COMPARATIVE PISTOL PROJECT
FINAL REPORT

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EXECUTIVE SUMMARY

This project examined the comparative effectiveness of traditional iron pistol sights with Trijicon, Inc.'s red dot optic sight. Twenty-seven students from Norwich University participated by undergoing a simulated training course of fire using International Defensive Pistol Association (IDPA) silhouette targets for four different stages. Thirteen students used iron sights and 14 students used the optic. The results of the project indicated that there was a statistically significant difference favoring the optic for "hits on paper" in Stage 1 (15 yard slow fire) and for accuracy (hits near the center mass of the target) for all four stages of fire.

INTRODUCTION

This project examined the possible benefits of shooting a pistol with traditional 3 dot iron sights vs. a pistol equipped with Trijicon Inc.'s red dot style sight (formally titled as the Trijicon Ruggedized Miniature Reflex sight and hereafter referred to as the "RMR"). Proficiency with pistols is a requirement for most persons engaged in law enforcement. Federal, state and local agencies all have qualification, as well as requalification, criteria that personnel must meet. Most requirements include demonstrated skill in a variety of qualifying relays. For instance the published relays provided by the Connecticut Police Academy include firing distances of two to twenty-five yards, the use of both the "strong" and "weak" side and hand, time limitations, holstering, and combat reloads-all with stringent accuracy standards.

Training to and maintaining an acceptable level of handgun proficiency is a challenging task. The red dot style sight might be beneficial in addressing a series of defensive pistol issues. For instance an illuminated red dot might make shooting with both eyes open easier. This kind of aiming aids situational awareness and reduces "tunnel vision." Furthermore, a red dot can eliminate "eye sprint," the constant focusing and refocusing on the front sight, rear sight and target to get a properly aligned sight picture. A red dot allows the shooter to simply place the red dot on the target. Finally a red dot style sight might reduce training time and produce higher levels of initial proficiency. The specifics of the comparative study follow.
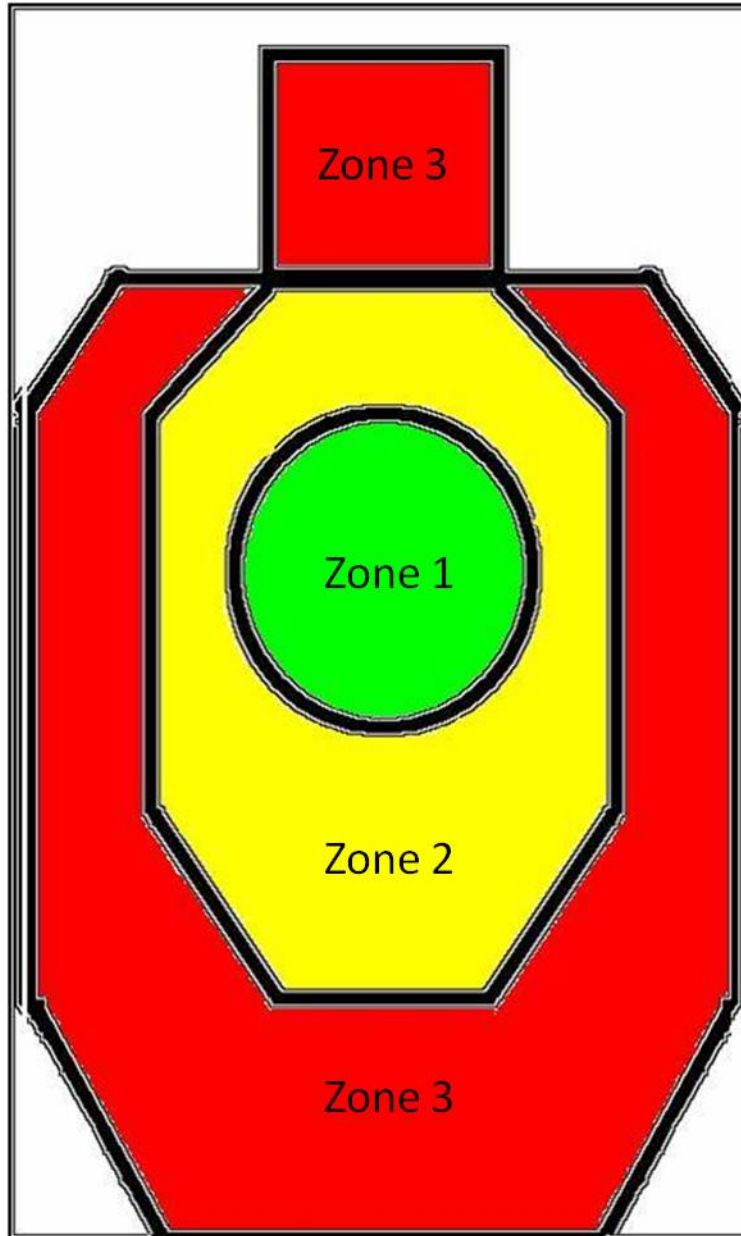
METHOD AND DATA

