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Tactile and Visual Identification of the XM106 Bursting Smoke Grenade: Limited User Evaluation

by Clifford C. Swiecicki, Elizabeth S. Redden, and Christian B. Carstens

ARL-TR-5416 **December 2010**

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Human Research and Engineering Directorate, ARL

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14. ABSTRACT
This experiment evaluated the tactile and visual identification of the XM106 bursting smoke grenade in a variety of situations representing the typical handwear and eyewear configurations of dismounted Warfighters. Thirty-six test Soldiers participated in the evaluation from 17 to 25 September 2009. After being trained on the visual and tactile features of the XM106 bursting smoke grenade and the M83 smoke grenade (with and without a "pull safe" device), each Soldier completed tactile and visual identification performance trial exercises. Tactile identification trials had Soldiers identify grenades by touch alone, using bare hands; contact gloves; nuclear, biological, and chemical (NBC) gloves; and cold weather gloves. Visual identification trials had Soldiers identify grenades using normal vision, the Enhanced Night Vision Goggles, the AN/PVS-14 night vision goggles, the NBC protective mask, and the ballistic laser eye protection system with tinted lens. Performance trials included identification under a cognitive load (while operating a robot) and identification while under a physical load (individual movement techniques). The XM106 was also evaluated through the use of Soldier questionnaires and observations from representatives of the U.S. Army Research Laboratory, Human Research and Engineering Directorate. Findings indicated that the XM106 bursting smoke grenade could be readily distinguished from the M83 smoke grenade under all handwear and eyewear conditions.

15. SUBJECT TERMS
XM106, smoke grenade, tactile/visual identification

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1. Introduction

Hand grenades have been effective weapons in the arsenals of fighting forces for hundreds of years. Skennerton[1] dates the first use of the grenade to be sometime during the 15th century. Hand grenades were widely used in World Wars I and II, the Korean War, and the Vietnam War.[1-3] Over time, their major role changed from that of an offensive weapon to a defensive weapon (e.g., production of smoke to obscure vision). Although hand grenades appear to be simple to use, safe, and effective, operation can be difficult. Without proper training, the hand grenade can be more lethal to the person employing it than to the enemy.

There are basically two types of smoke grenades: emission smoke grenades (those from which smoke escapes rather slowly from emission holes and that create heat which can harm the user) and bursting grenades (those from which smoke is spread by explosive action and that create an explosion which can harm the user). Incorrect use of either can cause injury or fatality; however, bursting grenades are much more dangerous to users, as they must throw the grenade quickly before it explodes. Thus it is particularly important to easily distinguish a bursting smoke grenade and one from which smoke is slowly emitted.

1.1 Differentiation Between Grenades

Differentiation of rounds of ammunition and types of grenades has been a topic of study for many years. Tactile markings, color coding, iconic drawings, shapes, etc., have been considered to help with the differentiation of ammunition and grenades. In the late 1960s, the Engineering Sciences Laboratory Information Report no. 254[4] was prepared by the Human Factors Section of Picatinny Arsenal, which investigated the problem of differentiating hand grenades with a delay fuze from those with an impact fuze. It discussed the advantages and disadvantages of six different approaches to solving the differentiation problem. The approaches included color coding, a pictorial display on the grenade body, an embossed safety lever, a dual safety, a knurled plastic tab or cap fitted to the grenade body and secured by the fuze, and user training. The recommendation from the report was that a knurled plastic cap placed upon the upper half of the grenade body offered the best means of differentiating dissimilarly fuzed grenades. Engineering Sciences Laboratory Information Report no. 255,[5] a follow-on to the previous report, provided the results from a field study of the grenade with the knurled plastic cap and a

[1]Skennerton, E. D. *An Introduction to British Grenades*; Margate: Dural, Austrailia, 1988.

[2]Canfield, B. N. *U.S. Infantry Weapons of the First World War*; Andrew Mowbray, Inc.: Lincoln, RI, 2000.

[3]Canfield, B. N. *U.S. Infantry Weapons of World War II*; Andrew Mowbray, Inc.: Lincoln, RI, 1996.

[4]Human Factors Section, Picatinny Arsenal. *Differentiating Hand Grenades Fuzed With a Delay Fuze From Those Fuzed With an Impact Fuze*; Report no. 254; Engineering Sciences Laboratory Information: Picatinny Arsenal, NJ, 1966.

