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Curt A. Carlson
Texas A&M University-Commerce

David F. Young
Texas A&M University-Commerce

Dawn R. Weatherford
Texas A&M University-San Antonio, dawn.weatherford@tamusa.edu

Maria A. Carlson
Texas A&M University-Commerce

Jane E. Bednarz E. Bednarz
Texas A&M University-Commerce

See next page for additional authors

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Authors
Curt A. Carlson, David F. Young, Dawn R. Weatherford, Maria A. Carlson, Jane E. Bednarz E. Bednarz, and Alyssa R. Jones

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The Influence of Perpetrator Exposure Time and Weapon Presence/Timing on Eyewitness Confidence and Accuracy

Curt A. Carlson[1], David F. Young[1], Dawn R. Weatherford[2], Maria A. Carlson[1], Jane E. Bednarz[1], & Alyssa R. Jones[1]

[1]Texas A&M University – Commerce

[2]Texas A&M University – San Antonio

Author Notes

Curt A. Carlson (corresponding author), Department of Psychology, Counseling, & Special Education, Texas A&M University – Commerce, Commerce, TX 75429, Phone: (903) 468-8723, Fax: (903) 886-5510, curt.carlson@tamuc.edu.

Abstract

Crimes can occur in a matter of seconds, with little time available for an eyewitness to encode a perpetrator's face. The presence of a weapon can further exacerbate this situation. Few studies have featured mock crimes of short duration, especially with a weapon manipulation. We conducted an experiment to investigate the impact of weapon presence and short perpetrator exposure times (3 versus 10 s) on eyewitness confidence and accuracy. We found that recall concerning the perpetrator was worse when a weapon was present, replicating the weapon focus effect. However, there was no effect on eyewitness identification accuracy. Calibration analyses revealed that all conditions produced a strong confidence-accuracy relationship. Confidence-Accuracy Characteristic curves illustrated almost perfect accuracy for suspect identifications at the highest levels of confidence. We conclude that weapon presence during a brief crime does not necessarily result in negative consequences for either eyewitness identification accuracy or the confidence-accuracy relationship.

Keywords: eyewitness identification, weapon focus effect, encoding time, confidence and accuracy

The Influence of Perpetrator Exposure Time and Weapon Presence/Timing on Eyewitness Confidence and Accuracy

In 1993, Stephen Lawrence was attacked by a small group of individuals in the UK. He was pummeled with fists and stabbed with a knife, in an attack lasting approximately 10 s (AETN UK, 2015). More recently, on January 4th, 2016, a man entered a fast food restaurant in Huntsville AL, pointed a gun at the cashier and demanded that the register be emptied. Seconds later, the perpetrator was gone (Thornhill, 2016).

It is well known that eyewitness identification is highly error-prone (for reviews, see Clark & Godfrey, 2009; Deffenbacher, Bornstein, Penrod, & McGorty, 2004; Meissner & Brigham, 2001; Wells & Olson, 2003). The brief duration of these two crimes likely made eyewitness identification even more difficult. There were several witnesses to the Stephen Lawrence murder, but none could make an accurate identification. Valentine, Pickering, and Darling (2003) found that 36% of crimes committed in London from January-September 2000 involved eyewitnesses who viewed the perpetrator for less than 1 min. Police in the US do not typically ask about the duration of a crime (e.g., Federal Bureau of Investigation National Incident-Based Reporting System, 2000; Force Science Institute, 2016; South Carolina Law Enforcement Division, 2004), but it is reasonable to assume a similar proportion of brief crimes. The length of exposure time to a face has been investigated by researchers, leading to a recent meta-analysis of facial identification studies, which found a significant relationship between encoding time and accuracy, even for short exposures of seconds rather than minutes or longer (Bornstein, Deffenbacher, Penrod, & McGorty, 2012).

We conducted an experiment to investigate encoding time within a short time span (3 versus 10 s), and also to manipulate weapon presence. Very little research has investigated the impact of perpetrator versus weapon exposure time on eyewitness identification (Kramer, Buckhout, & Eugenio, 1990). We will explore the effect of these estimator variables (Wells, 1978) on eyewitness recall, identification, and the confidence-accuracy relationship. We had two general goals: (a) assess the impact of weapon presence during a short crime, both on eyewitness recall of crime details and identification from a lineup; (b) continue recent research on the effect of weapon presence on the confidence-accuracy relationship. Before delving into our study, we will briefly describe the eyewitness identification literature involving perpetrator exposure time, followed by manipulations of weapon presence. Lastly, we will bring the reader up to speed on the current state of the field regarding eyewitness confidence and accuracy, and describe theoretical motivations.

Exposure Time to the Perpetrator

Studies of facial recognition have established that the ability to discriminate between targets and foils increases with longer encoding times for targets (e.g., DiNardo & Rainey, 1991; Light, Kayra-Stuart, & Hollander, 1979; Mueller, Carlomusto, & Goldstein, 1978). Bornstein et al. (2012) confirmed this with a meta-analysis, including 24 face recognition experiments and six eyewitness identification experiments (see their Table 1). There was a significant effect of encoding time on recognition accuracy for both samples. For the purpose of the present study, we were interested in the exact encoding times manipulated across these studies. Based on our interest in encoding times spanning seconds rather than minutes, we counted only those that did not exceed 60 s for their “long” encoding time condition. Of the six eyewitness identification experiments, two qualified (30 vs. 60 s for Meissner, Tredoux, Parker, & MacLin, 2005; 12 vs. 45 s for Memon, Hope, & Bull, 2003). All of the 24 face recognition experiments also fell within this range. Our comparison of 3 to 10 s encoding time fits well with these studies, as 14 of the 24 face recognition studies compared encoding times of under 10 s. However, our study will be the first to manipulate such brief encoding times with an eyewitness identification paradigm.

We will expand upon the findings of these studies in several ways. First, we will focus on the influence of encoding time on the confidence-accuracy (CA) relationship. Even though accuracy could improve within this short window (3 vs. 10 s encoding time), it is unknown how the CA relationship will be affected. We will discuss our expectations after describing the relevant CA literature. Second, the sample sizes across the six eyewitness identification experiments analyzed by Bornstein et al. (2012) were generally low (ranging from 14 to 34 per cell); we utilized a larger sample (average of 177/cell) to detect effects even within this short window. Finally, none of these studies included a manipulation of weapon presence, the importance of which we describe next.

Weapon Presence and Timing

Since the first experimental test of weapon presence on eyewitness identification by Loftus, Loftus, and Messo (1987; cf. Johnson & Scott, 1976), there has been evidence of a weapon focus effect (WFE). Generally, it is signified by worse eyewitness recall and recognition of various aspects of the crime scene and perpetrator when a weapon is present (e.g., Hope & Wright, 2007; Kramer, Buckhout, & Eugenio, 1990; Mitchell, Livosky, & Mather, 1998; Pickel, 1998). Historically, the effect on eyewitness identification has been less robust (e.g., Kramer et al., 1990; see meta-analysis by Fawcett, Russell, Peace, & Christie, 2013). However, four experiments have recently found that eyewitness identification accuracy does indeed decline for crimes involving a weapon (Carlson & Carlson, 2012, 2014; Carlson, Dias, Weatherford, & Carlson, in press; Erickson, Lampinen, & Leding, 2014). Two of these will be discussed in greater detail below.

