

Talk Is Cheap: Self-Reported Versus Actual Marksmanship Proficiency Among Military and Community Samples

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Marksmanship is a critical skill for military, law enforcement, and security professionals as well as recreational shooters who participate in competitions or hunting. Unfortunately, skill assessments vary wildly between branches of military service and even more so when compared with local law enforcement or security requirements. This heterogeneity creates wide-ranging opinions about what constitutes a firearm expert, with people claiming expertise despite only rudimentary training. The high degree of subjectivity undermines communication between firearm professionals and raises questions about the value of opinions. The current investigation thus explored self-reported marksmanship capabilities and their relationship with actual marksmanship capabilities. A novel firearm survey gauged subjective self-evaluations with participants also performing multiple objective shooting tasks. Participants included a community sample, who completed shooting tasks on simulator for safety reasons, and a military sample, who completed live fire exercises. Self-reported opinions sufficiently captured actual marksmanship variability among the community sample, although self-reported opinions did not predict marksmanship abilities among the professional military sample. This discrepancy identifies the relative practical value of using self-reported metrics based on the participant population, but more importantly, it underscores the limited value of professional opinion without some objective marksmanship data to provide a more direct comparison.

KEYWORDS: marksmanship, proficiency, survey, self-report

Attitudes and perceptions can be subject to a variety of biases, and people often have difficulty identifying their own personal preconceptions. For example, the blind spot bias describes a tendency for people to see bias in others rather than themselves (Pronin, Lin, & Ross, 2002). The illusion of superiority also illustrates how people typically judge themselves as superior to average people (Adler, 1927; Chambers & Windschitl, 2004; Hoorens, 1993). Although these biases and others can apply to many areas of cognition and human performance, there is enormous potential for attitudes about expertise to be influenced by perception. People may be ignorant of their own ignorance, a trait called meta-ignorance (Dunning, 2011), which describes how a lack of understanding allows a person to assume expertise for topics or skills that does not reflect their actual knowledge or abilities. These opinions are further complicated by *expertise* itself being a fluid term. Whereas a traditional approach to expertise presumes a person will steadily progress from novice to expert through training and experience (Ericsson, Krampe, & Tesch-Römer, 1993), alternative approaches argue that adaptive skill and not routine behavior in a domain should be the defining criterion of expertise (Ward, Gore, Hutton, Conway, & Hoffman, 2018). The debate on development and definitions of expertise can further exacerbate ambiguity in ascribing expert labels. Self-professed skill then becomes highly susceptible to perceptions and personal biases in determining expertise.

Psychomotor skills have a particular susceptibility to perceptions of expertise and performance. For example, people regularly provide overly positive assessments of their self-reported driving skill (Sundström, 2008). There are several contributing factors to this predisposition. First, psychomotor tasks often require repetition that increases familiarity with a given task, and familiarity changes cognitive processing (North & Williams, 2019; Wang, Cavanagh, & Green, 1994). This changed cognition allows the person to feel a sense of personal growth for a task, whether or not their skills actually improve. Next, development of some proficiency can allow other social cognition biases to influence perception of personal skill relative to others. The fundamental attribution error (Ross, 1977), as one example, predisposes people to underemphasize the role of situational factors for others while overemphasizing personal factors. As

it applies to psychomotor skills, people attribute errors by others to lack of skill, whereas their personal errors are overattributed to situational factors. Skill perception thus becomes biased in favor of personal proficiency beyond average. Another contributing bias could be the Dunning–Kruger effect (Dunning, Johnson, Ehrlinger, & Kruger, 2003; Kruger & Dunning, 1999; Schlösser, Dunning, Johnson, & Kruger, 2013; Simons, 2013), or the tendency of people with limited skill on a task to provide overly positive assessments of their abilities. This misattribution arises in part because the person is unaware of the full task complexity and may not be able to accurately describe expert performance. In turn, they come to believe that they achieved a higher level of expertise than is truly reflected in their behavior.

Consider these influences in the context of the driving example. Many people drive on a daily basis, and so they are highly familiar with the task. Their routine skills may be sufficient for day-to-day driving needs, and if involved in an accident, the average driver might be quick to implicate situational factors rather than personal skill as primary cause for the collision. Without an accident, the person may consider themselves a better-than-average driver simply by virtue of having a clean driving record. However, an average driver would have almost no experience with the type of high-performance skill needed for competitive racing. This latter issue would mean that the person has little understanding of true expertise in driving skills despite their high familiarity with the task. When combined, these factors predispose the average driver to overrate their ability and demonstrate how psychomotor tasks can be susceptible to biased perceptions of expertise.

Many psychomotor tasks also have implications for training and expertise that can affect day-to-day life and public health. Poor driving skills could lead to increased motor vehicle accidents if a person overestimates their ability to execute a maneuver on the highway. Marksmanship is another psychomotor skill with substantial public health implications. This skill is a core competency for military, law enforcement, and security personnel, who are authorized to carry firearms for public protection. Each organizational marksmanship test is influenced largely by the mission set for which they train, and these different standards produce very different ideas, opinions, and self-evaluations when it comes to quantifying

marksmanship proficiency. The resulting discrepancy is that two people with comparable firearm skills may have remarkably different perceptions of their own relative abilities.

Perception of firearm ability can also be affected by the many factors involved in firearm use. This complex psychomotor task taps into multiple skills related to sensorimotor learning (Clements et al., 2018; Liu et al., 2021; Rao et al., 2018), cognitive ability (Kelley et al., 2011; Pojman et al., 2009), and even affective components (Anglin, Novell, Murphy, & Goodwin, 2017). The diverse skillset within marksmanship becomes especially important in constructing reasonable performance assessments that could gauge expertise. Even if a person can complete a controlled evaluation well, there are questions as to whether marksmanship tests predict real-world shooting performance (Morrison & Vila, 1998). From a practical standpoint, there is also an open question of whether self-professed ability is indicative of actual performance in trained communities. Different professions have different training standards, and with so many different firearm courses and standards across various training and assessment programs, good performance on one test or drill does not automatically indicate that the person will perform well on another test or drill. Different shooters may also have different perceptions of expertise based on the quality of shooters to which they have been exposed. This uncertainty also extends to self-perception about firearm proficiency, where a person may develop a sense of hubris because of how they perform in one community despite other communities being superior.