Subjects for this project consisted of students majoring in criminal justice from Norwich University. This group represents those likely to be entry level recruits for the military or law enforcement. These subjects were all enrolled in one of two classes taught by one of the authors. The course is a required one in research methods. The instructor modified the course syllabus requirements so that the comparative pistol project could be used as the class research project.

Students were randomly assigned to either the group using traditional iron sights (the "control group") or the group using the RMR (the "experimental group"). This is standard research procedure to increase the likelihood that both groups are comparable in that variables which might affect the outcome of the test are evenly distributed between both groups. One of the authors also administered a questionnaire to the subjects that addressed shooting experience. The result of that instrument indicated no difference between groups. The experimenters limited group size to 15 for logistical reasons. Trijicon, Inc. provided three instructors. A member of the U.S. Border Patrol was also present to observe. Each group had one day on the firing range. It would have been difficult to manage groups larger than 15 considering the safety, instruction and shooting requirements of the test. Three alternates were also selected for each group. Additionally, some students in each class were specifically excluded because they had experience with handguns since they were members of the military or were part-time police officers. These students assisted the authors and instructors with the project by helping to record shooting data and supervising students who were shooting. The project was cleared by the Norwich University Human Subjects Committee in accordance with Norwich University Academic Memorandum no. 12 (Protection of Human Subjects). All subjects signed an informed consent statement.

Shooting took place at the Waterbury-Stowe Fish and Game Club in Waterbury Center, Vermont on 28 and 29 September, 2010. Those using the iron sights shot on the 28th and those using the RMR shot on the 29th. Each group arrived at the club at about 0800 hours for safety and weapons instruction. After these briefings students went to the range for live fire practice and familiarization. Following these sessions and a lunch break students went to the range to shoot for the test. All shooting took place outdoors. The weather on both days was comparable. The conditions were overcast and cool. A very brief, very light shower occurred on the 28th but this condition did not appear to affect the shooting.

The targets were standard International Defensive Pistol Association (IDPA) cardboard targets. The target figure shown below illustrates the zones used for analysis in the test. Zone 1 was the center mass and the desired area for hits. Zone 2 was an area consisting of an octagon that lay just outside of the center mass. Zone 3 was that area on the periphery of the target. The head area was in Zone 3. IDPA scoring credits hits in the head as equal to hits in the center mass but the investigators for this project designated it as being in Zone 3 since students were instructed to aim at the center mass.