In their meta-analysis of the WFE literature, Fawcett et al. (2013) included exposure duration as a factor. They found a significant WFE even for short encoding durations operationalized as 10 s or less. This effect size did not differ from “long” exposure of over 60 s, but both short and long exposure effect sizes were smaller than “intermediate” exposure of 10 to 60 s. Only two studies were shown to have manipulated weapon exposure time (Cutler, Penrod, & Martens, 1987; Kramer et al., 1990), both of which had certain limitations that will be addressed in the present study. Cutler et al. compared different exposure times to both perpetrator and weapon, but did not separate the two. Due to this confounding, it is not possible to evaluate the separate influence of encoding time for the perpetrator’s face versus the weapon. We separate these variables in the present study.

Kramer et al. (1990) conducted a series of experiments similar in several ways to the present study. In their first experiment, they presented a mock crime scenario in the form of a slide presentation, ending with a man striking another man in the head with a bottle. The only difference was in the timing of presentation of the bottle. In the experimental condition, it was visible the entire time with the perpetrator; in the control condition, the perpetrator’s face was visible for several seconds before he presents the bottle from behind his back. The experimental condition yielded lower recall of most details about the perpetrator (e.g., height, weight, age, facial features), in replication of the WFE. However, there was no difference in the ability to pick the perpetrator from a perpetrator-present lineup. In additional experiments (2a-d), Kramer et al. manipulated the presentation timing of a target’s face versus a central object he carried (cleaver or magazine) across a series of slides. Four separate experiments investigated the following conditions: (a) face and object visible for all slides; (b) object visible first, then target removes a mask to reveal his face for remainder of slides; (c) face visible first, then object is revealed and present for the remainder of the slides; and (d) face visible first, then object is shown briefly then hidden for remainder of the slides. Memory for the slides was tested with both a questionnaire and a target-present lineup in each experiment. They found a WFE for eyewitness recall of details from the slides in all but the last experiment. As in their first experiment, they did not support the WFE for eyewitness identification from target-present lineups.

There were some limitations to these experiments from Kramer et al. (1990), particularly involving methodology and power. Only target-present lineups were tested, which provide half of the data required for estimates of eyewitness accuracy (whether defined as diagnosticity, probative value, or discriminability); both correct identifications from target-present lineups and false identifications from target-absent lineups are required. Regarding power, Kramer et al. had the following sample sizes in each cell of Experiments 1 and 2a-d, respectively: 32, 32, 16, 24, and 21. The corresponding power to detect an effect, based on the effect size ($g = 0.22$) for laboratory studies of the WFE on eyewitness identification reported by Fawcett et al. (2013), ranges from .52 to .73. Due to this lack of power (Wilcox, 2001), it is possible that their null effects for eyewitness identification were Type II errors. The present experiment included an average of 177/cell, which boosted power to .99 (based on calculations using G*Power 3; Faul, Erdfelder, Lang, & Buchner, 2007).

Erickson et al. (2014) addressed many of these limitations (see also Carlson & Carlson, 2012, 2014). They conducted a large ($N = 1263$; about 70/cell) experiment involving the timing of a neutral object (empty glass), unusual object (rubber chicken), or weapon (fake but realistic-looking gun) during a slide presentation. Participants played the role of a bartender in an online game, viewing slides featuring customers as they ordered drinks. The object/weapon was shown either just before, during, or after the slide with the target individual. Presentation time of the target and object/weapon was not manipulated; each slide was presented for 2 s. Immediately after the slide presentation, and only a few seconds after viewing the target, participants were presented with either a target-present or –absent simultaneous lineup followed by some questions about the slides, target, and object/weapon. Confidence in the lineup decision was also collected, but not reported. They partially supported the WFE in the "during" condition (weapon/object and target person on same slide), such that correct identification rate was lower for the weapon compared to the neutral object, but false identification rates were no different. However, this effect on correct identifications was not significant overall when including the other two timing conditions (before, after). In other words, for correct identifications, the WFE was stronger when both weapon and target were present concurrently. However, stronger evidence in support of the WFE came in the form of false identifications from TA lineups: there were more for the weapon compared to the neutral object when all three timings (before, during, after) were combined.

We sought to continue in the spirit of Erickson et al. (2014) by conducting a well-powered study including all relevant conditions in one experimental design for the sake of easier comparison among conditions. We also addressed limitations present in either Kramer et al. (1990) or Erickson et al. First, Erickson et al. presented the lineup immediately after their slides. In order to align our design with the majority of the eyewitness identification literature, we included a distractor task of several minutes between our mock crime video and the lineup. This way, we tested long term rather than short term memory, corresponding better to real world lineups being presented after a retention interval. Also, neither Kramer et al. nor Erickson et al. presented confidence data. We extended the investigation of perpetrator versus weapon encoding time, and weapon presentation timing, by additionally focusing on the CA relationship rather than eyewitness identification accuracy alone.

The Confidence-Accuracy Relationship and the Optimality Hypothesis

The CA relationship for eyewitness identification has historically been analyzed by computing a point-biserial correlation coefficient between two levels of accuracy as a categorical variable (correct versus incorrect) and confidence on a scale (e.g., 0-100% or a Likert scale). Early research revealed widely varying CA correlations (see reviews by Bothwell, Deffenbacher, & Brigham, 1987; Deffenbacher, 1980). Later research continued to find a wide range of correlation coefficients, such as .07 (Wells & Murray, 1984), -.11 (Read, Vokey, & Hammersley, 1990, Experiment 1), .37 (Read et al., 1990, Experiment 2), and .41 (see meta-analysis by Sporer, Penrod, Read, & Cutler, 1995). It is now understood that the CA relationship is much stronger for those who identify someone from a lineup (correctly or incorrectly), compared to those who reject the lineup (Sporer et al., 1995).

Correlation coefficients have been used to provide some support for the *optimality hypothesis*, which suggests that the CA relationship should be stronger under more optimal encoding conditions, such as longer encoding times (Deffenbacher, 1980). In a meta-analysis of 35 studies, Bothwell et al. (1987) observed a modest but unreliable effect of face exposure time on the CA relationship. They concluded that the optimality hypothesis could be better evaluated by conducting studies that did not depend on the point-biserial correlation coefficient. Shortly thereafter, Read et al. (1990) found that increases in exposure duration did increase the strength of the CA relationship, but this pattern was again shown with correlation coefficients.

One of the goals of the present study is to provide tests of the optimality hypothesis with calibration analysis. The point-biserial correlation coefficient is an impoverished and misleading representation of the CA relationship (Roediger, Wixted, & DeSoto, 2012). Juslin, Olsson, and Winman (1996) applied calibration analysis instead, which, unlike correlation coefficients, breaks down the CA relationship across levels of confidence and accuracy separately. Calibration curves can be represented using this analysis, typically depicting some estimate of proportion correct (e.g., correct IDs/(correct + false IDs)) across levels of confidence (see Figure 1). This way, it can easily be determined whether a group of participants are well-calibrated across different levels of confidence (e.g., are those who indicate 90% confidence actually 90% accurate on average?). Calibration analysis and accompanying curves are now regularly utilized in eyewitness identification studies (e.g., Brewer, Keast, & Rishworth, 2002; Brewer & Wells, 2006; Carlson et al., in press; Palmer, Brewer, Weber, & Nagesh, 2013; Sauer, Brewer, Zweck, & Weber, 2010; Weber & Brewer, 2004).