To address these questions, the current investigation explored the role of self-reported firearm proficiency and training experience against actual firearm performance. Two samples were assessed under a variety of conditions. The first group included a sample of community participants in the Wright-Patterson Air Force Base area who completed marksmanship and lethal force scenarios on a military-grade shooting simulator. We chose a simulator for the community sample rather than live fire for safety reasons. The second group included a sample of active-duty military participants with prior military marksmanship training who completed their drills using live ammunition. Both groups also completed a firearm proficiency and experience survey that included self-reported comfort, self-reported expertise in multiple

techniques and procedures, dry firing practices, speed-accuracy tradeoffs, experience with hunting, and experience with competition shooting. Although community sample and military sample participants completed different firearms drills, the intent is to provide convergent evidence by determining whether similar predictive power for self-reported metrics occurs across both groups. Specifically, do self-reported marksmanship opinions accurately reflect individual skill with a firearm?

EXPERIMENT

METHODS

Participants

All participants provided written informed consent before engaging in the experiment. Study protocols were approved by the Naval Medical Research Unit Dayton Institutional Review Board in compliance with all applicable federal regulations governing the protection of human participants.

COMMUNITY SAMPLE.

Seventy-two adults (age: $M = 30.25$ years, $SD = 7.67$; 53 men) participated on a volunteer basis. Participants were recruited through flyers and online announcements and self-reported normal or corrected-to-normal vision.

MILITARY SAMPLE.

Forty-nine male active duty or reserve military service members (age: $M = 28.57$ years, $SD = 6.63$) participated on a volunteer basis. Participants were recruited as part of ongoing military training exercises and allowed to participate in the experiment or not participate without any consequences to themselves or their standing in the training program. All participants self-reported normal or corrected-to-normal vision.

FIREARM PROFICIENCY SURVEY AND STATISTICAL ANALYSES.

The firearm proficiency survey was created for this study and future firearm investigations. It consists of 12 questions, each of which contains multiple parts depending on the experience of the shooter. For example, question 6 asked whether a participant had ever competed in a shooting competition. If the answer was “yes,” then the participant would also be asked to answer how many competitions they had competed in and to describe the competitions. These open-ended answers allowed the participants to provide contextual detail while also providing cat-

egorical or continuous data as needed for statistical analyses. The questionnaire is available in the Appendix. All participants completed the survey on paper, with research assistants later transcribing the data into electronic files. Surveys were completed before marksmanship tasks for both the community and military samples.

For categorical data, several questions were divided into “yes” or “no” responses to determine group differences, including whether the person had taken a course on gun safety, whether the person hunts with a firearm, and whether the person had previously participated in shooting competitions. Independent-samples *t* tests were conducted based on the groups (e.g., hunters vs. nonhunters) for each respective sample. The two samples were not crossed for analyses because the marksmanship tasks were different: The community sample shooting tasks designed for a laboratory-based study (Blacker, Pettijohn, Roush, & Biggs, 2021) and the military sample shooting tasks were designed as part of a firearm training program.

For continuous data, there were several questions answered on Likert-type scales rather than “yes” or “no” responses. These data included the comfort level of the person around firearms and whether the person prefers speed or accuracy in shooting performance. One subset of questions specifically asked about a variety of live fire practice behavior to gauge the diversity of a person’s practice or training with a firearm. The live fire behaviors were summed based on “yes” or “no” answers to create a score from the live fire subscale that reflects the amount of variance

in their practice. Correlations were conducted on the various continuous data collected from the survey, whether single questions or calculated from subscales, and performance in the marksmanship tasks.

A final continuous subscale asked Likert-type questions from all responders (community sample and military sample participants) for opinions about their personal firearm abilities. This subscale represents self-rated firearm proficiency. Because this subscale was critical to interpreting self-perception about firearm performance versus actual performance, and the subscale contained multiple Likert-type questions, a principal component analysis was conducted on these questions to determine the underlying factors within the subscale. Based on these data, self-reported firearm proficiency opinions were compared against actual performance for the community sample and military sample, respectively.

Community Sample Shooting Tasks

Community sample shooting tasks were conducted with an Indoor Simulated Marksmanship Trainer (ISMT; Meggitt Training Systems, Suwanee, GA), which is the primary firearm simulation system used by the U.S. Marine Corps. This study used the enhanced (E) model of the ISMT. Scenarios were projected onto a screen via projector with a hit camera. The simulator firearm had an embedded laser that could simulate a shot from a given weapon at a given location on the screen. This study used Bluefire M9 Beretta pistols (Figure 1a), which were real pistols with internal components replaced by an infrared

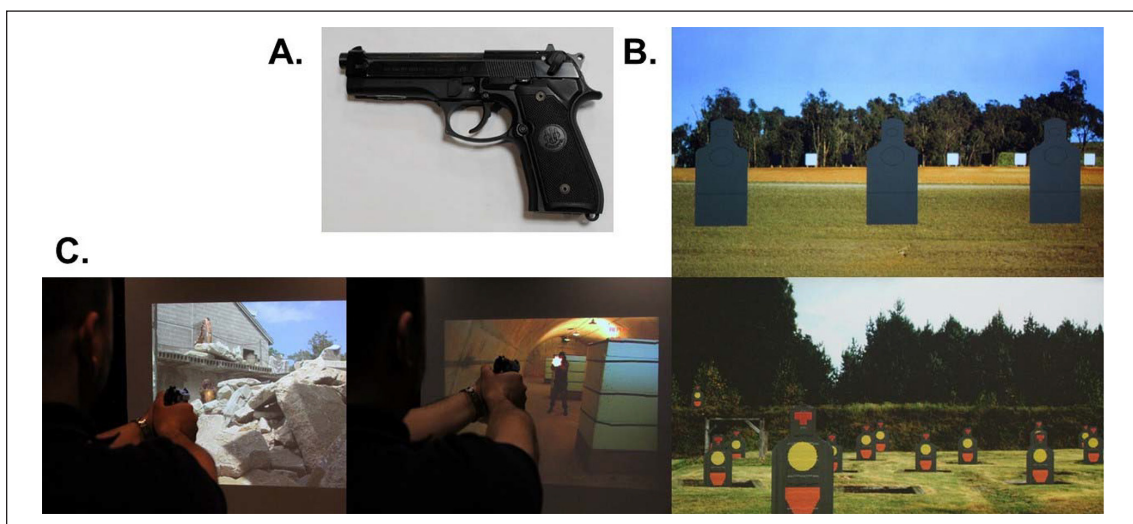


FIGURE 1. (a) M9 pistol used with the Indoor Simulated Marksmanship Trainer. (b) Example marksmanship targets used and (c) example shoot/don't shoot video scenarios used