The firearm used was the Glock model 19 in 9 millimeter. The course of fire consisted of four stages. Most of the time students engaged in relays of three. The subjects fired all shots from the standing position using a standard isosceles stance and a standard two handed grip. Stage 1 was a slow fire exercise at 15 yards. The subjects fired simultaneously instead of taking turns. Each subject fired ten shots. Stage 2 was a rapid fire engagement at five yards. The students fired individually starting from a center chest retention hold position and upon a signal from a pro timer engaged the target and fired two shots. The times were recorded for each shot. This exercise was repeated nine more times for a total of 20 shots for Stage 2. Stage 3 was identical to Stage 2 except that the distance was increased to 10 yards and the exercise was repeated five times for a total of 10 shots. Stage 4 consisted of rapid fire with multiple threats at a distance of 10 yards. The subjects faced two targets and, after a timer initiation, fired two shots, one at each target. Students alternated between shooting first at the target on the left and then

shooting first at the target on the right. Shot times were recorded. The targets were placed about six feet apart. This exercise was repeated six times for a total of 12 shots. Analysis follows.
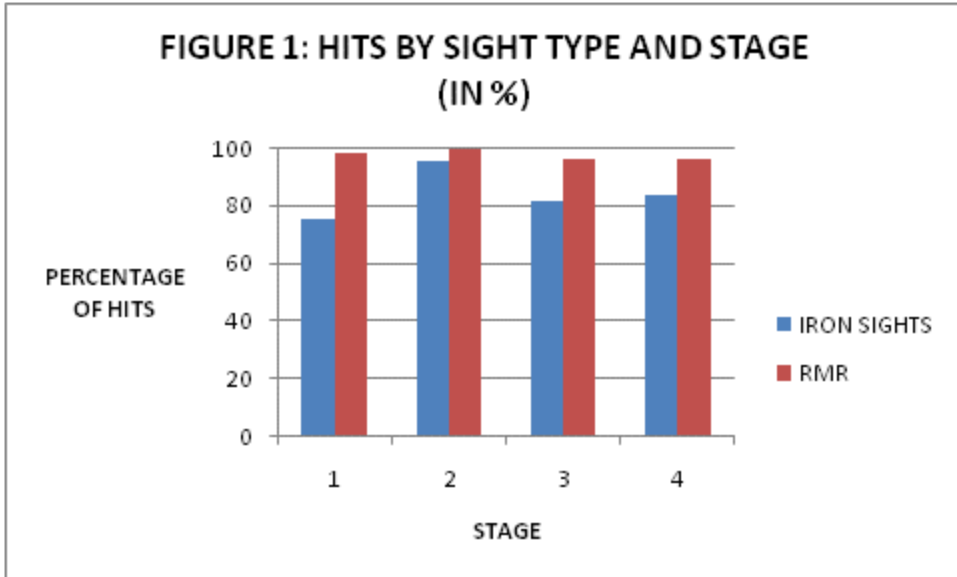
ANALYSIS

The analysis for this test consisted of two elements. The first and most important part of the analysis was that of the test firing. In addition the authors included an analysis of shooter experience between groups as a check on group comparability. Details follow.

Test Firing

The entire test firing for each subject consisted of 52 shots. Each student fired at a total of five targets, one each for Stages 1 through 3 and two targets for Stage 4. So each subject produced a total of 5 targets. All targets were labeled with a student identifying number and the stage. Ultimately 27 students took part in the test yielding 135 separate targets. One of the authors took possession of the targets for analysis of both the number of hits on the target and the placement of those hits. These data were recorded on the same form as that on which shot times had been recorded. Hence each subject was represented by one data form that had an identifying number and space to record shot times for stages, number of hits and placement of hits. The authors had all twenty seven completed forms copied and distributed to all students in one of the authors' research methods class. These forms provided the data for each student's research project. A detailed analysis follows.

