Law and Human Behavior, Vol. 16, No. 4, 1992

A Meta-Analytic Review of the Weapon Focus Effect*

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This meta-analytic review examined 19 tests of the weapon focus effect—the hypothesis that the presence of a weapon during commission of a crime will negatively affect an eyewitness's ability to later identify the perpetrator. A significant overall difference between weapon-present and weapon-absent conditions was demonstrated, with weapon presence leading to reduced identification accuracy. Overall, the size of the effect was small (.13) for the dependent measure of lineup identification and moderate (.55) for feature accuracy. Discussion focuses on those factors that appear to mediate and facilitate the weapon focus effect.

Research shows that eyewitness testimony can have a strong impact on juries (Loftus, 1974). Offered as direct evidence, positive identification of a perpetrator is uniquely powerful in its evidentiary status (Wells, 1985). Unintentional errors in eyewitness identification can occur, however, with possible miscarriages of justice involving incrimination of the wrong party and/or failure to identify the guilty party. Assessment of the accuracy of eyewitness testimony is a weighty charge for the court, and psychologists with knowledge relevant to eyewitness processes—perception, information processing, and memory—are in a position to help with this task. The usefulness of psychological knowledge in this arena and the appropriateness of psychologists in the role of advisor to the court, however, depend heavily on an adequate base of knowledge of eyewitness-relevant variables. One of these variables, termed *weapon focus,* is the subject of this investigation, and a statement about the base of knowledge regarding this variable is the goal of the project.

* This research was supported by a grant from the Bush Foundation through Augsburg College. Requests for reprints should be directed to Dr. Nancy Steblay, Department of Psychology, Augsburg College, 731 21st Avenue South, Minneapolis, MN, 55454.

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Weapon focus refers to the visual attention that eyewitnesses give to a perpetrator's weapon during the course of a crime. It is expected that the weapon will draw central attention, thus decreasing the ability of the eyewitness to adequately encode and later recall peripheral details. Research efforts have assessed eyewitness recall of various crime details in an attempt to establish the parameters of weapon focus effects on perception and memory (e.g., Kuehn, 1974). Most tests of the weapon focus effect have included a weapon's presence or absence during a crime as the independent variable and the subject's later attempt to identify the perpetrator in a lineup as the dependent measure. The experimental hypothesis has been that the frequency of correct identifications will be greater in the weapon-absent condition.

A quick tally of results from these studies indicates that six tests show clear support of the weapon focus effect (at the traditional .05 level of significance), no tests suggest a significant opposite effect (i.e., that weapon presence increases accurate identification) and 13 tests report no significant differences between weapon-present and -absent conditions. Thus, although there is support for the weapon focus effect, the number of nonconforming research results may lead to concern about the reliability of the phenomenon. Indeed, through a recent survey, Kassin, Ellsworth, and Smith (1989) found that only 56.6% of experts in this field reported that the weapon focus effect is reliable enough for psychologists to present in courtroom testimony.

A closer examination of these research results may more fully explain the weapon focus phenomenon. The presence (or absence) of certain factors in supportive studies may provide insight into the causal nature of the phenomenon and provide explanation as to when and why weapon focus may be detrimental to eyewitness performance.

This investigation is a statistical review of all available literature. Twelve studies have been located that address the weapon focus effect; these include 19 tests of the hypothesis. These studies examine conceptually similar variables and allow reliable application of the statistical procedures used in meta-analysis. Among other information, meta-analysis allows computations of the overall probability that the pattern of results in a set of studies was due to chance, an overall effect size estimate, and a figure regarding the number of additional nonsupportive studies needed to reverse the meta-analytic conclusions.

One useful outcome of such statistical conclusions is a quantitative indicator regarding the status of the weapon focus effect. As noted earlier, psychologists who take the role of expert witness need a base of knowledge upon which to draw for their testimony. As a practical and ethical issue, supporting research must be available to validate expert psychological testimony. Legally, the expert testimony must also meet the criteria of the *Frye* test (*Frye v. United States,* 1923, p. 1014.). Following *Frye,* the testimony should conform to a "generally accepted explanatory theory" (*U.S. v. Amaral,* 1973, p. 1153). The advantage of meta-analysis is that researchers generally agree on the meaning and usefulness of probability and effect size indicators. Thus the *Frye* test can be informed with a standard statistical indicator.