laser system and Bluetooth transmitter compatible with the simulator. Once these key components were properly calibrated through testing and the operator station, shots were given a response time (RT) or accuracy designation based on the particular scenario being conducted at the time. For this setup, participants stood 15 feet from a screen 75 in. wide and 57 in. high. Refillable magazines simulated weapon recoil through compressed air bursts. Auditory shot feedback was provided through speakers with the system.

Before firing any shots in the simulator, participants received a safety briefing about weapon handling to avoid injury due to moving parts of the weapon and were instructed on magazine loading, ejecting, and proper sight alignment. Participants could freely choose their stance, grip, or any aspect of the firing procedure so long as they had both hands on the pistol and stood behind the firing line. Although free to choose firing behaviors most comfortable for them, participants were instructed to use the same stance and grip throughout all shooting tasks during the study. Table 1 provides general details about the marksmanship scenarios used to assess performance in the community sample (Figure 1b). Familiarization sessions were not provided to either the community sample or military sample, to better reflect current abilities and knowledge upon walking into the task. A safety briefing and basic functionality instruction (e.g., how to load the weapon if the participant did not know) were the only guidance provided to participants.

In addition to marksmanship scenarios, participants also completed shoot/don't-shoot scenarios via preprogrammed videos in the ISMT system (Figure 1c). Each scenario could have hostile targets that

should be fired upon, nonhostile targets that should not be fired upon, or both. Participants were instructed to identify and fire on hostile targets as quickly as possible and before the hostile target could fire on them first. Circles appeared on screen to delineate a miss (green circle), nonlethal hit on a hostile (yellow circle), lethal hit on a hostile (red circle), or any hit on a nonhostile target (purple or maroon). Participants received no feedback from the experimenter.

Shoot/don't-shoot scenarios included 33 unique videos presented in one of two pseudorandom orders, with each scenario lasting between 20 and 180 s. For each ISMT scenario, there were 0–5 hostile targets presented and 0–5 nonhostile individuals presented (i.e., nonhostiles could be civilians or potential hostiles who surrendered). There were 9 don't-shoot scenarios that included no hostiles and 24 shoot scenarios that included at least one hostile. Video scenarios were biased to include more shoot scenarios (73% shoot scenarios, 27% no-shoot scenarios) as a means to create a strong prepotent response to fire and for purposes involving response inhibition investigations (for more detail, see Blacker et al., 2021). Dependent variables recorded from each scenario included number of shots fired, targets hit, targets missed, lethal hits, nonlethal hits, false alarms (i.e., shot too soon or shot a nonhostile), and first shot RT.

Military Sample Shooting Tasks

Military sample shooting tasks were determined by the training regimen already scheduled and not determined by the experimenters. Thus, the exercises provided were scored by the experimenters but not designed by the experimenters. Raw shooting data were converted based on a *z* score distribution to preserve performance differences between the shooters

TABLE 1. Marksmanship Shooting Tasks Completed by Participants in the Community Sample

Task	Score	Rounds	Distance	Time limit	Target
Short range	15	3	13 m	None	(1) USMC "A"
Box drill 1	90	9	7 m	None	(3) USMC "E" mod SF
Box drill 2	90	9	10 m	None	(3) USMC "E" mod SF
Box drill 3	90	9	7 m–3 m	4 s	(3) USMC "E" mod SF
Box drill 4	90	9	10 m–3 m	4 s	(3) USMC "E" mod SF
Pop-up	130	30	7 m–36 m	60 s	(26) USMC "E" color pop-up
Long range	15	3	25 m	None	(1) USMC "A"

Note. USMC = U.S. Marine Corps; mod = modification; SF = slow fire.

without presenting raw scores. Military participants completed marksmanship drills with both a pistol and a rifle. Weapons were service issued and not provided by the experimenters; therefore, the specific type of weapon was not controlled beyond its designation as a pistol or rifle. Pistol use controlled for weapon type between community sample and military sample participants, whereas rifle use represented primary marksmanship performance for infantry personnel. See Figure 2 for sample images.

Pistol drills included a bullseye task, one-shot draw from holster, and shot-to-shot reload. The bullseye task had participants stand 25 m from the target and fire 10 rounds at a ringed bullseye target with a generous time limit of 10 min to complete the drill. The one-shot draw task had participants begin with a holstered weapon and, upon the start signal, draw and fire one round at the target. The shot-to-shot reload task had participants fire two shots. The first shot was untimed, with the dependent variables being the average RT between shots and the average accuracy of the shot. Participants completed the bullseye task once, they completed the one-shot draw task three times, and they completed the shot-to-shot reload task three times. The primary dependent variables within each task were accuracy and speed.

Rifle drills included a one-shot drill, shot-to-shot reload, 100-m drill, and 300-m drill. The one-shot draw drill had participants begin at the low ready and, upon the signal, raise and fire the weapon. The shot-to-shot reload drill had participants fire two

shots. The first shot was untimed, with the dependent variables being the average RT between shots and the average accuracy of the shot. The 100-m drill had shooters begin in a standing position and, on the start signal, drop to a kneel and fire a shot at a 12-in. steel target 100 m away. The 300-meter drill had shooters begin in a standing position and, on the start signal, drop into the prone position and fire a shot at a 12-in. steel target 300 m away. Primary dependent variables were accuracy and speed for the one-shot drill and shot-to-shot reload drill, whereas the 100-m drill and 300-m drill were assessed for speed alone. Because the targets were steel and not ringed bullseye targets, the specific position of each successful hit was not recorded.