Figure 1 illustrates the hits on target by sight type and stage in percentages. The Mann-Whitney U statistic was used to calculate statistical significance. This measure is often used where small samples are involved. In this case both groups numbered less than 15 thus this measure is more valid than the familiar t-statistic. An appendix explaining statistical significance is part of this report. In Stage 1-15 yard-slow fire- the group using iron sights fired a total of 130 shots 97 of which hit the target for a hit percentage of 75 percent. Those using the RMR fired a total of 140 shots 137 of which hit the target producing a hit percentage of 98 percent. The difference was large enough to be statistically significant. In Stage 2- 5 yard rapid engagement-the group using iron sights fired a total of 260 shots 248 of which hit the target for a hit percentage of 95 percent. Those using the RMR fired a total of 280 shots and hit the target 274 times for a hit rate of 99 percent. The difference was not statistically significant. In Stage 3- 10 yard rapid engagement-the group using iron sights fired 130 shots 105 of which hit the target for a hit rate of 81 percent. Those using the RMR fired 140 shots 136 of which hit the target producing a hit rate of 96 percent. The difference, while large, was not large enough to be considered statistically significant. In Stage 4-10 yard rapid fire, multiple threats, data for each group was limited to 12 shooters. Some subjects were confused regarding the changing sequence of aim points and shot at the wrong targets. Data for these shooters were eliminated from the analysis. The group using iron sights fired a total of 132 shots hitting the target 110 times for a hit rate of 83 percent. The group using the RMR fired a total of 144 shots and hit the target 138 times for a hit rate of 96 percent. The difference was not statistically significant.

FIGURE 1: HITS BY SIGHT TYPE AND STAGE (IN %)

Figures 2 through 5 depict analyses of accuracy as measured by percentage of hits in designated target zones. As mentioned above, Zone 1 refers to the circular center mass of the target and was the desired hit point for all shots. Zone 2 refers to the inner octagon on the IDPA target that lies outside the center mass. Zone 3 refers to any area on the target that lies outside of the inner octagon. The measure used to determine statistical significance was the chi-square statistic. All results of the following analyses showed that the RMR group shot more accurately and all results were statistically significant.

Figure 2 illustrates hits by sight type and zone in percentages for Stage 1(15 yard-slow fire). Twenty-nine shots, or thirty percent of the 97 shots fired hit the center mass (zone 1). On the other hand 56 percent, or 78 of the 137 shots fired by the RMR group hit the center mass. Forty-three percent, or forty-two shots, fired by the iron sight group, hit zone 2 while thirty percent, or forty three shots, landed in the same area for the RMR group. Finally, 27 percent of the shots fired by the iron sight group hit in the outer zone 3 while only 13 percent of the RMR group hit the outer area.

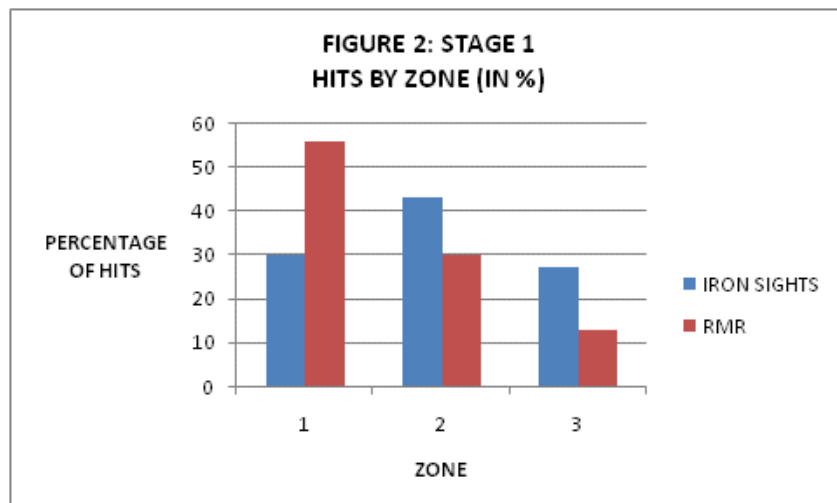FIGURE 2: STAGE 1 HITS BY ZONE (IN %)

Figure 3 illustrates hits by sight type and zone in percentages for Stage 2 (5 yard, rapid engagement). One hundred and forty-seven, or 59 percent of the 248 shots fired by the iron sight group that hit the target struck the center mass. This compares with a 74 percent hit rate on the center mass or 204 shots of the 274 hits by the RMR group. The hit rate in zone 2 was 27 percent and 23 percent for the iron sight group and RMR group, respectively. Finally 14 percent of the hits fired by the iron sight group hit the outer area (zone 3) while only three percent of the RMR group's hits landed in the same area.