The goals of the present review may be summarized as follows: (1) to exam-

ine the weapon focus literature, defining (a) the overall probability of a weapon present–absent difference in identification accuracy, (b) the size of this effect, and (c) a confidence level that the research reviewed accurately represents all studies conducted; (2) to examine a number of factors that relate to and may help to explain the weapon focus effect; and (3) to identify gaps in our knowledge and necessary areas for future research.

METHOD

Sample

Several steps were taken to locate potential studies, including a computer search of two abstract services, PsycINFO and SOCIAL SCISEARCH. A manual search of Psychological Abstracts and the library book catalog was also conducted. Subsequently, a complete search of relevant references cited in any of the previously located articles was performed. Finally, authors of primary articles were contacted by mail and asked to send any relevant works, published or unpublished. The final sample included nine published reports, two convention papers, and one unpublished dissertation (Kramer, personal communication, September, 1990). Possible selection bias in published studies was a concern and, as will be discussed later, was partially addressed through calculation of a fail-safe *N*. An individual study was selected for inclusion in the review if the author(s) used a weapon present/absent manipulation (including studies with high versus low visibility of weapon) with a dependent measure of lineup identification. The final sample consisted of 19 sets of data testing the weapon focus hypothesis, from 12 empirical reports representing 2,082 subjects. The review covered those studies available as of March, 1991 (see Appendixes A and B).

Study Characteristics

Several methodological and theoretical characteristics were recorded. Among these were source (published, convention paper, unpublished manuscript), author, number of hypothesis tests per study, sample size, variable definitions, specifics of research design, and supplemental dependent measures.

Statistical Analyses

Z-Score

Following the work of Rosenthal (1984), an overall probability level associated with the observed pattern of results was calculated by combining *Z*-scores of individual tests of the hypothesis. Exact one-tailed probability levels were calculated for each test through reconstruction of the data, by returning to other statistics reported within the article, or by obtaining this information directly from authors of the articles. Recovery of sample sizes and proportion of correct identifications per condition allowed calculation of *Z*-scores for the difference be-

tween proportions. For one test, retrieval of the data was not possible, and a conservative policy (Rosenthal, 1984) was followed: The report of a significant main effect with no statistics available was constructed as $Z = 1.65$, $p = .05$.

Following the technique of Beaman, Cole, Klentz, Preston, and Steblay (1983), three summary standard normal deviates (Z-scores) were calculated. The overall Z-score (Z_{ma}) provides an unweighted estimate of the overall probability level. In addition, a Z-score was calculated that included weighted individual test Z's (Z_{mn}). This weighting by sample size of the study provides an estimate of population parameters that allows greater emphasis on larger samples (with accordingly more reliable estimates). A final weighted Z (Z_{mf}) was computed using fractional weights equivalent to the reciprocal of the number of tests contained within each study. This weighting technique essentially adjusts for the nonindependence of hypothesis tests within single studies.

Mean Effect Size

The effect size computed for each individual hypothesis test is the coefficient recommended by Cohen (1977) for use when testing differences between proportions. To calculate an overall effect size, individual effect sizes were weighted by the reciprocal of the effect size variance and the summation of these values divided by the sum of the weights. This procedure is considered analogous to that offered by Hedges (1984) for mean differences and is appropriate for effect sizes based on differences between arc sin transformed proportions (see Beaman et al., 1983). This procedure is necessary to adjust for the different sample sizes which affect accuracy of effect size indicators. In the remainder of this article, reference to "mean effect size" denotes the weighted mean computed as above.

Fail-Safe N

In conjunction with the computation of the meta-analytic normal deviate, a fail-safe N was calculated following the procedure of Rosenthal (1978). This method results in an estimate of the number of additional tests averaging null results (Z-score of zero) that would be needed in order to bring the significance level attained through the meta-analysis to a value larger than .05. When appropriate, a "file drawer" analysis based on effect size was also calculated (Hunter & Schmidt, 1990). This figure reports the number of unlocated studies averaging null results needed to reduce the established effect size for a set of studies to a chosen (nonsignificant) value.