RESULTS

See Table 2 for descriptive statistics regarding firearm experience for the military sample and the community sample.

Firearm Opinion Survey

A subset of the firearm proficiency survey asked responders about the degree to which they possessed certain firearm skills or abilities on a Likert-type scale. These nine questions were analyzed via principal component analysis with varimax rotation across all 117 participants. Bartlett's test of sphericity was significant, $\chi^2(36) = 411.27, p < .001$, and the Kaiser–Meyer–Olkin measure of sampling adequacy indicated high relationship strength between the variables (0.87). Initially, two factors with eigenvalues greater than 1 were extracted. The first factor yielded an eigenvalue of 4.12 and accounted for 45.78% of the variance. The second factor yielded an eigenvalue of 1.27 and accounted for 14.06% of the variance. Results are shown in Table 3.

The factor analysis yielded two components that will be described as self-rated proficiency (component 1), which addresses perception of personal firearm competency, and natural proficiency (component 2), which addresses the belief that firearm competency includes some degree of natural ability. For self-rated proficiency, several questions were recoded so that all self-reported scores could be summed such that higher scores indicated greater self-confidence in firearm abilities. The military sample yielded a significantly higher score for self-rated proficiency, $M = 23.98, SE = 0.48$, than the community sample, $M =$

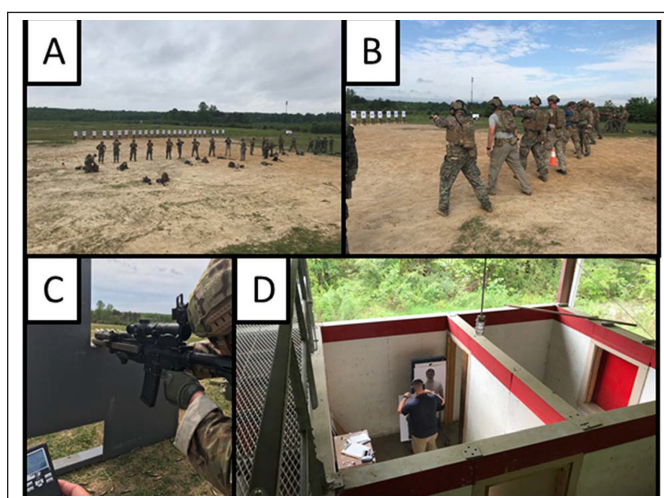


FIGURE 2. (a) Shooters preparing to perform shooting assessments. (b) Shooters performing the 25-m bullseye drill with pistol. (c) A shooter braced against a barricade during the 100-m shooting drill. (d) A researcher replacing a target in a live fire shoothouse for the lethality data

TABLE 2. Descriptive Statistics for Categorical Data and Continuous Data From the Firearm Proficiency Survey by Community Sample and Military Sample

	Community sample	Military sample
Categorical data (yes or no)		
Held a firearm	91.67% (<i>n</i> = 66)	100.00% (<i>n</i> = 47)
Shot a firearm	87.50% (<i>n</i> = 63)	100.00% (<i>n</i> = 47)
Taken a firearm course	63.89% (<i>n</i> = 46)	93.62% (<i>n</i> = 44)
Hunted with a firearm	19.72% (<i>n</i> = 14)	38.30% (<i>n</i> = 18)
Participated in a competition	14.29% (<i>n</i> = 10)	35.56% (<i>n</i> = 16)
Continuous data		
Comfort with a firearm (1–5)	3.93 (1.10)	4.79 (0.41)
Self-rated expertise (1–7)	4.00 (1.77)	5.45 (1.02)
Age began shooting, <i>y</i>	14.95 (7.01)	12.45 (4.88)
Times shooting per year	4.17 (4.86)	35.57 (31.99)
Speed vs. accuracy	1.89 (1.87)	0.83 (1.63)

Note. Categorical data report percentages of responders who answered “yes” to the question (with raw numbers in parentheses). Continuous data report the means for each question (with standard deviations in parentheses). For the “comfort with a firearm” question, a 5 was rated as highest comfort and 1 rated as the lowest comfort. For the self-rated expertise, 7 was rated as the highest expertise and 1 was rated as the lowest expertise.

TABLE 3. Factor Loadings of the Two Significant Components for the Firearm Proficiency Opinion Subscale

Question	Component 1	Component 2
In general, I am an exceptional firearm shooter.	–0.882	–0.046
I can attain a perfect score on a marksmanship test.	–0.795	–0.072
It is difficult for me to shoot under stress.	0.796	0.094
I would have a hard time passing a professional firearm qualification test.	0.817	0.145
I am not very familiar with the mechanical workings of firearms.	0.786	–0.055
I am generally at ease around firearms.	–0.766	–0.054
You need to be brought up with guns to be a good shooter.	0.137	0.763
Some people are naturally good at shooting.	–0.274	0.669
No matter how much I practice, my shooting performance does not improve much.	0.264	0.482

19.03, $SE = 0.72$, $t(116) = 5.72$, $p < .001$, Cohen’s $d = 1.01$. For natural proficiency, all questions loaded in the same direction and could be summed such that higher scores indicated greater belief that some extent of firearm proficiency was dependent on natural abilities. The military sample had a lower score for natural proficiency opinions, $M = 7.02$, $SE = 0.20$, than the

community sample, $M = 7.56$, $SE = 0.22$, although the two groups were not significantly different, $t(116) = 1.81$, $p = .07$, Cohen’s $d = 0.33$. Both factors were then compared against marksmanship performance in the community sample and military sample, respectively. See Table 4 for correlations between self-reported marksmanship performance.