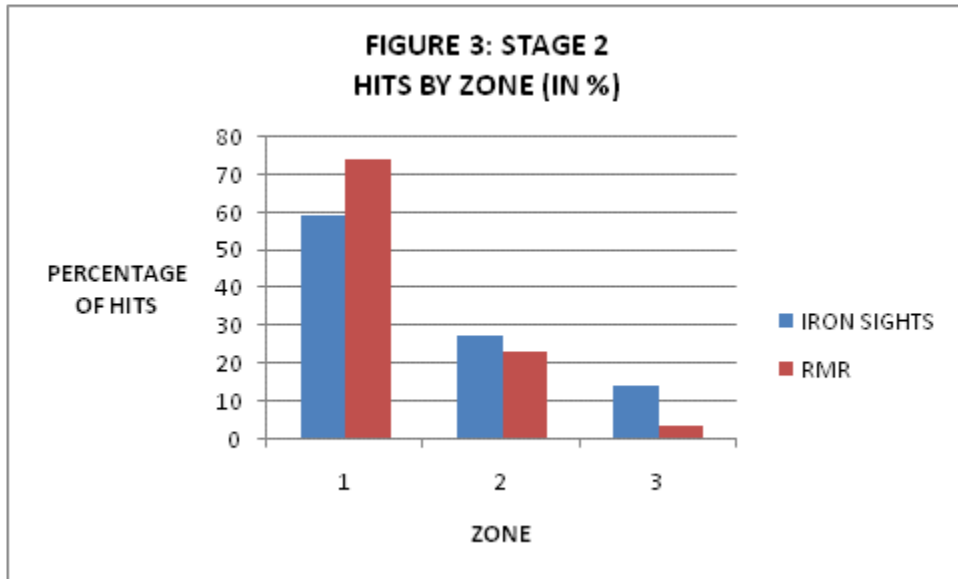FIGURE 3: STAGE 2
HITS BY ZONE (IN %)

Figure 4 illustrates hits by sight type and zone in percentages for Stage 3 (10 yard, rapid engagement). Thirty-one shots or 30 percent of the 105 shots fired by the iron shot group that hit the target, landed in zone 1. This compares with 46 percent, or 62 of the 136 hits from the RMR group. Fifty percent of the hits from the iron sight group hit in zone2 while 42 percent of the shots hitting the target landed in zone 2 for the RMR group. Finally 20 percent of the hits for the iron sight group landed in the outer area (zone 3) while only 12 percent of the RMR group's shot landed there.