Like Read et al. (1990), Palmer et al. (2013) studied the impact of exposure duration (5 vs. 90 s) on the CA relationship, but utilized calibration analysis. Those who viewed the target for 5 s were more over-confident in their lineup identification than those who viewed the target for 90 s. However, those who chose someone from the lineup under the 5 s condition actually produced higher resolution than those who chose someone after viewing the target for 90 s. This means that those in the 5 s condition elicited confidence levels that better discriminated between accurate and inaccurate identification decisions, which contrasts with the optimality hypothesis. One goal of the present study is to see if this finding will replicate within a shorter and tighter time frame (3 vs. 10 s encoding duration).

In an application of calibration analysis to a WFE experiment, Carlson et al. (in press) found that eyewitnesses could actually be better calibrated after viewing a crime involving a weapon, also in contrast to the optimality hypothesis. They found that the confidence provided by participants who saw a gun in their mock crime video, and then chose from the lineup, was better calibrated with identification accuracy than the confidence provided by those who did not see the weapon. However, all three conditions (weapon visible, concealed, or absent) yielded strong resolution. The present study will provide tests of the optimality hypothesis in the same spirit as Palmer et al. (2013) and Carlson et al., such that we will also utilize calibration analysis while investigating encoding duration and weapon presence.

Predictions

Based on recent experiments finding a WFE after brief exposure to a perpetrator (Carlson & Carlson, 2012, 2014; Carlson et al., in press; Erickson et al., 2014), we also expected to find a WFE. Specifically, when the weapon is visible for the entirety of the "long" condition (10 s), performance should be worse than a condition in which the perpetrator is visible for the same amount of time, but there is no weapon present. We sought to replicate the WFE in terms of both recall (with a memory questionnaire about the mock crime video) and recognition in the form of eyewitness identification from perpetrator-present and –absent lineups. We will also determine whether or not a WFE will occur when the perpetrator's face is visible for several seconds before the weapon is shown, in continuation of work by Kramer et al. (1990) and Erickson et al. (2014). This condition is similar to the concealed weapon condition from Carlson et al. (in press), which they found did not produce a WFE. However, ours is not a pure concealment condition, as the perpetrator eventually shows the weapon.

In terms of confidence and accuracy, the optimality hypothesis predicts a stronger relationship after better encoding conditions (Deffenbacher, 1980). This leads to two predictions for the present study: (a) encoding time of 10 s should yield a stronger CA relationship than 3 s, and (b) the relationship should be stronger when there is no weapon present, controlling for encoding time (i.e., 10 s without weapon should be better than 10 s with weapon). However, regarding weapon presence Carlson et al. (in press) found the opposite effect, with participants actually best calibrated after viewing a weapon. We will provide a similar test of the optimality hypothesis to determine its level of support versus a replication of Carlson et al.

After summarizing their findings regarding the effect of perpetrator exposure time on eyewitness identification, Memon et al. (2003) concluded, “The most important point is that if a witness has only seen a stranger’s face for just 12 s, their identification decision is likely to be highly unreliable” (p. 350). As described below, we will present confidence-accuracy characteristic (CAC) curves in addition to calibration curves, in order to provide another useful look at the CA relationship (Mickes, 2015). Essentially, CAC curves are designed for triers of fact to easily ascertain how accurate eyewitnesses are based on their confidence. In contrast to Memon et al., we predict that participants who report a very high level of confidence (after choosing from a lineup) will tend to have a very high level of accuracy in their lineup decision, regardless of a brief encoding time. This result would fit well with CAC curves based on other estimator variable manipulations (Carlson et al., in press; Mickes, 2015; Wixted, Read, & Lindsay, in press).

Method

Participants

Two U.S. universities provided participants ($N = 1619$) from their respective pool of undergraduate psychology students. We obtained ethical approval for the experiment from each university’s IRB. After removing participants who either did not complete the experiment ($n = 142$) or could not answer manipulation check questions correctly ($n = 62$), we were left with 1415 participants (75% female; *M* age = 20.9, *SD* = 5.6; 65% Caucasian, 18% African-

American, 8% Hispanic/Latino, 8% Other/Undisclosed) for analysis. See Table 2 for the number of participants in each condition. There was not a great disparity in the overall number of participants eliminated across conditions (*M* = 25.5, *SD* = 2.83, range: 23-32), or in the number removed for missing the manipulation check questions (*M* = 7.75, *SD* = 0.46, range: 7-8). There was no difference in the below patterns of results when including the 62 who did not pass the manipulation check.

Materials

The second author recorded a mock-crime video with a tripod-mounted HD camera (see Figure 2 for static images) depicting a woman sitting on a park bench surrounded by trees. Several feet in the bench's background, and towards the right of the frame, is a large tree behind which the culprit is initially hiding. In all conditions, he comes out from behind the tree, approaches the woman, steals her purse, and runs away. Each version of the video lasts approximately 25 s. The distance between the perpetrator and the camera is about 3 m when he comes out from behind the tree, and then about 1.5 m when he is next to the victim. We manipulated the presence of a handgun and how much time the culprit is visible, across four versions: (a) visible for 10 s, no weapon; (b) visible for 10 s, gun in right hand during the entire video; (c) visible for 10 s, gun in pocket for first 8 s, then pulled out and pointed at victim just prior to taking the purse and running away (conceptual replication of Experiments 1 and 2c by Kramer et al., 1990); and (d) visible for 3 s, with gun in his right hand during the entire video. We realize that both 3 s and 10 s are very short encoding times. However, previous WFE research has utilized similar encoding times (e.g., 2 s in Erickson et al., 2014; 12-18 s in Kramer et al., 1990). In addition, based on pilot testing with our short retention interval (5-10 minutes), we found that both encoding times resulted in reasonable correct and false identification rates that were well above chance.

We took a photo of the culprit several days after recording the videos, to serve as his mugshot in the lineup. Based on a basic description of the culprit (Caucasian male in his 20's with long brown hair covering his forehead), a research assistant found matches in the Florida Department of Corrections (2015) offender database. We selected five of these faces to serve as foils in the perpetrator-present lineup, and an additional six to serve as foils in the perpetrator-absent lineup. In other words, we employed a different-foils design (e.g., Carlson, Gronlund, & Clark, 2008; Carlson & Carlson, 2012, 2014; Gronlund, Carlson, Dailey, & Goodsell, 2009; Meissner et al., 2005; see Clark & Tunnicliff, 2001). We did not select a face to serve as a designated innocent suspect. A group of 50 undergraduates read the description of the culprit, and then viewed each of these lineups, choosing the person who best matched the description. Based on their choices, we calculated the effective size of each lineup with Tredoux's *E'* (Tredoux, 1998). This statistic ranges from 1 to the nominal lineup size (6 in this case). The closer the value is to six, the fairer the lineup. Both our perpetrator-present lineup (*E'* = 4.07, 95% CI: 3.14-5.79) and our perpetrator-absent lineup (*E'* = 4.65, 95% CI: 3.74-6.13) were reasonably fair.