TABLE 4. Correlations Between Self-Reported Marksmanship Performance Areas (Comfort, Expertise, Self-Rated Proficiency, and Natural Proficiency) as Divided Between the Community and Military Samples

Group	Comfort	Expertise	Self-rated proficiency	Natural proficiency
Community				
Comfort	—	-.77**	-.80**	-.08
Expertise	-.77**	—	.84**	-.09
Self-rated proficiency	-.80**	.84**	—	-.02
Natural proficiency	-.08	-.09	-.02	—
Military				
Comfort	—	-.23	-.51**	.26
Expertise	-.23	—	.64**	-.13
Self-rated proficiency	-.51**	.64**	—	-.23
Natural proficiency	.26	-.13	-.23	—

Note. Statistical significance is evaluated via Bonferroni correction, setting p value to .008 for significance.
** $p < .008$.

Community Sample Results

The community sample had four types of marksmanship drills for comparison: short-range drill, box drills, pop-up targets, and long-range drill. See Table 5 for correlations on performance between drills. An overall marksmanship score was calculated as the percentage of possible points earned across the drills. Lethality metrics were calculated from the scenarios as the hostile hit rate and the false alarm rate, which described those incidents of firing on civilians during a scenario. These drills were compared with self-

reported metrics, including comfort with a firearm, self-rated expertise, self-rated proficiency opinions, and natural proficiency opinions.

Several trends emerged from evaluating the marksmanship data (Table 6 and Figure 3). First, several self-report metrics (comfort, expertise, and self-rated proficiency) correlated significantly with marksmanship performance, and only natural proficiency did not significantly correlate with any variables. This outcome suggests that the self-reported marksmanship metrics could explain a significant

TABLE 5. Correlations Between Marksmanship Drills and Lethality Drills on the Shooting Simulator

Correlation table	Short range	Box drill	Pop-up targets	Long range	Lethality hit rate	Lethality false alarm
Short range	—	.36	.16	.24	.27	-.19
Box drill	.36	—	.62**	.37	.69**	-.20
Pop-up targets	.16	.62**	—	.36	.55	-.12
Long range	.24	.37	.36	—	.25	-.16
Lethality hit rate	.27	.69**	.55	.25	—	-.15
Lethality false alarm	-.19	-.20	-.12	-.16	-.15	—

Note. Statistical significance is evaluated via Bonferroni correction, setting p value to .003 for significance.
** $p < .003$.

TABLE 6. Correlations Observed Between Self-Reported Firearm Performance (Comfort, Expertise, Proficiency) and Marksmanship Metrics Among Community Sample Participants

	Comfort	Expertise	Self-rated proficiency	Natural proficiency
Marksmanship				
Overall	$r = .52, p < .001^a$	$r = .49, p < .001^a$	$r = .51, p < .001^a$	$r = -.14, p = .26$
Short range	$r = .15, p = .22$	$r = .12, p = .39$	$r = .02, p = .88$	$r = .01, p = .95$
Box drill	$r = .53, p < .001^a$	$r = .49, p < .001^a$	$r = .53, p < .001^a$	$r = -.13, p = .32$
Pop-up targets	$r = .39, p < .001^a$	$r = .36, p = .006$	$r = .34, p = .005$	$r = -.18, p = .15$
Long range	$r = .05, p = .71$	$r = .10, p = .44$	$r = .03, p = .82$	$r = -.06, p = .63$
Lethality				
Hostile hit rate	$r = .64, p < .001^a$	$r = .57, p < .001^a$	$r = .58, p < .001^a$	$r = -.09, p = .48$
False alarm rate	$r = -.17, p = .20$	$r = -.08, p = .55$	$r = -.10, p = .46$	$r = -.31, p = .02$

^aSignificant results following Bonferroni correction ($\alpha = .05/35 = .0014$).

amount of overall variation both for individual tasks and when collapsed across tasks. Although self-reported metrics did not correlate with either short-range marksmanship or the long-range marksmanship task, it is possible that the limited round count did not produce enough variance to indicate any differences, although this explanation does not address why the long-range drill produced more variance than any other drill. Additionally, none of the primary metrics correlated with false alarm rate in lethal force, supporting other evidence indicating the independence of pure marksmanship assessments from decision-making performance (Blacker et al., 2021). In sum, it appears that self-reported opinions adequately captured a large amount of observable difference in overall marksmanship capabilities when sampling from the general population and capturing a wide range of abilities.

Military Sample Results

The military sample had seven different marksmanship drills, three with a pistol and four with a rifle. Correlations between tasks are available in Table 7. These marksmanship drills are also compared with a simulated room clearing exercise where experimenters evaluated the number of lethal rounds fired on hostile targets and the number of nonlethal rounds fired on hostile targets (Table 8). Across all the observed correlations, there were only three findings

that reached the $p < .05$ level of significance. However, these findings would not be significant after Bonferroni correction of the data. Given all the correlations conducted, the conclusive trend is that no self-reported marksmanship metric correlated with actual performance as measured during static marksmanship assessments on a flat range or lethality metrics during a simulated room clearing exercise. It is also worth noting that the correlations presented primarily include time to complete the drill, given the high accuracy rate among trained infantry personnel who conducted the drills. Still, the same analyses were conducted on accuracy, as well as time to completion, and arrived at the same conclusion of no significant correlations between self-reported marksmanship capabilities and actual marksmanship performance.