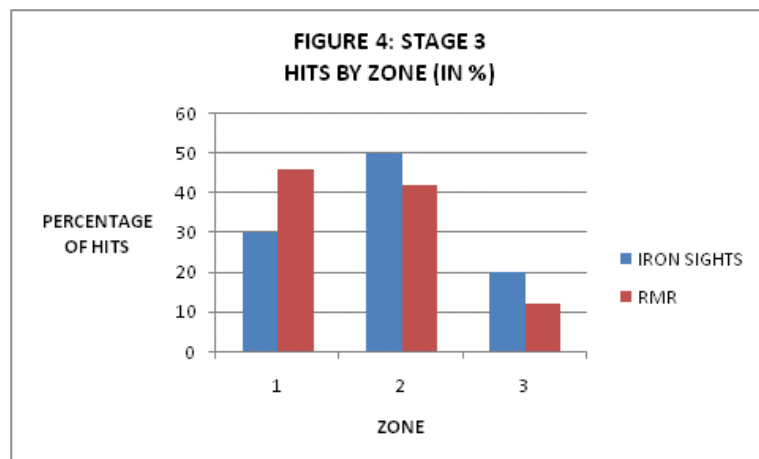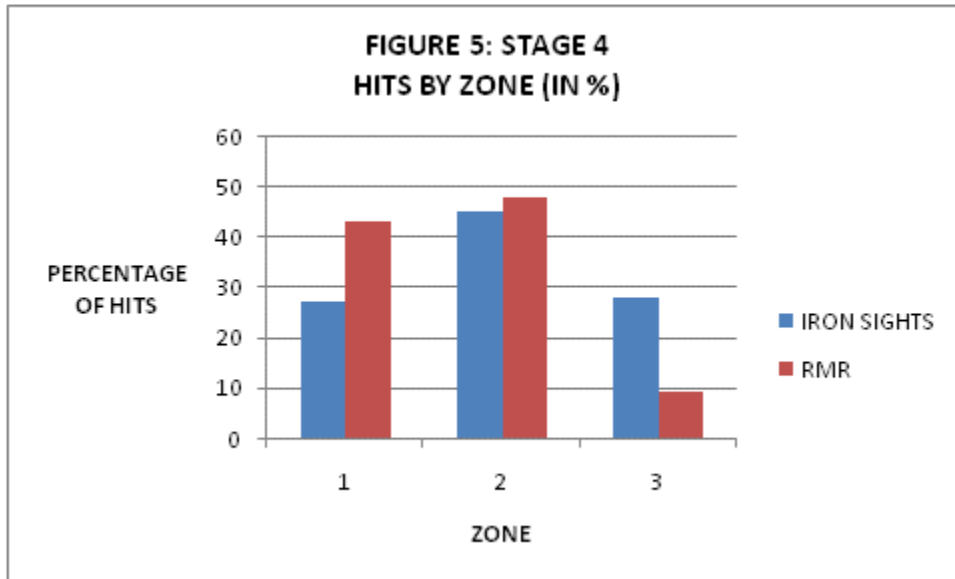FIGURE 4: STAGE 3
HITS BY ZONE (IN %)

Figure 5 illustrates hits by sight type and zone in percentages for Stage 4 (10 yard, rapid engagement, multiple threats). The iron sight group hit the center mass, or zone 1 of the target twenty-seven percent of the time. This percentage translates to 30 hits out of the total of 110 hits. Conversely the RMR group hit the center mass 43 percent of the time hitting the center mass 59 times out of the 138 hits. Both groups hit zone 2 with about equal accuracy. The iron sight group had 45 percent of its hits in zone 2 while the RMR group had 48 percent of its hits in the same region. Finally the iron sight group had 28 percent of its hits, or 30 out of 110, in zone 3 while the RMR group had 9 percent or 13 out of 138 hits.

FIGURE 5: STAGE 4
HITS BY ZONE (IN %)

Shooter experience

As mentioned above there was no difference in either shooter experience. Question 1 on the shooting questionnaire asked if the subject had any hunting, military or law enforcement experience. The answers were a simple "No" or "Yes." The data showed no difference between those who shot with iron sights and those who used the RMR. About half of each group had had some experience. Question 2 addressed pistol shooting experience. Again, about half of each group had had some pistol experience. Other questions had numerous answer categories and the results produced empty cells for answers and thus were not analyzed. The last question was a shooters' rating of their own experience. These results were considered too unreliable to use for analysis. A copy of the questionnaire is attached to this report. The results of Questions 1 and 2 are addressed in the statistical appendix which is also attached to this report.