Procedure

SurveyMonkey hosted the experiment for all participants, and they could take part from any computer except a mobile device. Following random assignment to condition and informed consent, they read instructions to pay close attention to a video on the following screen. After the video, participants worked on anagrams of U.S. states for 5-10 minutes. They were then instructed that the upcoming lineup may or may not contain the perpetrator from the video, and that they could either choose someone or reject the lineup. The lineup members were presented in a 2x3 photo array. Immediately following the lineup, participants entered their confidence on a 0-100% scale (presented in 10% increments). They were then presented with 11 forced-report questions testing their memory for various aspects of the video, including the victim, perpetrator and peripheral details like the bench and surrounding objects. Two of these questions were general manipulation questions: “What crime occurred in the video?”, “Did the perpetrator have a gun?”. Finally, participants answered demographic questions concerning their sex, age, and race/ethnicity.

Design

We implemented a 4 (video version: 10 s of culprit with no weapon, 10 s of culprit with gun in hand, 10 s of culprit with gun shown only at the end, 3 s view of culprit with gun in hand) x 2 (perpetrator-present versus –absent lineup) between-subjects design. Due to the large number of participants needed for analysis, we did not undertake a fully crossed factorial design (encoding time fully crossed with weapon presence and timing). We focused on the conditions of greatest relevance to our hypotheses rather than analyzing a complete theoretical space.

Results

Eyewitness Recall

We first calculated an overall recall score for each participant based on the questionnaire about the mock crime (see Table 1). Based on the WFE literature, this kind of measure should be particularly sensitive to the presence of a weapon (Fawcett et al., 2013; Steblay, 1992). There were nine questions about various elements of the video. For example, we asked for the color of the victim’s jacket. Both fine-grained (e.g., beige) and more course-grained (e.g., light colored) responses were deemed acceptable. Two independent raters scored each correct response as a 1, and each incorrect response as a 0 (κ = .946, p < .001). The proportion correct for each participant was averaged across participants within each condition (collapsed across perpetrator-present versus –absent lineup) so that we could conduct a one-way ANOVA with planned comparisons.

The primary comparison is between the 10 s condition with the weapon present the entire time versus the 10 s condition with no weapon. We predicted lower recall accuracy for the weapon present condition, in replication of the WFE. There was an effect of condition on overall recall, $F(3, 1412) = 18.48$, $p < .001$. This effect was driven entirely by the short exposure (3 s) condition, which produced lower recall than the three 10 s conditions ($p < .001$ for each comparison). A separate one-way ANOVA on just the three 10 s conditions revealed no differences ($p = .17$), contrary to what might be expected based on the WFE.

However, this analysis included all questions about the video, including what took place before, during, and after the perpetrator was present. A more targeted analysis would focus on questions regarding the perpetrator, as these are particularly sensitive to the WFE (e.g., Hope & Wright, 2007). We had only one question specific to the perpetrator, regarding what he was wearing. We expected to replicate the WFE by finding fewer accurate descriptions from those in the 10 s weapon condition compared to the 10 s no weapon condition.

As with overall recall score, we again collapsed across perpetrator-present and –absent lineups. We then conducted a logistic regression, which revealed differences across conditions in the number of descriptions coded as accurate, Wald (3) = 37.34, $p < .001$. In replication of the WFE (e.g., Pickel, 1998; Pickel, Ross, & Truelove, 2006), there were more accurate descriptions for the no weapon condition compared to the condition in which the weapon is shown the entire time, controlling for exposure time (10 s), $\chi^2(1, N = 723) = 13.76$, $p < .001$, $\phi = .14$. A secondary prediction was that the 10 s condition in which the weapon is shown only after the perpetrator is visible for several seconds could also produce a WFE. This was confirmed (in replication of Kramer et al., 1990), such that there were fewer correct descriptions compared to the no weapon condition, though the effect was not as strong, $\chi^2(1, N = 723) = 4.46$, $p = .038$, $\phi = .08$.

Eyewitness Identification

See Table 2 for counts and proportions of correct IDs, foil IDs, and rejections. Our manipulations had no effect on either correct IDs from perpetrator-present lineups, Wald (3) = 1.08, $p = .78$, or on false IDs from perpetrator-absent lineups, Wald (3) = 0.60, $p = .90$. Foil IDs from perpetrator-present lineups also were not affected, Wald (3) = 4.48, $p = .21$. To more directly assess the WFE, we conducted a chi-square analysis comparing just the 10 s weapon condition (visible the entire time) to the 10 s no weapon condition. This also revealed no difference, either for correct IDs ($\chi^2(1, N = 348) = 0.15$, 1-tailed $p = .39$) or for false IDs ($\chi^2(1, N = 375) = 0.004$, 1-tailed $p = .52$).

Though contrary to our hypotheses, it is not uncommon to find no WFE on eyewitness identification (see Fawcett et al., 2013; Steblay, 1992). A single recognition test in the form of a lineup is not as sensitive of a memory measure as a series of recall questions (Pickel, 2007; Steblay, 1992). However, recent studies involving both perpetrator-present and –absent lineups have found a WFE for eyewitness identification (Carlson & Carlson, 2012, 2014; Erickson et al., 2014)[1]. We come back to this issue in the General Discussion. For now, we will turn to our dependent variable of primary interest: the confidence-accuracy relationship.

[1] In addition to separate analysis of correct versus false identifications, as we present here, Carlson and Carlson (2014) also utilized Receiver Operating Characteristic (ROC) analysis to analyze them together with confidence to determine the influence of weapon presence on the objective ability of their participants to discriminate between the guilty suspect and innocent suspects (e.g., Gronlund, Wixted, & Mickes, 2014; Mickes, Flowe, & Wixted, 2012; Wixted & Mickes, 2012). We also applied ROC analysis to our data, but found no differences among conditions, in line with our results from analyzing correct identifications separately from false identifications. Due to these null

Calibration Analysis and Confidence-Accuracy Characteristic Curves

We depict the calibration curves for choosers in Figure 1. Proportion correct is defined here as correct IDs/(correct IDs + false IDs), where correct IDs are perpetrator IDs from the perpetrator-present lineup, and false IDs include all IDs from the perpetrator-absent lineup. Table 3 contains the calibration statistics (choosers only): calibration, over/under confidence, and resolution. These are all measures of monitoring accuracy from the eyewitness metacognition literature (see Hollins & Weber, 2016), but it is important to note that high calibration does not necessarily imply high resolution, or vice versa, as they represent different metacognitive skills. Specifically, they differ in either representing the correspondence between the subjective and objective likelihood of being correct (calibration and over/under confidence) or the distance between the distributions of confidence ratings for correct and incorrect responses (resolution). In other words, calibration (*C*) represents how close confidence is to accuracy across the entire range of confidence. A cursory examination of Figure 1 reveals that all conditions produced fairly good calibration, as the curves do not stray far from the diagonal line of perfect calibration. *C* ranges from 0-1, and as a curve aligns closer to the diagonal, it approaches zero, which indicates better calibration. Over/under confidence (*O/U*) is a related index of the CA relationship, as it essentially restates calibration with a direction. Again considering the CA relationship across the entire confidence range, if a curve strays more often above the diagonal, this indicates under-confidence (because accuracy is usually higher than confidence). In contrast, over-confidence is represented by a curve dipping below the diagonal. O/U ranges from -1 to 1, with negative numbers representing under-confidence, and positive numbers indicating over-confidence. Lastly, resolution can be seen in the slope of each curve. If there appears to be a