[5]Human Factors Section, Picatinny Arsenal. *Effectiveness of a Knurled Plastic Cap as a Grenade Coding Device*; Report no. 255; Engineering Sciences Laboratory Information: Picatinny Arsenal, NJ, 1966.

standard M26 delay fuzed grenade. Blindfolded subjects had to differentiate between the two types of grenades solely by the sense of touch with bare hands and while wearing Arctic gloves. Correct differentiation was achieved over 97% of the time, which demonstrated that a knurled plastic cap was an effective aid in differentiating grenades with different functions.

1.2 Overview of Experiment

This study was an investigation of Soldiers' ability to differentiate between the XM106 and two versions of the M83 smoke grenade rounds. Several smoke grenades are currently fielded; they are all very similar in terms of physical characteristics. The M83 was chosen as a representative of currently fielded smoke grenades. Many of the XM106 physical characteristics are similar to these other smoke grenades as well. However, the XM106 is a bursting grenade and needs to be thrown immediately after the pin is pulled, otherwise the Warfighter incurs the risk of injury or compromise to the mission. Therefore, it is important that the Warfighter be able to distinguish the XM106 from other smoke grenades. Currently, the most distinguishing feature of the XM106 is the "pull-safe" device on top, which is not a feature of the M83. However, the pull-safe device is envisioned to be placed on other smoke grenades in the future. Therefore, it is important to include an M83 with this device added in the experiment to ensure that Soldiers will be able to differentiate between the M83 and the XM106 in the future.

The experiment took place at Fort Benning, GA. Thirty-six Soldiers from the Officer Candidate School (OCS) and Warrior Training Center (WTC) participated in the study. After training on the characteristics of the grenades, each Soldier completed exercises in which they had to differentiate between the grenade types. The presentations were counterbalanced, and the design of the XM106 was evaluated based on objective performance data, data collector observations, and information from Soldier questionnaires.

1.3 Objectives

The primary objectives of this experiment were to evaluate the capability of Soldiers to distinguish between the current M83 and the XM106 and between the M83 with "pull-safe (w/PS)" device (envisioned for the future) and the XM106. Trials were conducted to evaluate the Soldiers' ability to correctly identify grenades under various environmental clothing conditions. The major goals were as follows:

1.3.1 Handwear Compatibility

- Assess the impact of various handwear on the Soldiers' ability to correctly distinguish the XM106 from the two versions of the M83 smoke grenades using their bare hands or while wearing contact gloves; nuclear, biological, and chemical (NBC) gloves; and cold weather gloves.
- Soldiers' overall ratings of identification tasks.

1.3.2 Eyewear Compatibility

- Assess the impact of various eyewear on the Soldiers' ability to correctly identify or distinguish the XM106 from the two versions of the M83 smoke grenades using their normal vision or while wearing the Enhanced Night Vision Goggles (ENVG), AN/PVS-14, NBC protective mask, and ballistic laser eye protection system (BLEPS).
- Soldiers' overall ratings of identification tasks.

1.3.3 Physical Load

- Assess the impact of a physical load on the Soldiers' ability to correctly identify or distinguish between the XM106 and the two versions of the M83 smoke grenades using their bare hands and normal vision.
- Soldiers' overall ratings of identification tasks.

1.3.4 Cognitive Load

- Assess the impact of a cognitive load on the Soldiers' ability to correctly identify or distinguish between the XM106 and the two versions of the M83 smoke grenades using their bare hands and normal vision.
- Soldiers' overall ratings of identification tasks.

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2. Method

2.1 Participants

Thirty-six Soldiers were recruited from the OCS and WTC to participate in the study. Although the OCS and WTC were officially requested for troops, it was made clear that Soldier participation in the experiment was voluntary. OCS Soldiers included those with prior service as well as those who entered directly from college.

2.2 Apparatus

2.2.1 XM106 Grenade, Hand, and Smoke: Visual Restricted Terrain

The XM106 (figure 1) answers the need for rapid obscuration in urban operations and restricted terrain. The grenade weighs 18.8 oz and is 2.5 inches in diameter and 5.55 inches long. The XM106 contains titanium dioxide, a nontoxic, noncombustible fill, and is explosively dispersed to form a dense, obscurant cloud within 1–2 s after employment. The XM106 uses 8 g of potassium perchlorate, aluminum, and pentaerythritol with nitrocellulose binder burster mix,