RESULTS

Meta-Analysis 1: Identification Accuracy

The 19 experimental tests of the weapon focus hypothesis yield a Z_{ma} of 3.40 ($p = .0003$), indicating greater lineup identification accuracy for the weapon-absent condition than the weapon-present condition. Weighting the individual

tests by their sample sizes produce a Z_{mn} of 2.65 ($p = .004$). A weighting based on the number of tests per study generates $Z_{mf} = 2.24$ ($p = .01$). These significant results are further underscored by calculation of the fail-safe N (N_{fs}). For Z_{ma}, this figure is 1,523, which suggests that this large number of unlocated and unsupportive studies would need to exist before the p figure would change to a nonsignificant level. This well exceeds the tolerance level (105) computed as directed by Rosenthal (1984). Even the smallest Z derived, Z_{mf}, still generates a respectable N_{fs} of 280.

The mean effect size for the group of 19 tests is .13 [CI (95%) = .01 to .25]. This is a relatively small effect size; in practical terms this suggests that the area of nonoverlap (Cohen, 1977) between the distributions of the weapon-present and -absent conditions is 9.8%. A file drawer analysis based on effect size indicates that 216 uncovered studies averaging null results are needed to reduce the effect size to .01 (approximating zero).

Meta-Analysis 2: Feature Accuracy

Ten of the weapon focus data sets included dependent measures beyond the lineup identification test. Although the form of the dependent measures varied somewhat from study to study, the existing commonality is a series of questions posed to subjects that assessed each subject's memory of perpetrator characteristics peripheral to the weapon. For example, subjects were asked to describe the target's clothing or facial features.

The 10 studies that reported comparisons between weapon-absent and -present conditions for feature accuracy scores produce a Z_{ma} of 5.88 ($p < .0001$), establishing that the weapon-absent condition generated significantly more accurate descriptions of the perpetrator than did the weapon-present condition. The fail-safe N for this group of studies is 1,263, and the overall effect size, now calculated as d, is .55 [CI (95%) = .24 to .86].[1]

Meta-Analyses of Subsets of Data

It is valuable to go beyond the original primary analyses to seek information regarding relationships among various subsets of the data. This allows investigation into both methodological issues and theoretical underpinnings of the hypothesized weapon focus effect. It is particularly important to account for the range of effect sizes (−.43 to .67) in this set of studies. This was attempted through examination of the following variables.

Author of Publication

The lower end of an effect size frequency distribution, specifically including outcomes of zero or negative effect size, is comprised of work by Bothwell,

[1] Hedges's (1984) correction applied.

Kramer, and Cutler and colleagues.[2] Each of these author subsets was reviewed separately in an attempt to isolate methodological factors that differentiate these studies and that might shed light on the causal nature of the weapon focus effect.

The work of Bothwell includes at least two characteristics that may relate to a reduced effect size. First, Bothwell used a video presentation as the stimulus for his subjects. Second, and perhaps more importantly, the video scenario did not portray a crime; rather, a single actor simply carried a weapon as he walked down a corridor. The Z_{ma} generated for these two tests of the hypothesis is $-.79$, $h = -.22$.[3]

Five of the six hypothesis tests of Kramer et al. are also represented on the lower end of the effect size continuum ($Z_{ma} = .68$, $p = .25$, $h = .08$). This work similarly includes noteworthy methodological aspects: These five tests were designed to create a very nonarousing, environmentally stark scenario. No crime is actually committed, no other bystanders surround the actor, and the "weapon" (a bloody meat cleaver) is not used as a weapon, but rather just carried by the actor. Also, Kramer et al.'s scenario is presented on slides. An interesting contrast in scenario is provided by a sixth test of the hypothesis by Kramer et al. (actually the first reported in the 1990 article). This was also a slide presentation, but a crime was enacted, complete with sound effects. The Z_{ma} for this single test was 1.64 ($p = .05$, $h = .61$). At this point it should be noted, also, that although five tests from Kramer et al.'s work produce quite low effect sizes for lineup identification, feature accuracy scores show significant differences between conditions, with a combined effect size of .79.