Military Sample Versus Community Sample

Each population sample has an omnibus marksmanship performance score, which was converted to a respective z score within the group to allow a direct comparison between the two groups. A hierarchical linear regression was conducted, with the first step having five factors: military experience (categorical), comfort, self-rated expertise, self-rated proficiency, and natural proficiency. The second step compared interaction terms between military experience and the four self-reported measures to identify any potential interactions. See Figure 3 for plots related to the

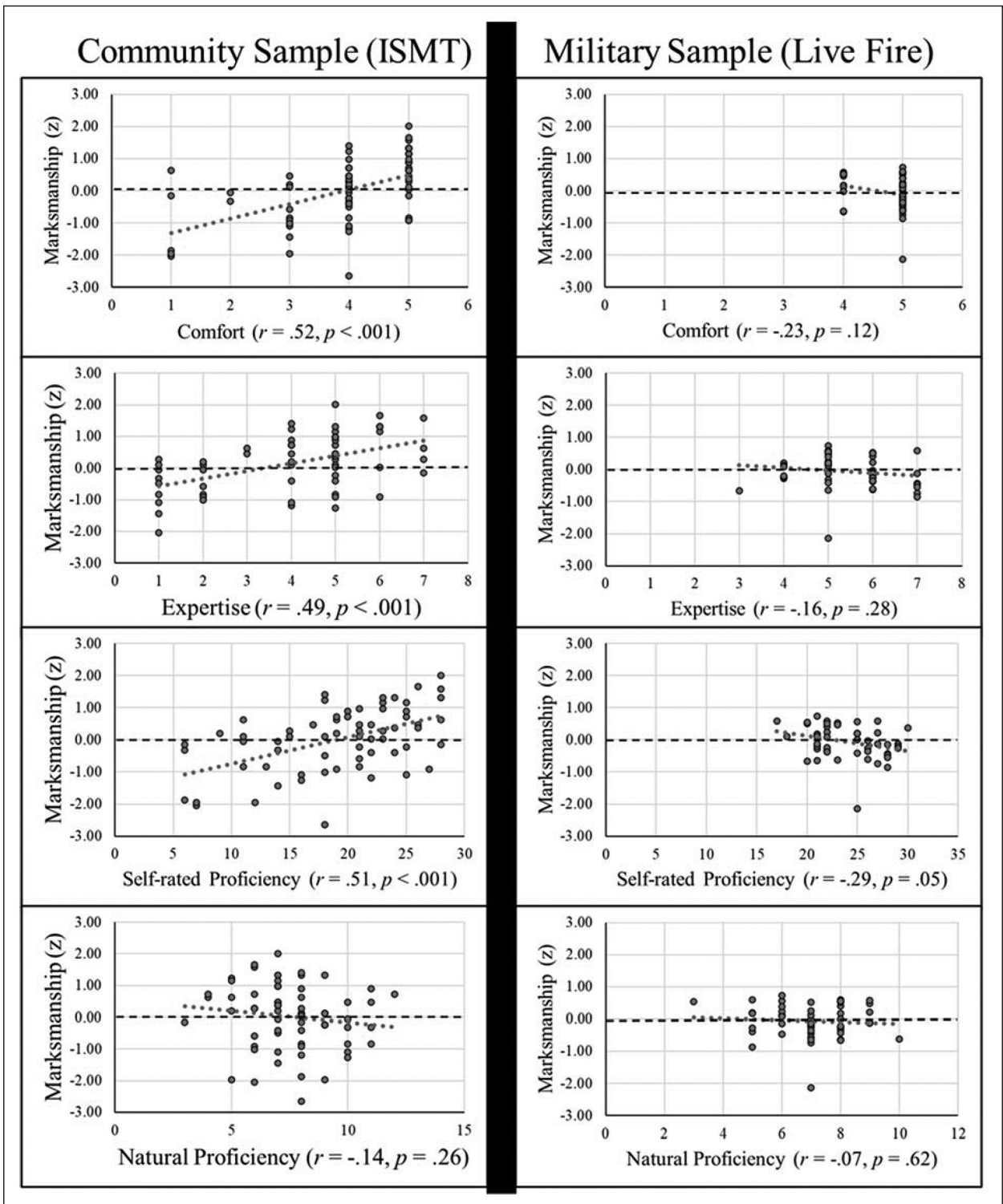


FIGURE 3. The z scored overall marksmanship capabilities for community sample and military sample participants plotted against scores for comfort, expertise, self-rated proficiency, and natural proficiency. Dotted blue lines indicate the line of best fit for the relationship, and dotted black lines indicate the zero mark for the z-scores. ISMT = Indoor Simulated Marksmanship Trainer

TABLE 7. Correlations Between Live-Fire Marksmanship Performance

Measure	Pistol bullseye	Pistol OSD	Pistol S-to-S	Rifle OSD	Rifle S-t-S	Rifle 100 m	Rifle 300 m
Score							
Pistol bullseye	—	-.01	.15	.06	.00	-.24	-.12
Pistol OSD	-.01	—	.56**	-.04	.13	-.05	.02
Pistol S-to-S	.15	.56**	—	-.12	-.13	.11	.01
Rifle OSD	.06	-.04	-.12	—	.10	.06	-.07
Rifle S-t-S	.00	.13	-.13	.10	—	-.19	-.53**
Rifle 100 m	-.24	-.05	.11	.06	-.19	—	.28
Rifle 300 m	-.12	.02	.01	-.07	-.53**	.28	—
Time							
Pistol bullseye	—	—	—	—	—	—	—
Pistol OSD	—	—	.62**	.27	.48**	-.07	.17
Pistol S-to-S	—	.62**	—	.43**	.34	.05	.18
Rifle OSD	—	.27	.43**	—	.37	-.01	.15
Rifle S-t-S	—	.48**	.34	.37	—	-.04	.08
Rifle 100 m	—	-.07	.05	.00	-.04	—	-.33
Rifle 300 m	—	.17	.18	.15	.08	-.33	—

Note. *Pistol* or *rifle* refers to the weapon used during the drill. *Bullseye* describes an untimed bullseye drill where only accuracy was measured. Scores for the one-shot draw (OSD) and shot-to-shot (S-t-S) drills were calculated based on points. Scores for 100-m and 300-m rifle tasks were based on number of shots to hit the target. Statistical significance was evaluated via Bonferroni correction, setting p value to .002 for significance. ** $p < .002$.

