (as in Figure 3). Mirror-reversals of each image were created for a total of 76 images. The apparatus was the same as in Experiment 1.

Procedure. In this experiment, participants held both the gun and the ball in separate blocks of trials. Participants were randomly assigned to start in the hold-gun or the hold-ball condition.

Participants initiated each trial by positioning the object on the mouse. Then a fixation cross was presented for a random duration ranging from 200–800 ms followed by the image of a person holding a gun or a shoe. The image remained until the participant made his or her pointing response. The response was the same as in Experiment 1: Point to the screen if they detected a gun and point to the ground if they detected a shoe. Participants completed one block of trials holding one object and one block holding the other object. Each block consisted of all 76 images presented twice for a total of 152 trials per block. Prior to the experimental trials, participants completed 12 practice trials with arrows as stimuli to get used to making the type of response required. As in Experiment 1, an experimenter coded the participants' movements. The experimenter could not see the display with the stimuli, and just recorded whether participants moved up, down, or with a reversal of movement direction.

Results and Discussion

Data were analyzed using nonparametric signal detection measures. Once again, the object held by the participant did not affect A′, $t(37) < 1$ (Ms = .97, SDs = .02), but participants were more biased to respond "gun present" when they also held a gun than when they held the ball, $t(37) = 2.26$, $p = .03$ (see Figure 4). As in Experiment 1, wielding a gun increased the bias to see guns.

Figure 3. Sample stimuli from Experiments 2 and 5.

An interesting contrast between these results and those obtained in Experiment 1 can be drawn in that participants in Experiment 2 were biased to report "gun present" in both conditions, ts(37) > 6.04, ps < .001. The nature of the stimuli used in this experiment (i.e., a closely foregrounded person wearing a ski mask and pointing an object toward the camera) may have led to an overall bias to report "gun present." This increase is consistent with other work documenting an influence of the priming of concepts related to threat on detection of guns (e.g., Payne, 2006). What is critical for the purpose of the present article is whether there were any differences in this bias as a function of the object being wielded by the participant at the time of the judgment. Indeed, the results suggest that this object influences their responses. Furthermore, the result that the change in bias persists even as priming of threat concepts increases suggests that the effect of responding with an object may be additive with the effect of priming concepts.

Response time analysis (see Table 2) indicated that participants were faster to respond when the picture contained a gun than when it contained a neutral object, $F(1, 37) = 28.08$, $p < .001$, $\eta_p^2 = .43$. In this experiment, participants were also faster when they held the gun than when they held the ball, $F(1, 37) = 9.29$, $p < .01$, $\eta_p^2 = .20$. The interaction between held object and target was also significant, $F(1, 37) = 20.60$, $p < .01$, $\eta_p^2 = .36$. Participants were faster to respond when a gun was present than when a shoe was present both when they held a ball, $t(37) = 2.87$, $p < .01$, and when they held a gun, $t(37) = 6.05$, $p < .001$. When viewing a gun, participants were faster when they also held a gun than when they held a ball, $t(37) = 4.53$, $p < .001$. However, when viewing a shoe, participants were just as fast when holding a gun as when holding a ball, $t(37) = 1.38$, $p > .17$. Wielding the gun made participants more biased to act as if they had seen a gun and

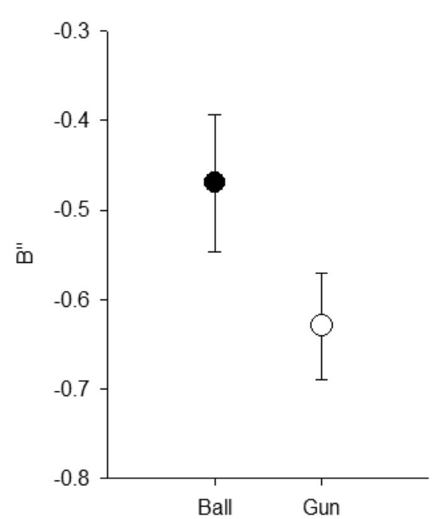

Figure 4. Results from Experiment 2. Bias (as measured by B″) to report "gun present" is plotted as a function of the object held (gun or ball). A lower value indicates a greater bias to report "gun present." Error bars are 1 SEM.

Table 2
Mean RTs in ms (Standard Error in Parentheses) for Experiment 2

	Target Object	
Held object	Gun	Shoe
Gun	570 (14)	601 (16)
Ball	600 (14)	611 (14)

quicker to make this judgment; however, wielding a gun did not impair their ability to discriminate the depicted object, as indicated by the similar A's as when holding a ball.