The work of Cutler and colleagues (which also includes the O'Rourke article) provides six tests of the hypothesis and generates a significant Z_{ma} (1.62, $p = .05$) and an effect size of .11, only slightly less than the complete sample. Cutler's work, like Bothwell's involved a video scenario; an important difference is that a crime was enacted in the Cutler video. An additional characteristic may also be important: The weapon (a gun) was not entirely absent in the weapon-absent condition, but rather in the pocket of the perpetrator.

Having identified potential explanatory variables from these subsets, subsequent analyses address these variables and others across the complete set of studies.

Weapon Visibility

The most direct test of the weapon focus hypothesis, as previously stated, would involve the absence versus presence of a weapon. The operational definition of weapon absence varied from one project to another, resulting in three primary subgroups. The absent weapon in the Cutler studies actually involved a weapon present in the perpetrator's pocket; $Z_{ma} = 1.62$, $h = .11$. One test

[2] In order to simplify reporting of results, only the first author of research articles included in the meta-analysis will be named from this point on.

[3] Z_{mf} and Z_{mn} were also calculated for these and the following groups. However, such figures are reported only if they differ from Z_{ma} in a noteworthy manner.

(Kramer, 1990) involved a weapon visible in hand (a bottle), but not used as a weapon in the weapon-absent condition (Z_{ma} = 1.64, h = .61). Studies in which the weapon was truly absent from the subject's view (N = 12) produced Z_{ma} = 2.67, p = .0038, h = .12.

Mode of Presentation

In presenting the stimulus scenario to subjects, researchers used one of three general strategies. The Cutler and Bothwell research used a video mode (Z_{ma} = 1.01, p = .16, h = −.10). Johnson and Maass used actors to simulate a real-life event (Z_{ma} = 2.25, p = .01, h = .38). The remaining researchers (N = 9) used a slide presentation. (Z_{ma} = 2.93, p = .002, h = .25).

Arousal Level

The studies can also be considered as three separate groups based on the potential for emotional arousal in the experimental scenario. Assuming that the "real-life" scenarios of Johnson and Maass can be considered to be potentially more arousing than the remaining tests, these two can be compared to the others. As noted above, Z_{ma} = 2.25, p = .01, h = .38. Studies in which a crime scene with a recognizable weapon is viewed via video or slides (N = 10) can be considered as moderately arousing. In this case, Z_{ma} = 3.56, p = .0002, h = .44. Finally, included as low arousal studies are those in which a weapon is present but no crime occurs or the central character carries a dangerous object (meat cleaver), not a prototypical weapon. For these seven studies, Z_{ma} = .16, p = .44, h = .05.

Confidence intervals computed for the above three groups show no overlap between the low arousal group [CI(95%) = −.13 to .23] and the moderate [CI(95%) = .27 to .61] or high arousal [CI(95%) = .30 to .46] groups. The narrowest interval is around the high arousal group.

Weapon Type

Assuming that the prototypical weapon is a gun, studies that use a gun (N = 10) were examined. This subset produces Z_{ma} = 2.69, p = .0036, h = .14. As a comparison, the only other weapon used in more than one test of the hypothesis, the meat cleaver, generated Z_{ma} = .68, p = .25, h = .08.

Lineup Type

The majority of tests used offender-present lineups (N = 13). For this group, Z_{ma} = 2.82, p = .002, h = .12. Five of the tests include a manipulated variable of offender present/absent lineups. In two of these tests, the interaction between the lineup type and weapon focus cannot be assessed (i.e., the variables are confounded); in the remaining three tests, one reports a significant interaction between the variables, such that the weapon focus effect occurred in the offender-present lineup only. The only test with a clear offender-absent lineup also produces a significant effect, Z = 1.96, p = .03, h = .43.

From a data set including all types of lineups it is evident that lower percent-

ages of correct identifications in the weapon-absent (control) condition are associated with larger effect sizes, $r(17) = -.44$, at a level approaching significance. Thus, it appears that scenarios (and more specifically, lineups) that produce low identification accuracy for subjects in general (i.e., control subjects) accentuate the weapon-focus effect.