TABLE 8. Correlations Observed Between Self-Reported Firearm Performance (Comfort, Expertise, Proficiency) and Marksmanship Metrics Among Military Sample Participants

	Comfort	Expertise	Self-rated proficiency	Natural proficiency
Marksmanship				
Overall	$r = -.23, p = .12$	$r = -.16, p = .28$	$r = -.29, p = .05$	$r = -.07, p = .62$
Pistol				
Bullseye drill	$r = .09, p = .53$	$r = .16, p = .29$	$r = -.04, p = .79$	$r = -.17, p = .25$
One-shot draw	$r = .13, p = .38$	$r = -.04, p = .77$	$r = -.13, p = .37$	$r = .00, p = .99$
Shot-to-shot	$r = .07, p = .65$	$r = .10, p = .53$	$r = -.07, p = .63$	$r = -.09, p = .56$
Rifle				
One-shot draw	$r = .23, p = .12$	$r = -.22, p = .15$	$r = -.37, p = .01$	$r = -.08, p = .59$
Shot-to-shot	$r = .17, p = .25$	$r = -.24, p = .10$	$r = -.14, p = .33$	$r = -.04, p = .81$
100 m	$r = .07, p = .66$	$r = -.14, p = .37$	$r = -.12, p = .42$	$r = .32, p = .03$
300 m	$r = .06, p = .68$	$r = -.24, p = .10$	$r = -.19, p = .21$	$r = -.14, p = .34$
Lethality				
Lethal rounds fired	$r = -.06, p = .73$	$r = .04, p = .79$	$r = .13, p = .50$	$r = .02, p = .92$
Nonlethal rounds fired	$r = -.04, p = .81$	$r = .17, p = .31$	$r = .13, p = .52$	$r = -.15, p = .43$

regression model. Both regression steps produced significant results. The first step, adjusted $R^2 = .20$, $F(5, 98) = 6.23$, $p < .001$, produced two significant predictors: military experience, $\beta = -0.395$, $p < .001$, and comfort, $\beta = 0.44$, $p < .01$. The second step, adjusted $R^2 = .28$, $F(9, 94) = 5.34$, $p < .001$, produced three significant predictors: military experience, $\beta = 2.48$, $p = .02$; comfort, $\beta = 1.28$, $p < .01$; and the interaction between military experience and comfort, $\beta = -2.69$, $p = .03$.

Comfort may not be a particularly reliable predictor among the military population given the ceiling effects in their reported comfort levels with firearms. However, there is an overall trend toward decreases in actual proficiency, as measured by marksmanship scores, when there are increases in reported proficiency, as measured by the self-reported survey results. Still, the primary reason for the interaction between military experience and comfort appears to be the reversal, where increased comfort predicts increased marksmanship in the community sample and not the military sample.

DISCUSSION

Marksmanship remains a critical skill to develop for military, law enforcement, and security personnel. Many models have been proposed to evaluate the development of these skills, such as the phases-of-skill-development model that suggests critical roles for perceptual-motor abilities, cognitive abilities, and even affective abilities (Chung, Delacruz, de Vries, Bewley, & Baker, 2006). Such models highlight the importance of many different factors, although one underexplored factor has been the relationship between self-reported opinions of marksmanship performance and the actual marksmanship capabilities. The distinction is important because, without concrete data to the contrary, discussions about marksmanship competence and training are based largely on self-reported abilities. This issue is further complicated by the myriad weapons, distances, and assessment tasks that often make it difficult or impractical to compare different marksmanship evaluations, leaving self-report and opinions as primary means of communicating marksmanship skill.

The observed results suggested some significant relationships between marksmanship performance and self-reported opinions when evaluated among a community sample. These correlations applied primarily to marksmanship alone, whether in drills or in lethal force scenarios, but these relationships did not extend to the likelihood of inflicting civilian casualties during lethal force scenarios. It could be argued that the lack of any predictive relationship among civilians is due to lack of exposure or experience with lethal force training; however, this explanation would apply only to civilians and would not explain the lack of a relationship between lethal force errors for military personnel and self-reported opinions. Moreover, the professional participants—people trained in firearm use—did not have any consistently significant relationships between their self-reported firearm capabilities and their actual marksmanship performance. This lack of correlation occurred for both the marksmanship assessments and the number of lethal rounds fired during a close quarters room clearing exercise.

A concise summary of the findings is that self-reported firearm capabilities correlated with actual marksmanship performance but only for a community sample, not a professional military sample. The question then becomes, Why did we observe this difference between the samples? One plausible explanation is that this community sample reflects a wider swath of marksmanship abilities, from people with some prior firearm experience (e.g., hunting) and those who have never used a firearm. Previous university-based samples tended to report lower rates of firearm experience, with less than half the participants having ever fired a weapon (Biggs, 2017). The greater range of abilities may be due to the current study recruiting from a community sample near a military base, which increased the overall experience and exposure to firearms relative to a collegiate undergraduate population. Given this wide range of abilities, self-reported opinions appear to provide at least an adequate facsimile in lieu of a quantifiable marksmanship task. This distinction changes in a military sample. Different people have been exposed to different forms of training and different levels of skill among their peers. This latter point is especially important because some of

the disparity might be due to the relative comparison made in evaluating expertise. That is, a professional marksman might consider the highest skill to be one of the best shooters in the world, with an ample understanding of the implications that skill level confers. The comparison is then akin to the community sample using a reference point of being “skilled” among their local community, whereas the military sample using a reference point of much greater capabilities—not unlike asking whether a runner is fast compared with high school athletes versus Olympic sprinters.

An interesting alternative explanation is that the lack of significant relationship between self-reported opinions and actual marksmanship could be an extension of the Dunning–Kruger effect (Dunning et al., 2003; Kruger & Dunning, 1999; Schlösser et al., 2013; Simons, 2013). The average population (e.g., a community sample) has low marksmanship abilities without seeking out some source of training, given that many people never fired a weapon previously in their life. In this case, a marginal amount of training creates the presumption of higher skill, which preserves differences of opinion and skill while the sample remains limited to the general community. However, when extended to a truly professional population with a high degree of knowledge and expertise, the opinions become far more diverse. Shooters become aware of precisely how much there is to know relative to what they do know, and the end result is a self-reported score moderated by greater knowledge about the myriad factors that can influence marksmanship. Highly skilled shooters are in a position to recognize the shortcomings of their marksmanship performance, and when evaluated in that light, their self-reported opinions no longer adequately reflect differences in actual marksmanship capability. This interpretation does have some assumptions inherent to it, although this explanation could describe why self-reported marksmanship adequately explains actual marksmanship differences in a community sample but not a professional military sample.