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results, and the fact that we want to focus on the confidence-accuracy relationship, we do not present the ROC curves in this paper. However, we do include an Appendix with the ROC analysis for the interested reader.

strong positive slope, this means that the confidence judgments are discriminating well between accurate and inaccurate identifications. In other words, low confidence is associated with low accuracy, and high confidence is associated with high accuracy. Resolution ranges from 0-1, with 1 representing a perfect discrimination between correct and incorrect identifications based on confidence judgments. There are several measures of resolution, and we chose the Adjusted Normalized Discrimination Index (Yaniv, Yates, & Smith, 1991). Brewer & Wells (2006) provide a more detailed description of each of these CA indices.

Based on the optimality hypothesis (Deffenbacher, 1980), we could expect better calibration and resolution with longer encoding time (10 s with weapon compare to 3 s with weapon) and with no weapon compared to weapon present. Each statistic is presented in Table 3 with inferential 95% confidence intervals (e.g., Palmer et al., 2013); if there is no overlap, then there is a significant difference. These results could be interpreted as partial support for the optimality hypothesis, such that the no weapon condition did yield better calibration and resolution than the weapon condition, controlling for encoding time (10 s). In addition, seeing the perpetrator and weapon for 10 s produced better calibration and resolution than seeing them for 3 s. However, these numerical differences were not statistically significant based on the overlap of inferential confidence intervals. Therefore, we conclude that, despite manipulations of weapon presence, timing, and exposure duration, the CA relationship remained strong for all conditions. These findings replicate general trends in recent studies showing a strong CA relationship across estimator variable manipulations such as encoding duration (Palmer et al., 2013), weapon presence (Carlson et al., in press), and retention interval (Wixted et al., in press).

Another useful way of portraying the CA relationship is with Confidence-Accuracy Characteristic (CAC) curves (Mickes, 2015). There are two main differences between CAC and calibration curves. First, proportion correct for calibration curves typically include all IDs made from the perpetrator-absent lineup (but see Carlson et al., in press). In contrast, CAC curves are based only on suspect IDs (guilty suspect IDs/guilty suspect IDs + innocent suspect IDs). If there is no designated innocent suspect, as in the present study, then the number of foil IDs from the perpetrator-absent lineup is divided by the nominal lineup size (six) in order to arrive at an estimated number of innocent suspect IDs (given a fair lineup). This way, the emphasis is placed on IDs most relevant to the criminal justice system. Second, rather than comparing each condition to perfect calibration across the entire range of confidence and accuracy, CAC analysis simplifies this space in two ways: (a) confidence on the x-axis is collapsed into usually three bins representing "low" versus "moderately-high" versus "very high" confidence (Mickes, 2015), and (b) the y-axis is usually truncated to show proportion correct ranging from approximately .5 – 1 (Mickes, 2015; Wixted et al., in press). Therefore, the emphasis is placed on relatively high confidence and accuracy.

Figure 3 presents the CAC curves from the present study. The strong CA relationship indicated by the calibration curves is no longer as clear, as all eyewitnesses were accurate regardless of confidence when just suspect IDs are represented. Specifically, even those who provided fairly low confidence (0-60%) were reasonably accurate (82-87%). However, those who provided the highest levels of confidence (90-100%) were even more accurate (97-99%), $z = 2.99$, $p = .001$. This link between very high confidence and very high accuracy has now been replicated across estimator variable manipulations such as encoding time (the present study and Palmer et al., 2013), weapon presence and concealment (Carlson et al., in press), retention interval between encoding and identification procedure (see Wixted et al., in press), and across system variables such as lineup presentation (simultaneous vs. sequential) and showups (Mickes, 2015). Though not as robust as the link between very high confidence and very high accuracy, it is not uncommon to also see the pattern from the present study of low confidence suspect IDs being relatively accurate as well (Mickes, 2015; Wixted et al., in press).

General Discussion

The present study is the first to systematically manipulate perpetrator versus weapon encoding time in an experimental design testing both perpetrator-present and perpetrator-absent lineups (cf. Kramer et al., 1990). In support of the weapon focus effect (WFE), memory for the perpetrator's clothing was better when no weapon was present. However, contrary to predictions, we did not find a WFE for eyewitness identification from perpetrator-present or perpetrator-absent lineups. We also investigated the confidence-accuracy (CA) relationship, finding that all conditions produced a strong relationship regardless of our manipulations of encoding time or weapon presence. As described next, our findings fit well within the broader eyewitness literature and fill some important gaps.

Eyewitness Recall and Recognition

First, it should not be too surprising that we found a WFE for eyewitness recall but not eyewitness identification, as this supports findings from two meta-analyses of the WFE literature (Fawcett et al., 2013; Steblay, 1992). Much of the literature has not found an effect on eyewitness identification (e.g., Hulse & Memon, 2006; Kramer et al., 1990; Pickel, 1998, 1999; Pickel, French, & Betts, 2003; Shaw & Skolnick, 1994). However, recent studies have found an effect, which led us to take a close look at methodological differences between our study and these others.

Four recent experiments have supported the WFE with short exposures to a perpetrator and weapon (Carlson & Carlson, 2012, 2014; Carlson et al., in press; Erickson et al., 2014).

Three of these studies depicted the event from a first-person point-of-view (POV; Carlson & Carlson, 2012, 2014; Erickson et al., 2014), but Carlson et al. (in press), like the present study, utilized a more typical third-person POV. This led us to focus more on the distance of the perpetrator and weapon (when present) from the POV. Our perpetrator (and weapon, when present) was visible from 1.5 to 3 m from the camera, yielding a greater average distance than these other studies. Erickson et al., in their slide presentation, showed the target individual and weapon directly in front of the participant's point of view, acting as a bartender viewing a customer ordering a drink. Carlson et al. (in press) showed their perpetrator and weapon from no more than 1.5 m away. Carlson and Carlson (2012, 2014) initially showed the perpetrator about 3 m away, but he runs up to be directly in front of the participant's point of view for the duration of the crime (a physical assault of the participant from victim POV).

It is possible that the WFE could be contingent upon a fairly close view of the perpetrator and weapon, at least for crimes of very short duration. This would qualify the common view of attorneys and judges that eyewitness memory is necessarily weakened by the presence of a weapon during a crime (Desmarais & Read, 2011). Future research should systematically manipulate weapon presence and distance in order to address this issue. To our knowledge, no research has explored the potential interaction between these two estimator variables.