The results in this experiment corroborate those from Experiment 1. Wielding a gun influenced participants' behavior in detecting whether or a not a gun was present. In particular, holding a gun increased their bias to detect a gun. In the following experiments we sought to determine the mechanism that underlies this bias.

Experiment 3

The principle purpose of Experiment 3 was to determine whether the observer's increased bias to report that a gun is present when also holding a gun is due to a perceptual bias or response-based bias. That is, we sought to determine whether the apparent increased bias to detect guns when wielding a gun was due to an increased bias to simply raise one's arm when holding a gun. Any such motor bias to lift up a gun regardless of the viewed stimulus would generate the patterns of results presented in Experiments 1 and 2. To assess this possibility, Experiment 3 replicated the design of Experiment 1 except that participants lowered their arms toward the ground when they saw a gun and lifted their arms up toward the monitor when they saw a neutral stimulus. If the results reported above stem from a perceptual bias, participants should continue to show stronger biases to report "gun present" when holding a gun compared to a ball. If the previous results are due to an increased motor bias to lift a gun, then the bias should be reversed and participants who hold a gun should appear to be more biased to report "neutral object present."

Method

Sixty-one students at Purdue University participated in exchange for course credit. All gave informed consent. All aspects of the experiment were the same as in Experiment 1 except that participants were instructed to point at the ground when they saw a gun and to point at the screen when they saw a neutral object. An experimenter who could not see the stimuli recorded their movements.

Results and Discussion

A′ and B″ scores were calculated as before. Five participants did not follow instructions and responded up for gun instead of down (the experimenter could not correct participants because the stimuli were out of her view) and their data were removed prior to analysis. Two additional participants in the hold-gun condition had either an A′ score or a B″ score that differed from the group mean by at least 1.5 standard deviations. Their data was also removed.

Participants in the hold-gun condition showed reduced A′ scores (M = .88, SD = .05) compared with participants in the hold-ball condition (M = .95, SD = .03), $t(52) = 5.77$, $p < .001$. This could be due to differences in perceptual discriminability due to having to perform the difficult task of lowering one's weapon in the presence of a gun. Alternatively, the incongruent movement with the gun may have increased response difficulty, not necessarily perceptual performance. A third and likely possibility is that reduced ability to discriminate could reflect a speed–accuracy tradeoff. Participants in the hold-gun condition were also faster than participants in the hold-ball condition, $F(1, 52) = 10.51$, $p < .01$, $\eta_p^2 = .17$ (hold-gun: M = 625 ms, SE = 10; hold-ball: M = 670 ms, SE = 10).

Despite the differences in A′ and participants' self-reported difficulty with the task, observers who responded with the gun did not adopt a "neutral object present" bias as a motor bias would predict. In fact, there was still evidence that participants who responded with the gun were more biased to report "gun present" compared with participants who responded with the ball. An independent-samples t test revealed a significant effect of hold condition on the bias to report "gun present," $t(52) = 1.66$, $p = .05$ (one-tailed), d = .50 (hold-gun: M = .15, SD = .25; hold-ball: M = .30, SD = .40). B″ scores were calculated with respect to detecting a gun, so a lower value indicates a greater bias to report "gun present." As in the previous experiments, participants who held and responded with the gun were more biased to respond "gun present" than did participants who responded with the ball. The current results suggest that the bias found in Experiments 1 and 2 is not due just to a bias in the type of response. Specifically, the bias does not arise just from an increased bias to move a gun up (additional converging evidence for this conclusion is presented in Experiment 5).