Some limitations should be noted with these findings. Foremost, the community and military samples used different platforms to evaluate marksmanship.

This difference could lead to concerns about the transferability of results between simulator and live fire performance, but previous work has demonstrated some comparable performance for people on both simulators and live fire (Getty, 2014; Jensen & Woodson, 2012). Equipment-related differences could also have affected performance because the physical load of military equipment can affect marksmanship (Brown & Mitchell, 2017; Brown, McNamara, & Mitchell, 2017), although the equipment issue remains a limited confounding variable because comparisons were made within groups, and the interpretations looked for differences between the two communities. Another limitation could be the sample size. Despite military rankings of expertise on marksmanship tasks, the comparison of expertise within and between trained and untrained populations remains largely unknown. Presumed firearm experts, deemed as such from qualifying on military marksmanship tasks, could potentially have less skill and experience with a firearm than the typical hunter or recreational shooter. The range of knowledge and skills may then require a larger sample to adequately probe skill differences between individuals with firearm experience.

In conclusion, self-reported or survey metrics have been understudied in the field of marksmanship, yet these aspects remain critically important because self-report is the primary means by which to compare marksmanship ability when the tests themselves are quite different from one another. Opinions should not drive military and law enforcement procedures for evaluating performance or designing new training methods, yet opinions are sometimes the only avenue available to compare skills. For researchers, self-reported opinions appear to be a sufficient way to gauge marksmanship ability when dealing with a community sample. These questions could supplement computer-based investigations of lethal force decision making when a more concrete evaluation of marksmanship is not available. However, opinions do little to reflect actual performance when dealing with a military or law enforcement community. Talk is cheap among professionals, and performance needs to be measured through action, not words.

- 7c. How many times per year do you fire your duty firearm as part of your ongoing training?
- 7d. When did you last shoot your duty firearm as part of your ongoing training (e.g., last week, 2 months ago)?
- 7e. Describe this training (average number of rounds fired, exercises/drills, target types, etc.).
- 7f. How many times in your career have you participated in force-on-force training using non-lethal training ammunition (e.g., Simunition®)?
- 7g. How many times in your career have you participated in laser-based firearms training (e.g., MILO, Range 2000/3000, BEAMhit)?
- 7h. Describe the most stressful/realistic firearms training you have done, and when and where you did it.
- 7i. Over and above your ongoing training, do you practice with a firearm in your own time?
- Yes
- No

If you answered Yes to Question 7i:

- 7j. How many times a year?
- 7k. When did you last practice?
- 7l. How long is your average practice session (hours and minutes)?
- 7m. How many rounds do you fire during an average session?

- 7n. How many occasions during your career have you had to draw your firearm on a suspect?
- 7o. How many occasions during your career have you had to fire your firearm at a suspect?

8. If you practice with live fire on your own, do you

Yes No

- Draw your firearm from a holster
- Practice speed drawing
- Draw from concealment
- Shoot from different positions (standing, kneeling, prone)
- Shoot with your non-dominant hand
- Shoot from behind cover
- Shoot while moving
- Shoot with environmental stressors (flashing lights, noise, etc.)
- Shoot under reduced lighting conditions
- Use a flashlight to illuminate your target
- Shoot at silhouette targets
- Shoot at multiple targets
- Shoot at moving targets
- Shoot at targets closer than three yards
- Shoot at targets further than twenty yards
- Practice quick shooting
- Practice point shooting
- Practice clearing malfunctions or jams
- Practice quick or tactical reloading
- Practice trigger control
- Practice making shoot/don't shoot decisions
- Shoot after physical exertion (running, jumping jacks, etc.)
- Shoot under time pressure
- Practice team tactics with at least one other person
- Shoot against others competitively
- Score your shots
- Physically measure your group size

9. Do you practice dry firing?

- Yes
- No

If you answered Yes to Question 9:

- 9a. How often do you engage in dry fire practice?
- 9b. How long do you typically practice?

10. How often did you carry a firearm for self-defense during the last 12 months?

- Almost every day
- Several times a week
- About once a week
- Several times a month
- About once a month
- Several times a year
- Only once
- Never

11. The following questions are intended to investigate your beliefs about the degree to which you possess various skills and abilities. If you have not shot a firearm before, respond with what you think would be the case. There are no right or wrong answers. Please respond with the first thing that comes to mind (i.e., your “gut instinct”).

Strongly disagree		Neither		Strongly agree	
①	②	③	④	⑤	In general, I am an exceptional firearm shooter.
①	②	③	④	⑤	I can attain a perfect score on a marksmanship test.
①	②	③	④	⑤	It is difficult for me to shoot under stress.
①	②	③	④	⑤	You need to be brought up with guns to be a good shooter.
①	②	③	④	⑤	I would have a hard time passing a professional firearms qualification test.
①	②	③	④	⑤	Some people are naturally good at shooting.
①	②	③	④	⑤	I am not very familiar with the mechanical workings of firearms.
①	②	③	④	⑤	No matter how much I practice, my shooting performance does not improve much.
①	②	③	④	⑤	I am generally at ease around firearms.

12. Circle the number that best describes your shooting preference of speed and accuracy (5 = speed/accuracy are most important, 0 = both are equally important).

Speed ← 5 4 3 2 1 0 1 2 3 4 5 → Accuracy

NOTES

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or U.S. Government. The authors are military service members or employees of the U.S. Government. This work was prepared as part of their official duties. Title 17 U.S.C. §105 provides that “Copyright protection under this title is not available for any work of the United States Government.” Title 17 U.S.C. §101 defines a U.S. Government work as a work prepared by a military service member or employee of the U.S. Government as part of that person’s official duties. The authors have no financial or nonfinancial competing interests in this manuscript. This work was supported by the Office of Naval Research and funded by work unit number H1202. The study protocol was approved by the Naval Medical Research Unit Dayton Institutional Review Board in compliance with all applicable federal regulations governing the protection of human subjects.

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