As for the timing of weapon presentation, we replicated findings from an early study that also manipulated this factor (Kramer et al., 1990). Our participants provided more accurate descriptions of the perpetrator's clothing when there was no weapon present, compared to the condition in which he showed the weapon after already being visible for about 8 s. Overall encoding time for the perpetrator was the same across these two conditions (10 s). Similarly, Kramer et al. (Experiment 2c) found improved recall of details from their slide presentation when there was no weapon, compared to when a weapon was presented after the target had been visible for several seconds. However, they found no effect of weapon presentation timing on eyewitness identification from a perpetrator-present lineup (Experiments 1 and 2c), and we replicated this non-significant difference with greater power as well as with both perpetrator-present and –absent lineups. Again, this pattern mimics the general literature by finding a WFE with a recall measure but not with eyewitness identification.

Erickson et al. (2014) also manipulated the timing of weapon presentation, finding a WFE when both weapon and face were presented concurrently, but not when the weapon was shown before the face or afterward. The most similar comparison from the present study is our 10 s condition in which the weapon and face are both present for the same amount of time versus the 10 s condition in which the perpetrator's face is visible for about 8 s prior to showing the weapon. This is analogous to the "during" versus "after" weapon conditions from Erickson et al. Unlike them, we found no differences in terms of eyewitness identification or recall. However, our manipulation of timing was not as extensive as in their study, and we leave it to further research to continue exploring this issue.

This brings us to a weakness of the present study: our incomplete experimental design. Due to a practical issue of obtaining a sufficient number of participants per cell of the design, we did not establish every combination of a full factorial design. This resulted in three 10 s conditions (including weapon present and absent) and one 3 s condition (weapon present only). One important condition left out of the design was a 3 s condition with no weapon present. It would have been informative to compare this condition with the 10 s condition with no weapon, in order to provide a purer comparison of the effect of perpetrator encoding time. This would serve as a clearly applied goal as well as provide another test of the optimality hypothesis

(Deffenbacher, 1980). We leave it to further research to tackle this important issue as well.

Eyewitness Confidence and Accuracy

Turning now to the CA relationship, we found that our participants were generally well-calibrated, slightly under-confident, and produced confidence judgments that discriminated well between accurate and inaccurate choices. Other than the fact that our participants were slightly under-confident, whereas those in Palmer et al. (2013) were over-confident, our findings align fairly well with their comparison of 5 s to 90 s encoding, as they found a strong CA relationship regardless of this manipulation. Similarly, Carlson et al. (in press) found a strong CA relationship across weapon manipulations (absent, concealed, or visible). However, their visible weapon condition actually produced better calibration than did their no weapon condition, whereas we found no difference between these two conditions. It is unclear what could be creating this discrepancy, but, as noted above, it could be tied to the difference in distance of the perpetrator from the participant's point of view (greater than 1.5 m in the present study; less than 1.5 m in Carlson et al.). If the WFE on eyewitness identification accuracy is influenced by perpetrator distance, the CA relationship could be as well. This speculation should be explored with additional research.

Confidence-accuracy characteristic (CAC) curves create another perspective on the CA relationship. They indicate that, at least when confidence is collected immediately after a lineup decision under fairly controlled conditions, participant-eyewitnesses are generally accurate with their suspect identifications, and especially so when reporting the highest levels of confidence. Our results correspond with other eyewitness identification studies (Carlson et al., in press; Mickes, 2015; Wixted et al., in press), as well as studies of eyewitness event memory (e.g., Kebbell, Wagstaff, & Covey, 1996), in showing that participant-eyewitnesses who indicate 90-

100% confidence tend to be accurate within that range as well.

Conclusions and Practical Implications

There are two applied implications of the present study. First, the weapon focus effect is apparently smaller, and perhaps non-existent, for eyewitness identification after a very short crime (Fawcett et al., 2013). The inconsistent WFE for eyewitness identification has been known for some time, but this study is the first to find no effect even with high power and both perpetrator-present and –absent lineups. The implication is that, at least for crimes of short duration in which the perpetrator is several meters from the eyewitness, a weapon might have less impact on eyewitness identification. Therefore, we agree with Bornstein et al. (2012) that police should ask eyewitnesses about the duration of a crime.

Second, and of broader importance, is the fact that confidence was again found to be a strong indicator of eyewitness accuracy (e.g., Brewer & Wells, 2006; Wixted, Mickes, Clark, Gronlund, & Roediger, 2015). This relationship is most clearly shown with calibration curves (e.g., Juslin et al., 1996; Palmer et al., 2013), and confidence-accuracy characteristic (CAC) curves (Mickes, 2015) present another important interpretation of the data. Specifically, CAC curves consistently indicate that highly confident participant-eyewitnesses tend to be highly accurate with their suspect identifications. However, this pattern has only been found in a handful of studies under controlled conditions manipulating a few estimator or system variables such as exposure time to the perpetrator's face (the present study and Palmer et al., 2013), weapon presence (the present study and Carlson et al., in press), retention interval (Wixted et al., in press), and lineup presentation (Mickes, 2015). More work is needed before any arguments can be made to police or the criminal justice system about the true value of high confidence identifications provided by real eyewitnesses, particularly in light of the evidence indicating that even low confidence suspect identifications can be reasonably accurate. Regardless, we still conclude that police, in addition to asking eyewitnesses how long they were able to view the perpetrator during the crime, should always collect eyewitness confidence immediately after their lineup decision. We do not see how this could be harmful, and immediate confidence is a much better indicator of eyewitness accuracy to be presented in court, compared to confidence provided long after the identification (e.g., Wixted et al., 2015).

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Table 1

Recall Scores across Conditions

Condition	Overall Recall	Perpetrator Clothing Recall
10 s View of Face (No Weapon)	.46 (.20)	.65 (242/373)
10 s View of Face and Weapon	.44 (.21)	.45 (161/356)
10 s View of Face, 2 s View of Weapon	.42 (.20)	.51 (182/355)
3 s View of Face and Weapon	.35 (.21)	.37 (126/343)

Note. Standard deviation in parentheses for overall memory score.

Table 2

Proportions of Correct Identifications, Foil Identifications, and Rejections

Condition	**Target-Present Lineup**			**Target-Absent Lineup**	
	Correct IDs	Foil IDs	Rejections	Foil IDs	Rejections
10 s View of Face (No Weapon)	.58 (103/177)	.20 (35/177)	.22 (39/177)	.37 (71/191)	.63 (120/191)
10 s View of Face and Weapon	.56 (96/171)	.21 (36/171)	.23 (39/171)	.38 (69/184)	.62 (115/184)
10 s View of Face, 2 s View of Weapon	.53 (95/180)	.23 (41/180)	.24 (44/180)	.41 (71/175)	.59 (104/175)
3 s View of Face and Weapon	.55 (97/175)	.15 (25/175)	.30 (53/175)	.40 (64/162)	.60 (98/162)