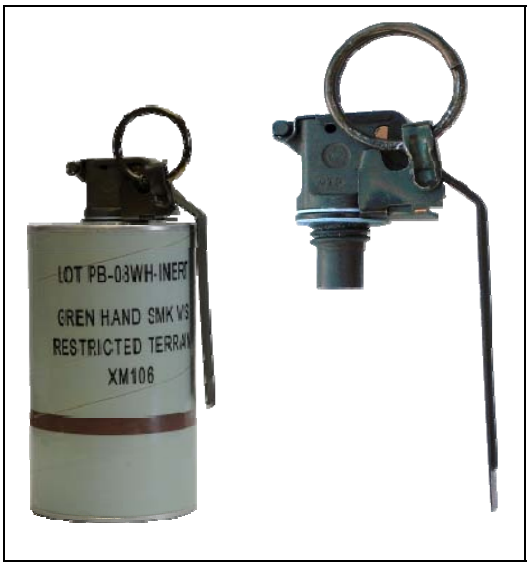

Figure 1. XM106 bursting smoke grenade.

which is initiated by the M201A1 MOD3 fuze. Although it is safer and less toxic than current smoke grenades, its short fuze and the burster composition make it dangerous to untrained Soldiers. The cloud formed by the XM106 is a particulate, rather than a toxic burning smoke generated by the AN M8 grenade. The XM106 obscures the visual and near-IR spectra. In an outdoor environment, the XM106 provides 5–9 s of effective obscuration (weather dependent). For long-lasting smoke (outdoor only), the M8 or M83 could be employed in conjunction with the XM106. Inside of a building, the XM106 provides 1.5–2 min of effective obscuration (it visually obscures a 12- × 12- × 12-ft room).

The XM106 will be employed in three mission areas:

- Detection Avoidance. The Warfighter will employ the XM106 in uncertain situations, (e.g., suspected ambush sites in restricted terrain) to degrade threat detection, observation, and engagement capabilities by the aided (image intensifiers and viewers) and unaided eye, and electro-optical devices associated with various weapon systems and equipment.
- Breaking Contact. The Warfighter will employ the XM106 to rapidly break line-of-sight contact with threat forces when unexpected detection, observation, or engagement has occurred.
- Assault Position. The Warfighter will employ the XM106 to cover dismounted maneuver prior to or during an assault on a threat position.

The XM106 grenade features a pull-safe device to prevent premature or inadvertent functioning of the grenade (the M83 currently does not have this device). Inert variants of the XM106 and M83 smoke grenades will be used in the study. The XM106 has similar physical characteristics to the M83. Its color is a lighter green than the forest green of the M83 with a brown band, and has a smooth top as compared to the indention on the top of the M83 grenade.

2.2.2 M83 White Smoke Hand Grenade

The M83 smoke hand grenade (figure 2) is used for screening the activities of small units and for ground-to-air signaling. The body is a cylinder of thin sheet metal, 2.5 inches in diameter, which is filled with 11 oz of terephthalic acid. The fuze is an M201A1. The grenade weighs 16 oz and is 2.5 inches in diameter and 5.7 in long. It currently has no safety clip, but one is planned for the future. The M83 produces a stream of white smoke for 25 to 70 s. The grenade has a forest green body with light green markings, a blue band, and a white top. The fuze is an M201A1.

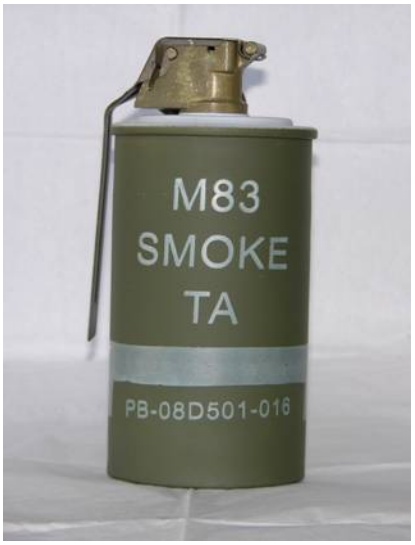

Figure 2. Fielded version of the M83 smoke grenade without pull-safe device.

2.3 Instruments

The questionnaires were designed to elicit Soldiers' opinions about their performance and experiences with each of the grenade types. The questionnaires asked the Soldiers to rate the distinguishing characteristics on a seven-point semantic differential scale ranging from "extremely good/easy to differentiate" to "extremely bad/difficult to differentiate." Questionnaires were administered to each Soldier at the end of the experiment day. Questionnaires were also used to gather information concerning demographic data, experience, and physical characteristics that might affect the participant's ability to differentiate between grenades.