Retention Interval

The amount of time between viewing of the event and subsequent lineup testing varied across studies from same-day testing to a 28-day delay. Comparison of same-day versus 2+ days of interval shows the following outcomes: 14 same-day tests produce $Z_{ma} = 2.34$, $p = .009$, $h = .12$; delayed lineups produce $Z_{ma} = 2.44$, $p = .007$, $h = .22$ ($N = 4$).

Published versus Unpublished Data

Four tests of the hypothesis were unpublished (Bothwell, 1991 [2]; Kramer, 1990; and Johnson, 1976). Kramer reports nonsignificant results; calculation of a Z score and an effect size for his data shows $Z_{ma} = .16$, $h = .04$. Johnson's data generate $Z_{ma} = 1.21$, $p = .11$, and $h = .35$; Bothwell's work produces $Z_{ma} = -.79$, $h = -.22$.

Subjects

Subjects were male and/or female undergraduate college students in all but one of the studies. O'Rourke et al. specifically addressed a concern of sample limitation by including a wide range of noncollege subjects from age 18 to 74, with results supporting the generalizability of eyewitness findings across age groups and subject populations.

DISCUSSION

Status of the Hypothesis

The data support the hypothesized weapon focus effect, with the combination of all tests producing a Z_{ma} of 3.40, $p = .0003$. This significant difference between weapon-present and weapon-absent conditions is apparent in the overall analysis and in many subset comparisons. The data also show that both dependent measures—lineup identification accuracy and feature accuracy—are sensitive to the weapon focus effect. The fail-safe N's calculated lend support to the credibility and generality of this sample of studies. The presence of a weapon does make a significant difference in eyewitness performance.

Although the overall effect size generated for lineup accuracy is not of great magnitude, it is well within a theoretically consistent range given that weapon absence or presence is only one of many variables that investigators recognize as influential in lineup identification accuracy. The greater effect size found for

feature accuracy measures underscores the relevance of weapon focus in understanding eyewitness processes beyond the dependent measure of lineup identification.

The weapon focus effect has been found to be relatively robust across variations in stimulus presentation, experimental scenario, and experimenter and subject variables. The effect has been documented primarily with college student subjects, but also with noncollege populations. The effect occurs across experimental modes of "real life" enactments, video, and slide presentations; for experimental scenarios of high to moderate arousal; for both offender-absent and offender-present lineups; and with varying intervals of retention time. Most importantly, the effect is clearly discernable in those experimental paradigms that speak to the real-world issue at hand: situations in which a witness observes a threatening object play a central role in an event of short duration. Also it appears that the weapon focus effect is accentuated by longer intervals between the observed event and the lineup task and in low-optimality situations where the identification task is quite difficult.

The presence of a weapon during a crime is an "estimator" variable (Wells, 1978) in eyewitness performance. That is, the influence of this variable on an eyewitness's performance can only be estimated post hoc. Yet the data here do offer a rather strong statement: To not consider a weapon's effect on eyewitness performance is to ignore relevant information. The weapon effect does reliably occur, particularly in crimes of short duration in which a threatening weapon is visible. Identification accuracy and feature accuracy of eyewitnesses are likely to be affected, although, as previous research has noted (e.g., Pigott, Brigham, & Bothwell, 1990), there is not necessarily a concordance between the two. This information represents an important update in our state of knowledge regarding eyewitness accuracy, and as argued by Kassin et al. (1989), the weapon focus effect provides a good example of a phenomenon that may be viewed differently at this time compared to its status as a hypothesis just a few years before. There is now a convergence of data to support confidence in this effect.

Theoretical Implications

Past theoretical conjecture about the cause of the weapon focus effect has centered on two factors: arousal level and focus of attention. The present data show that the effect, as expected, is more pronounced in research scenarios that appear as real life to the subject. The effect is also present even in more artificial experimental settings when subjects view commission of a crime in which the weapon is clearly a threatening object. To the extent that moderate to high subject arousal levels may be inferred from these situations, it may be assumed that arousal is a correlate of a strong weapon focus effect.