Experiment 4

Experiment 4 examined whether the biases observed in previous experiments are dependent on using the gun or if the bias would also be apparent when a gun is present but not used by the participant during the task. It is well-established that the activation of situationally and personally relevant schemas affects the categorization of objects. Objects are easier to identify when they appear in typical contexts or locations (e.g., Biederman, Mezzanotte, & Rabinowitz, 1982; Biederman, Rabinowitz, Glass, & Stacey, 1974; Palmer, 1975), and when they are consistent with stereotypes evoked by the individuals present (e.g., Correll et al., 2002; Eberhardt et al., 2004; Payne, 2001, 2006) because the thresholds needed to identify an object as belonging to a particular category are lowered. For example, Eberhardt and colleagues (2004) showed that among both undergraduates and police officers, black faces influenced participants' ability to spontaneously detect degraded images of crime-relevant objects. Just as priming a stereotype affected categorization thresholds, it is possible that holding a firearm could also affect categorization thresholds in a similar manner by activating schemas associated with shooting, crime, and/or threats. The activation of these schemas would lower the thresholds necessary for determining a match between perceived features and object categories such as firearms. According to this account, the mere presence of a particular object in the environment can give rise to perceptual biases toward similar objects. If true, similar biases should be obtained when the firearm is present but not being used to respond. On the other hand, if the biases observed in the previous experiments depend on use of the firearm, these biases should disappear when the gun is present but not used to respond. Such a finding would suggest that tools such as guns need to be incorporated into an action representation in order to influence perception and object identification.

Method

Participants. Forty students at the University of Notre Dame participated in exchange for course credit. Participants gave informed consent.

Stimuli and apparatus. To provide greater realism, and to engender greater confidence in the interpretation of a theoretically motivated null-result, the Wii gun used in Experiments 1–3 was replaced with a .177 Caliber CO_2 powered Crossman C11 BB pistol (see Figure 5). This firearm was rendered nonfunctional by the Notre Dame Security Police Department. The stimuli were the same as in Experiment 1. As shown in Figure 5, the experiment was conducted on equipment analogous to that used in the Experiments 1 and 2 (e.g., the stimuli were presented on a 19" LCD monitor and responses were made using a single button mouse resting on an inclined plane).

Procedure. Participants were randomly assigned to either the gun-absent or gun-present conditions. For those in the gun-absent condition, no gun was physically present in the testing room. Participants assigned to the gun-present condition first consented to participating in an experiment where a nonfunctioning firearm would be present in the room during testing. After providing this consent, the experimenter removed the firearm from a locked gun safe in full view of the participant. The participant was shown the gun and the experimenter reiterated the fact that despite its appearance, it was nonfunctional (participants were not permitted to handle the firearm). The experimenter then set the gun on the table in front of the participant so that it leaned against the monitor on which they viewed the stimuli (see Figure 5). The gun, therefore, remained in full and conspicuous view throughout the entire experiment.

Figure 5. Experimental set-up for Experiment 4. Participants responded with a ball, but for one group of participants, a gun was present and visible near the display throughout the experiment (as shown here).

In both conditions, observers held the ball when making their responses. As in the previous experiments, observers positioned the ball on the mouse after which a stimulus was presented. They were instructed to raise their arm and point to the monitor if they detected a gun in the image and to lower their arm and point to the ground if they detected a neutral object. All other aspects of the procedure, including the timing of experimental events, were the same as in Experiment 1.

Results and Discussion

In terms of signal detection measures, A′ scores did not differ across groups, $t(38) < 1$ (gun-present: $M = .97$, $SD = .01$; gun-absent: $M = .97$; $SD = .02$). Likewise, and most importantly, B″ scores were equivalent across groups, $t(38) < 1$. When a gun was present in the environment, but not used by the participants, B″ scores averaged .24 ($SD = .61$). When guns were completely absent from the testing environment, B″ scores averaged .23 ($SD = .63$). This bias is similar to that found in the hold-ball condition in Experiment 1.

As in Experiment 1 and prior research (Payne, 2001), responses were elicited faster when a gun was present in the display ($M = 684$ ms, $SD = 145$ ms) compared to cases where no gun was displayed in the image ($M = 756$ ms, $SD = 141$ ms), $F(1, 38) = 11.37$, $p < .01$. That said, response times were unaffected by whether or not a gun was present in the testing environment, $F(1, 38) = 1.19$, $p = .28$, and these factors did not interact $F(1, 38) < 1$.

The presence of a conspicuously placed gun in the testing room did not result in a change in the bias to perceive guns in the hands of others. This result stands in stark contrast to the results obtained in Experiments 1 and 2 and implies that visual object-priming or visual matching cannot account for the results obtained previously. Instead, actions incorporating the gun are necessary for perceptual biases to ensue. Given that the concept of "gun" was already primed in many ways (instructions indicated the response participants should make when they see a gun and stimuli depicted guns 50% of the time), the presence of a real gun did not lead to any additional priming or schema activation that further influenced the bias to detect guns. Instead, the previously found bias is dependent on wielding and using the gun to make the response.