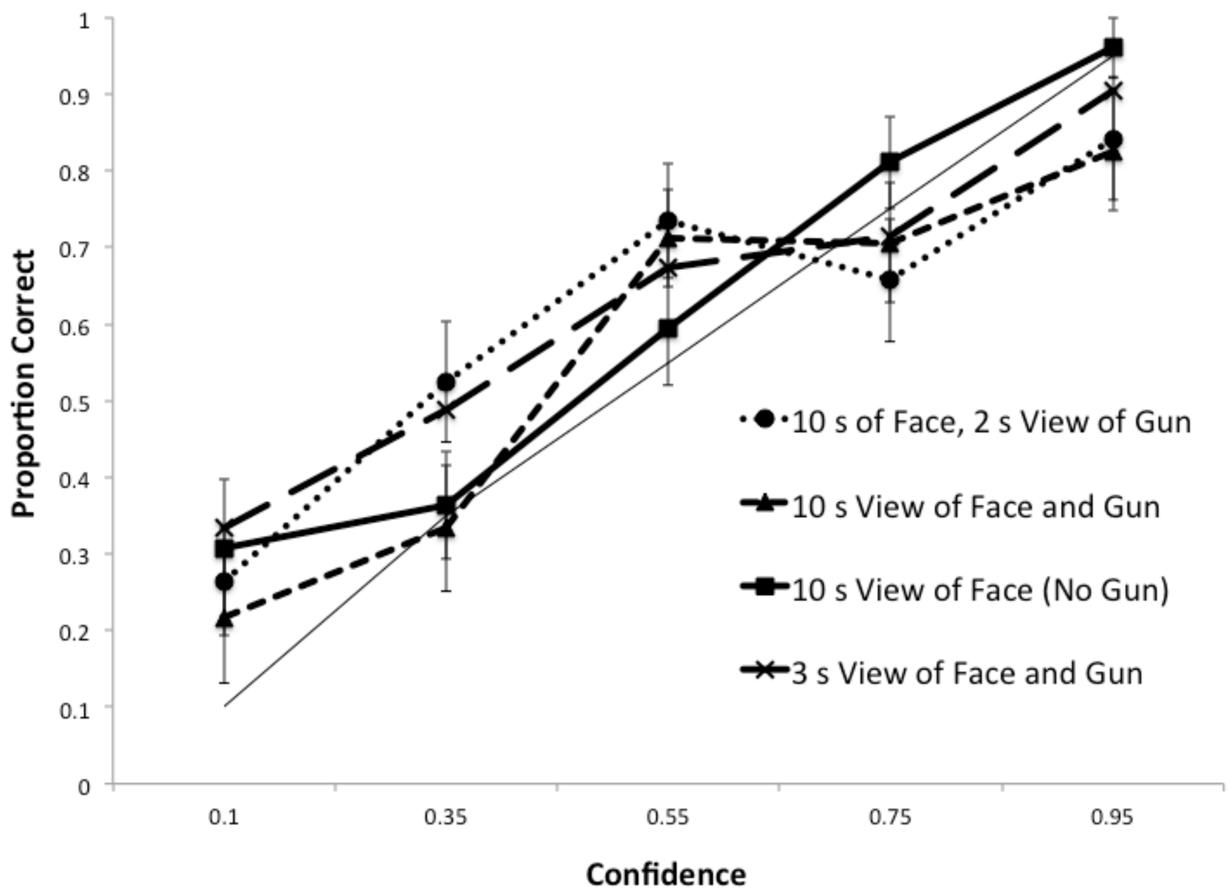
Note. IDs, Identifications

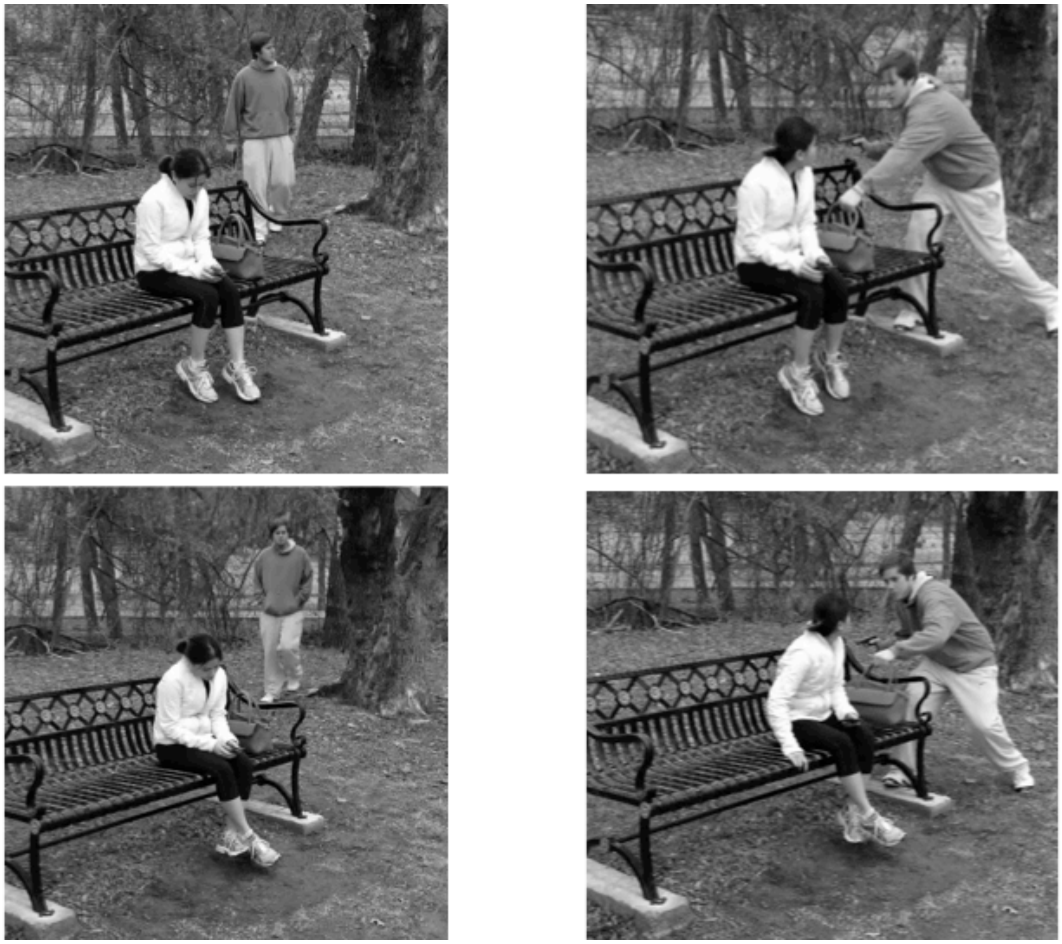
Table 3

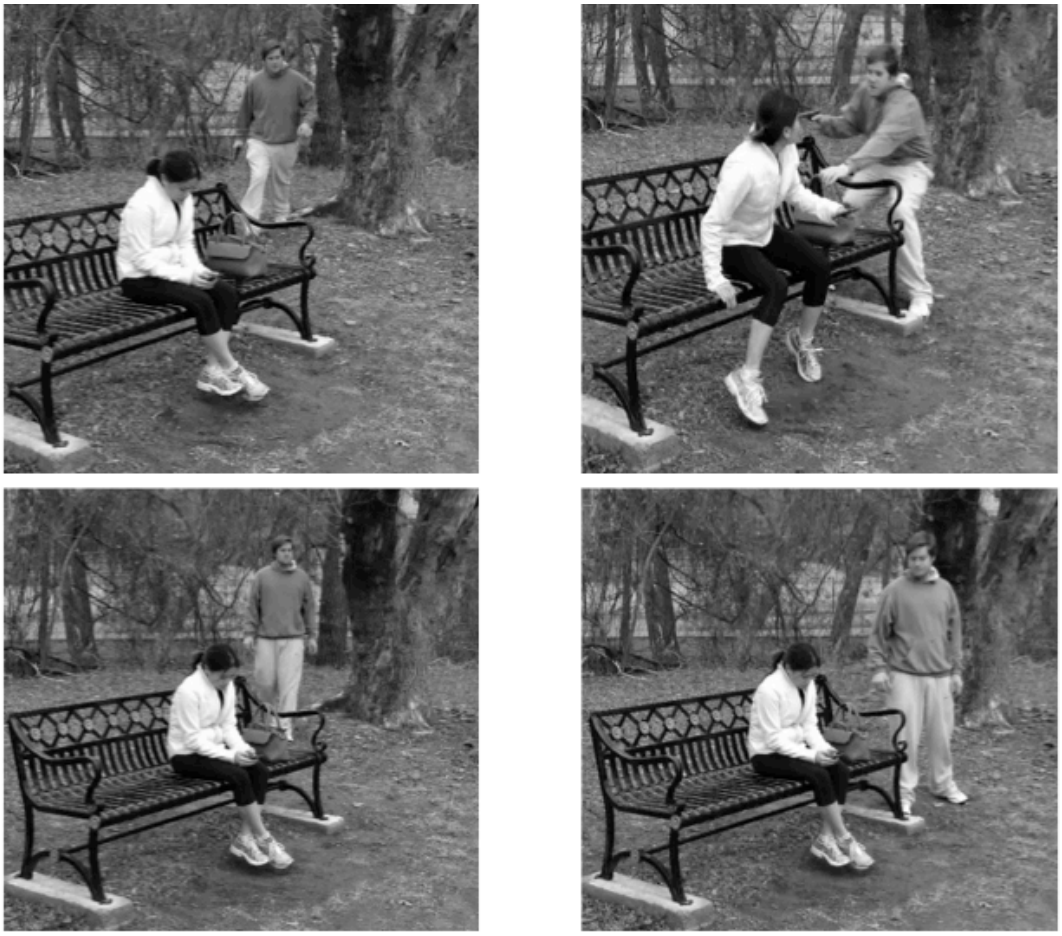
Calibration Statistics with Inferential 95% Confidence Intervals

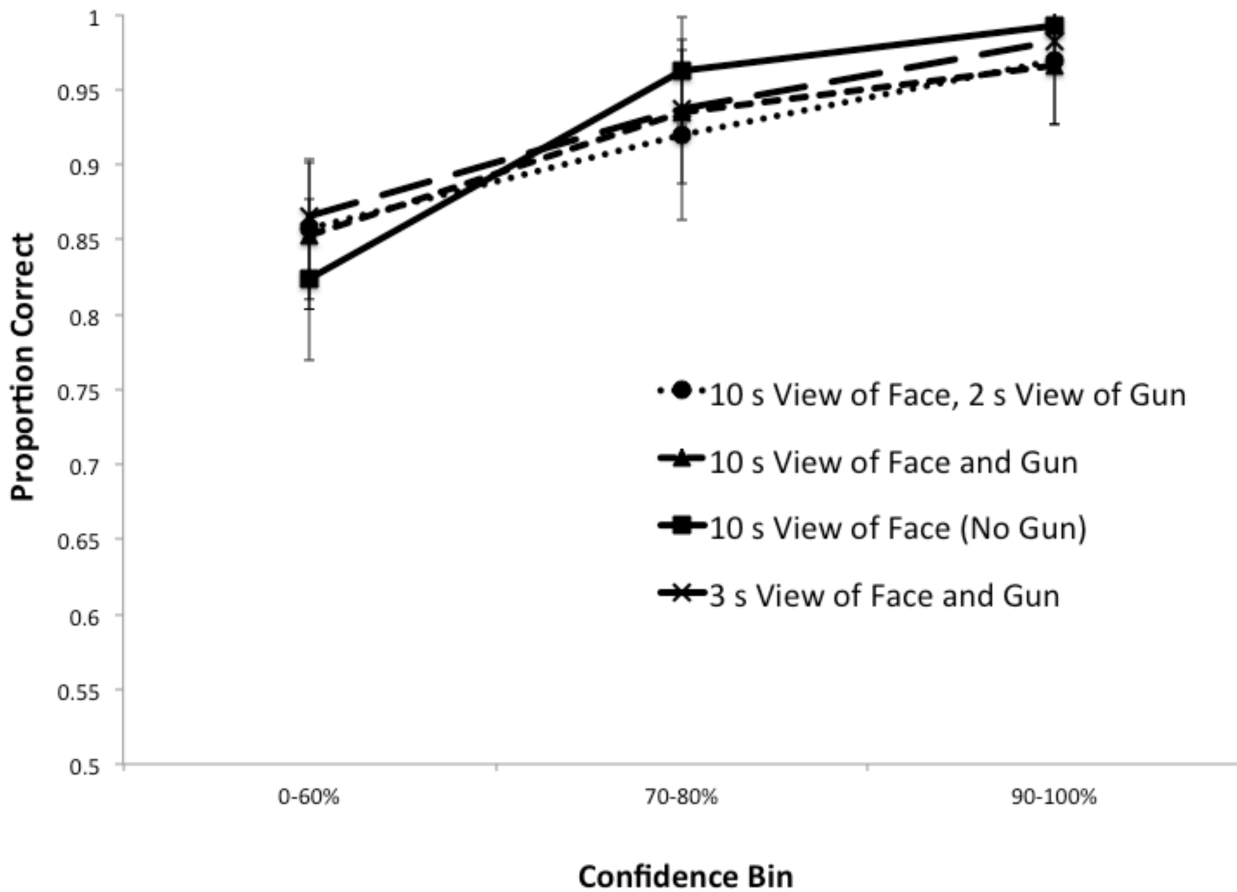
Condition	**C**	**O/U**	**Resolution**
10 s View of Face (No Weapon)	.008	-.057	.227
ICI	.001, .015	-.112, -.002	.180, .274
10 s View of Face and Weapon	.013	-.034	.196
ICI	.001, .025	-.083, .015	.145, .247
10 s View of Face, 2 s View of Weapon	.024	-.076	.154
ICI	.011, .037	-.136, -.016	.099, .209
3 s View of Face and Weapon	.019	-.097	.134
ICI	.001, .037	-.162, -.032	.070, .198

Note. ICI = Inferential Confidence Interval ($\alpha = .05$); C = calibration; with lower numbers representing better calibration; O/U = Over/Under confidence, with negative numbers indicating under-confidence. For resolution, higher numbers indicate a better ability of confidence to discriminate between correct and incorrect identifications.


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Proportion Correct
0.1
0.35
0.55
0.75
0.95
Confidence
10 s of Face, 2 s View of Gun
10 s View of Face and Gun
10 s View of Face (No Gun)
3 s View of Face and Gun







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