Kramer et al.'s (1990) research, however, suggests that even in low-arousal situations a weapon can have an impact on feature accuracy. His data, which found the weapon focus effect to be dependent on the percentage of time the weapon was visible, do not rule out arousal as a causal factor, but suggest an explanatory emphasis on attentional processes. In an attempt to demonstrate

more directly the importance of focus of attention in this phenomenon, Loftus et al. (1987) employed a corneal reflection device. This tool allowed researchers to track eye movements of subjects, noting both number and duration of eye fixations. Their results provide direct evidence that eye fixation on a weapon is a critical correlate of reduced identification accuracy.

The importance of attention is also indirectly supported by the Cutler work. This research involved a weapon-absent condition in which the perpetrator's gun was in his pocket. Although it is difficult to isolate the reason for the lesser effect sizes produced by Cutler's scenario, perhaps the attention of these control group subjects was drawn to the pocket by what they inferred was there. Thus the attentional focus of control subjects may have been unintentionally similar to that of the experimental group.

Although focus of attention may be the critical mediating variable for the effect, it is also possible that the interaction of the two variables—narrowed focus of attention and high arousal—provides a situation that maximizes the potential for a weapon focus effect. As Loftus et al. suggest (1987; following Easterbrook, 1959), in a real-life crime situation, the narrowing of perceptual focus may be in fact accelerated by high arousal. A desirable goal for future research is to clarify the interactive effect of arousal and attention in the weapon focus phenomenon.

A variable related to both arousal and attention, crime scene complexity, could not be assessed with these data. It may be argued that real-life crime events include so many stimuli that the hypothesized weapon focus effect becomes irrelevant or insignificant in magnitude. The problem of ecological validity of these laboratory-based data can only be addressed here by noting that those researchers who have attempted to maximize complexity by adding additional bystanders or noise (e.g., Kramer, and Johnson) have not effectively eliminated the effect.

In sum, the weapon focus effect remains a worthwhile avenue for research. There is a need to more precisely identify the mechanics of the process in forensically relevant settings. At this point, however, the data provide evidence of its significant impact.

APPENDIX A: STUDIES INCLUDED IN THE META-ANALYSIS (N = 12)

Bothwell, R. K. (1991). *Eyewitness description accuracy*. Paper presented at the meeting of Southeastern Psychological Association, New Orleans, LA.

Cutler, B. L., & Penrod, S. D. (1988). Improving the reliability of eyewitness identification: Lineup construction and presentation. *Journal of Applied Psychology, 73,* 281–290.

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APPENDIX B: SUMMARY OF STUDY CHARACTERISTICS

Study	Date	Effect size	*Z*	Total *N*	Arousal	Mode	Weapon	Interval
Bothwell	1991	−.43	−1.11	27	Low	Video	Gun	Same day
		.00	.00	28	Low	Video	Knife	Same day
Cutler and Penrod	1988	−.14	−.91	175	Moderate	Video	Gun	Same day
Cutler et al.	1987a	.29	1.32	165	Moderate	Video	Gun	Delay
Cutler et al.	1987b	.04	.34	290	Moderate	Video	Gun	Delay
Cutler et al.	1986	.00	.00	320	Moderate	Video	Gun	Same day
		.23	1.93	287	Moderate	Video	Gun	Delay
Johnson and Scott	1976	.35	1.21	48	High	Staged	Opener	—
Kramer	1990	.04	.16	62	Low	Slides	Cleaver	Same day
Kramer et al.	1990	.61	1.64	64	Moderate	Slides	Bottle	Same day
		.06	.25	64	Low	Slides	Cleaver	Same day
		.00	.00	32	Low	Slides	Cleaver	Same day
		.43	1.50	48	Low	Slides	Cleaver	Same day
		−.12	−.38	42	Low	Slides	Cleaver	Same day
Loftus et al.	1987	.67	1.93	36	Moderate	Slides	Gun	Same day
		.47	2.06	80	Moderate	Slides	Gun	Same day
Maass and Kohnken	1989	.43	1.96	86	High	Staged	Syringe	Same day
O'Rourke et al.	1989	.22	1.28	132	Moderate	Video	Gun	Delay
Tooley et al.	1987	.08	1.65	96	Moderate	Slides	Gun	Same day

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