Experiment 5

According to the action-specific perception account of perception, the biases reported in Experiments 1–3 emerged because tools changed the action capabilities of the observer. Guns clearly afford different actions than balls, and as such, perceivers view the world differently in each case. It is possible, however, that these effects have less to do with action capabilities as they do with congruency between objects used by the observer and objects present in an environment.

To distinguish between these possibilities, in Experiment 5, participants held a shoe or a ball (rather than a gun and a ball) and viewed the images from Experiment 2 of a person holding a shoe or a gun. If the bias depends on functional changes to the perceiver's action capabilities, holding a shoe should not create the same increase in bias to see shoes as did holding a gun on detection of guns. However, if the bias is independent of functional changes and depends instead on congruency between the used and viewed objects, then there should be an increased bias to detect shoes when holding a shoe.

Method

Forty-four students at Purdue University viewed the same stimuli as in Experiment 2. The procedure was exactly the same as in Experiment 2 except for the objects that were held and for the direction of the responses. Participants held the ball for one block of trials and an orange gym shoe for the other block of trials. In addition, participants were instructed to point up at the screen when the person in the photograph was holding a shoe and to point down to the ground when the person in the photograph was holding a gun. When holding the shoe, participants held it on the heel and used it to point with the toe of the shoe.

Results and Discussion

Signal detection measures were calculated with respect to participants' ability to determine if a shoe was present. Discrimination, as measured with A′, was unaffected by the object held, $t(43) = -0.12$, $p > .91$ (*M*s = .94, *SD*s = .04−.05). However, when holding the shoe, participants showed an increased bias to report: "shoe present" than when holding the ball, $t(43) = 2.69$, $p = .01$ (see Figure 6). This finding suggests that the previously found changes in bias are a function of the object used to respond but do not rely on a change in action capabilities. For the most part, wielding a shoe does not change the actions that the participants could perform. However, holding the shoe was encoded into their response representation, and this influenced subsequent detection of similar objects. This result rules out an action-specific account of these effects, which predicted only increased bias when holding objects that change the functional abilities of the perceiver. The results also suggest that the bias is not due to inherent responses with each object. Holding a shoe presumably does not trigger an upward motion, yet we found a similar increased bias to respond "shoe present" as the increased bias to respond "gun present" when holding a gun. Thus, the results corroborate the conclusion from Experiment 3 that the bias is inherent in the detection, not the response itself.

Participants responded faster when they viewed a shoe than when they viewed a gun, $F(1, 43) = 82.38$, $p < .001$, $\eta_p^2 = .66$ (see Table 3). This was unexpected as previous results (Experiments 1–4; Payne, 2001) revealed faster times when viewing a gun. However, the result may also be due to a difference in time to move up versus time to move down. When we looked at the practice data in which participants responded to an up or down arrow, we found that participants were faster to initiate an upward movement ($M = 436$ ms, $SE = 19$) than a downward movement ($M = 468$ ms, $SD = 17$). This difference (32 ms) is approximately the same difference between moving down to indicate gun minus moving up to indicate shoe (33 ms). Thus, the apparently faster times to detect a shoe may be due to the type of movement needed to make the response rather than the stimulus per se. Response times did not differ when they held a ball than when they held a shoe, $F(1, 43) = 1.79$, $p = .19$, and the interaction between held object and target object was not significant, $F(1, 43) < 1$.

The results from this experiment extend the results from Experiments 1–3 by demonstrating that the bias is not specific to guns per se, nor is the bias even specific to tools. One possible explanation is that participants may be more biased to detect a pose that matches the anticipated response. However, this explanation cannot account for all of our data because the images in Experiments 1 and 3 depicted people holding objects off to one side, and thus, never matched the posture of the response. Similarly, the response with the shoe (hold the heel and point the toe) did not match the pose of the person holding the shoe, which was held in the middle and oriented sideways. However, while posture-matching cannot explain all of our results, it might contribute to some of the effects and should be further investigated. Instead, we think the current results are best explained by the theory of event coding (Hommel et al., 2001). We expand on this idea in the General Discussion.