LIMITATIONS

This study, while methodologically sound, has some limitations. First, although the samples were sufficient for this project, their small size would be reason enough to repeat the exercise in order to replicate the results. Also a larger sample size might produce statistically significant results that were lacking in Stages 2 and 3 and 4 of this effort. Second, stages 2, 3 and 4 involved rapid fire that was timed on a competition shot timer. There was little analysis

performed on effectiveness and time because, although shot times were recorded, specific shots could not be matched with specific recorded times given the logistics of the testing. One of the authors did suggest that students could get extra credit by taking an average time to first shot and number of hits in Zone 1 for stages 2, 3 and 4. However sample size considerations suggested that the data for both sight groups be combined for analysis and correlation. Results showed no statistically significant correlation however this could have been the result of the type of sight and not a result of time to first shot.

CONCLUSION

This comparative pistol project indicated the Trijicon Inc.'s RMR was more effective than traditional iron sights. The results suggest that trainees in military and law enforcement specialties may gain proficiency more efficiently with the RMR. In addition the RMR is useful for seasoned professionals.

REFERENCES

Connecticut Police Academy. n.d. Post Council Firearms Qualification Relays. Meriden, CT.

McGrath, Peter. 2010. Norwich University Comparative Pistol Test. Trijicon, Inc. Fredericksburg, VA.

Mendenhall, William. 1975. Introduction to Probability and Statistics (4th Ed.). North Scituate, MA: Duxbury Press

Mendenhall, William and Ott, Lyman. 1976. Understanding Statistics (2nd Ed.). Belmont, CA: Wadsworth Publishing.

Royse, David, Thyer, Bruce A., Padgett, Deborah, K.,Logan, TK. 2006. Program Evaluation: An Introduction (4th Ed.) Belmont CA: Thomson Publishing.

SHOOTING QUESTIONNAIRE

DIRECTIONS: Print your name. Circle appropriate answer

Name _____

1.   Have you had any hunting, military or law enforcement experience?   No-0   Yes- 1

2.   Have you had any pistol shooting experience?   No-0   Yes-1

    (If you answered No do not answer any more questions)

3.   How many years have you shot pistols?   1-0   Between 2 and 4-1   More than 4-2

4.   About how often did you shoot?   Once or twice a year-0;

                                        3-6 times a year-1

                                        Once a month-2

                                        Weekly-3

5.   How would you rate your pistol shooting ability (1 is low; 10 is high)

        1   2   3   4   5   6   7   8   9   10

APPENDIX II

STATISTICAL SIGNIFICANCE

Inferential statistics, the kind used in this project, is that branch of quantitative analysis that attempts to infer unknown population parameters from the results of a sample. The term "statistical significance" refers to the likelihood that the results of a sample were due to simple chance. By convention a sample result is considered statistically significant if there was less than a one in twenty probability of getting such a result from random chance. While this probability may seem excessively small this standard reflects the scientific research value of skepticism. Generally speaking, in the research community, one must present overwhelming evidence in favor of a proposition before that assertion will be accepted.

The formal process of using samples to infer population parameters is known as "hypothesis testing." One begins with a "null hypothesis," that is the proposition that there is "no difference" or "it isn't so." In this project the null hypothesis would state that there is no difference in the effectiveness of iron sights and the RMR. The "alternative hypothesis" or "research hypothesis" states that there IS a difference in effectiveness between iron sights and the RMR. The researcher then takes samples from the population to test whether or not there is evidence to reject the null hypothesis. In this case the samples were the Norwich students shooting at targets with different sights. Various kinds of test statistics were used and will be discussed below. If a test statistic takes on a value that is contradictory to the null hypothesis, we conclude that the alternative is true and the result is "statistically significant."

Hits on the Target

The first set of tests in the project compared the number of hits anywhere on the target. The number of shooters using the iron sights was 13. The number using the RMR was 14. Because the sample sizes were quite small, differences between groups would have to be relatively large to indicate statistical significance. Statistical tests exist to examine these small samples. Many, including the one used here are also "non-parametric." That is, they require no assumption regarding the parameters of the population. The test statistic reported here is known as the Mann-Whitney U.