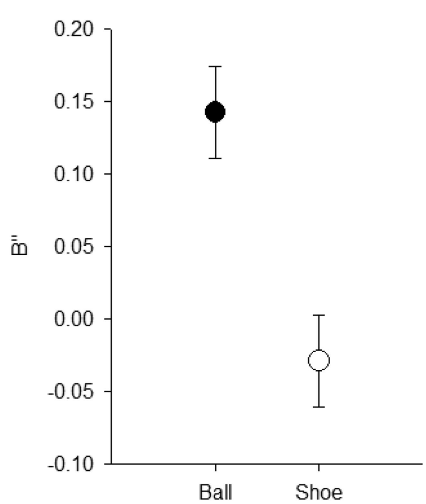

Figure 6. Results from Experiment 5. Bias (as measured by B″) to report "shoe present" is plotted as a function of the object held (shoe or ball). A lower value indicates a greater bias to report "shoe present" and a higher value indicates a greater bias to report "gun present." Error bars are 1 SEM.

General Discussion

The familiar saying goes that when you hold a hammer, everything looks like a nail. The apparent harmlessness of this expression fades when one considers what happens when a person holds a gun. We have shown here that, having the opportunity to use a gun, a perceiver is more likely to classify objects held by others as guns and, as a result, to engage in threat-induced behavior (in this case, raising a firearm to shoot).

What mechanism gives rise to this bias? One possibility is that it arises from either perceptual or conceptual priming. According to this account, holding a gun could lead observers to adopt particular expectations regarding the presence of firearms. For example, just as stereotypes can evoke a bias to report "gun present," so might the mere presence of a gun in the environment. This explanation, however, is not supported by our data. While using a gun to respond to the stimuli increased participants' bias to see guns, the conspicuous presence a real gun that was never used did not alter the bias to detect guns. Thus, the presence of a gun did not evoke additional priming above and beyond the images and nature of the task, suggesting that action is critical to this perceptual bias.

Table 3
Mean RTs in ms (Standard Error in Parentheses) For Experiment 5

	Target object	
Held object	Gun	Shoe
Ball	627 (9)	593 (9)
Shoe	618 (10)	585 (10)

In the introduction, we outlined two separate means by which action may alter object identification. The first was the theory of event coding which posits that both perceptual and action-based representations arise from a common code. As such, planning an action with a given object or tool should bias observers to identify similar objects, a contention supported by our data. Just as planning an action that involves a gun influenced the perceptual detection of the presence of other guns, planning an action with a shoe influenced perceptual detection of shoes. What of the action-specific account of perception? This account argues that psychophysical judgments of dimensions such as distance, size, or speed are correlated with the perceiver's ability to act. Hence, it is the modification of an observer's action capabilities that is critical. The fact that both holding guns (tools which clearly change one's capabilities when interacting with objects and people) and shoes (objects that do little to change one's capabilities when not worn on the feet) altered perception is, therefore, less consistent with this hypothesis. At a minimum, this result challenges the possible extension of action-specific effects beyond perception of spatial properties to higher-order visual processes such as object identification.

While the current results fit best with the theory of event coding (Hommel et al., 2001), it is important to note two ways in which the present data refine and extend the theory's claims. First, the current results extend the theory of event coding by demonstrating common codes influence object identification, not just feature detection. Prior to the experiments reported here, the theory of event coding has been tested in tasks where observers judge the orientation, direction, color, or spatial location of objects. Here, we suggest it is likely that the same mechanisms captured by such tasks also play a role in the determination of object identity. Second, our results demonstrate an effect of common codes on acting *with* an object, not just acting *on* an object. In previous research, responses were coded based on features such as spatial location (e.g., left or right) or the color of the button to be pressed. Here again, we have documented that common coding effects occur not just for the feature of the response, but also for objects used to make a response (see also Miles & Proctor, 2011). Together, our findings suggest that common coding representations are pervasive, and include many—if not all—types of actions, and influence many—if not all—aspects of perception.

The practical implications of the current results are also clear. It is true that the action-induced biases we observed were not specific to guns. That said, while the bias created by holding a shoe is benign, the act of wielding a firearm raises the likelihood that nonthreatening objects will be perceived as threats. This bias can clearly be horrific for victims of accidental shootings. According to the American Civil Liberties Union, approximately 25% of all law enforcement shootings involve unarmed suspects and, although it is impossible to derive a precise number, it is certain that many similar accidental shootings occur among private citizens. It is, therefore, in the public's interest to determine the factors that can lead to accidental shootings as well as measures to reduce the impact of these factors. While several factors including one's beliefs and expectations have been previously identified, the current results indicate that the mere act of wielding a firearm raises the likelihood that nonthreatening objects will be perceived as threats. This bias is also detrimental for the armed officers and soldiers who act violently after mistakenly thinking they saw a gun. Public gun safety and police training courses should incorporate these findings into their training protocols.

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