Stage 1

In Stage 1 (15 yard, slow fire) the iron sight group averaged 7.46 hits per shooter for ten shots. The RMR group averaged 9.79 hits. This difference produced a Mann-Whitney U test statistic of 31.5. This was a statistically significant result. The chance of such a result happening by simple chance was .002 –less than 1 chance out of 100.

Stage 2

In Stage 2 (5 yard, rapid engagement) the average number of hits per shooter with iron sights was19.1 out of 20 shots. The average for the RMR group was 19.7. This difference produced a Mann-Whiney U value of 72.00 and the likelihood of that result happening by chance was .252 and not statistically significant.

Stage 3

In Stage 3 (10 Yard, rapid engagement) the iron sight group averaged 8.08 hits out of ten shots. The RMR group averaged 9.64 hits. This difference produced a Mann-Whitney U of 65.00. The likelihood of this difference happening by chance was .101 and thus not statistically significant.

Stage 4

In Stage 4 (10 yard, rapid engagement-multiple threats) the group using iron sights averaged 9.25 hits out of 12 shots fired. The RMR group averaged 11.33 hits. The Mann-Whitney U was 47.00. This difference was not statistically significant.

Accuracy

The investigators also examined accuracy as defined by the percentage of shots that hit in the different target zones. The procedure used was contingency table analysis. The measure used to determine the statistical significance of differences between sights was the chi-square statistic. This measure is a test for the independence of two different categories. In this case the categories are type of sight and hits in zones. The statistic is produced by comparing the observed frequencies in categories and the expected frequencies if indeed the two were independent. The object is to determine whether such a result would have occurred by chance or if the result was highly unlikely to be due to chance. In the case of the four stages of fire, the results showed that there was a less than 1 in 100 chance of such a result occurring at random. Hence there is strong evidence that the RMR produces more accurate results. Shown below are the numerical results of the four stages of fire and the chi-square number produced.

Stage 1

HITS BY ZONE

		ZONE 1	ZONE 2	ZONE 3	TOTAL
SIGHTS	IRON SIGHTS	29	42	26	97
	RMR	78	43	16	137
	TOTAL	107	85	42	234

Chi-square = 19; d.f. 2; $p < .01$

Stage 2

HITS BY ZONE

		ZONE 1	ZONE 2	ZONE 3	TOTAL
SIGHTS	IRON SIGHTS	147	68	33	248
	RMR	204	63	7	274
	TOTAL	351	131	40	522

Chi-square= 25; d.f. 2; $p < .01$

Stage 3

HITS BY ZONE

		ZONE 1	ZONE 2	ZONE 3	TOTAL
SIGHTS	IRON SIGHTS	31	53	21	105
	RMR	62	58	16	136
	TOTAL	93	111	37	241

Chi-square = 37; d.f. 2; $p < .01$

Stage 4

HITS BY ZONE

		ZONE 1	ZONE 2	ZONE 3	TOTAL
SIGHTS	IRON SIGHTS	30	50	30	110
	RMR	59	66	13	138
	TOTAL	89	116	43	248

Chi square = 12; d.f. 2; $p < .01$

Shooter Experience

There was no difference in the experience level of shooters using iron sights and the RMR. The tables below display the results of the shooter questionnaire. Two of the shooters answered the questionnaire incorrectly and were eliminated from the analysis. Nevertheless, one can see simply by inspection that no important difference existed. Although the numbers are small, the expected values produced for each cell were sufficient so special procedures that would have been required by small numbers or sparse data were not indicated.

For question 1:   Have you had any hunting, military or law enforcement experience?

HUNTING, MILITARY LAW ENFORCEMENT EXPERIENCE

		NO	YES	TOTAL
SIGHTS	IRON SIGHTS	6	7	13
	RMR	5	7	12
	TOTAL	11	14	25

For question 2:   Have you had any pistol shooting experience?

PISTOL SHOOTING EXPERIENCE

		NO	YES	TOTAL
SIGHTS	IRON SIGHTS	6	7	13
	RMR	4	8	12
	TOTAL	10	15	25