2.4 Procedures

2.4.1 Overview of Activities

Six Soldiers a day participated in this experiment. They were first trained on the distinguishing characteristics of the three grenade types—the M83, the M83 with pull-safe device, and the XM106. After training, the Soldiers completed a series of exercises designed to evaluate the distinguishable visual and tactile characteristics of the grenades. These exercises included:

- Tactile differentiation using various gloves and bare hands.
- Visual differentiation using normal vision, night-vision goggles, and while wearing an NBC mask, and while wearing tinted eye protection.
- Differentiation while experiencing a cognitive load.
- Differentiation after physical exertion.

Differentiation exercises included exercises in which all three grenade types were available, and the Soldier had to choose the type requested. There were also exercises in which one of the grenade types was presented, and the Soldier must determine which type it was without the ability to make comparisons (i.e., compare which is the lighter color of green or which has the larger indentation). Soldiers were allowed to review the grenade characteristics during the time between each session.

2.4.2 Soldier Orientation

The experiment Soldiers reported in groups of six for one day each, 0800–1700 daily. Soldiers were issued a meals-ready-to-eat lunch by their unit. After they arrived, the experiment Soldiers received a roster number, which was used to identify them throughout the evaluation. The Soldiers were given an orientation on the purpose of the study and their participation. They were briefed on the objectives and procedures, as well as on the grenades. Any questions the Soldiers had concerning the experiment were answered. They were also told how the results will be used and the benefits the military can expect from this investigation.

2.4.3 Medical Status

After arriving at the experiment site, the Soldiers were asked to complete the medical status form shown in appendix A. If any of them had a medical profile or history that would jeopardize them if they participated in the study, they were excluded from the experiment.

2.4.4 Demographics

Demographic data was taken for each Soldier. Data concerning their physical characteristics and experience, especially their knowledge of grenades, was included in the demographic data sheet.

2.4.5 Training

No specialized experience was required from the requested Soldiers. Representatives from the Human Research and Engineering Directorate trained the Soldiers on the use of the grenades and their features. Training questions were included in the postiteration questionnaire so that Soldiers would have the opportunity to comment on the adequacy of training and provide suggestions for improvement of the training course.

2.4.6 Tactile Differentiation Using Gloves and Bare Hands

Soldiers stood and reached for the requested grenade from a box that contained two of each of the grenades with an opaque cover placed on a table in front of them. (See tables 1–4 for the order of grenades requested by handwear condition, with A representing the baseline M83 with current pull pin, B representing the M83 with the pull-safe pull ring configuration, and C representing the XM106 with the pull-safe pull ring configuration.) They were requested to quickly withdraw the requested grenade without looking at it and hand it to the data collector. The grenade was then returned to the box so the Soldier had six grenades to choose from. The position of the grenades inside the box was changed after each attempt. Data collectors recorded the number of correct grenades chosen and which grenade was chosen if incorrect.

Table 1. Order of grenades requested from the box barehanded.

	Iteration					
Roster	**1**	**2**	**3**	**4**	**5**	**6**
1, 16, 31	C	A	B	B	C	A
2, 17, 32	B	C	A	A	B	C
3, 18, 33	B	A	A	B	C	C
4, 19, 34	A	C	C	A	B	B
5, 20, 35	C	B	B	C	A	A
6, 21, 36	A	B	C	C	A	B
7, 22	C	B	B	A	C	A
8, 23	A	C	A	C	B	B
9, 24	B	A	A	C	B	C
10, 25	B	A	B	A	C	C
11, 26	C	B	C	B	A	A
12, 27	A	C	C	B	A	B
13, 28	B	C	A	A	B	C
14, 29	B	A	A	B	C	C
15, 30	A	C	C	A	B	B

Table 2. Order of grenades requested from the box using Nomex gloves.

	Iteration					
Roster	**1**	**2**	**3**	**4**	**5**	**6**
1, 16, 31	C	A	B	B	C	A
2, 17, 32	B	C	A	A	B	C
3, 18, 33	B	A	A	B	C	C
4, 19, 34	A	C	C	A	B	B
5, 20, 35	C	B	B	C	A	A
6, 21, 36	A	B	C	C	A	B
7, 22	C	B	B	A	C	A
8, 23	A	C	A	C	B	B
9, 24	B	A	A	C	B	C
10, 25	B	A	B	A	C	C
11, 26	C	B	C	B	A	A
12, 27	A	C	C	B	A	B
13, 28	C	A	B	B	C	A
14, 29	C	B	B	C	A	A
15, 30	A	C	C	B	A	B

Table 3. Order of grenades requested from the box using NBC gloves.

	Iteration					
Roster	**1**	**2**	**3**	**4**	**5**	**6**
1, 16, 31	B	A	A	C	B	C
2, 17, 32	B	C	A	A	B	C
3, 18, 33	A	C	C	A	B	B
4, 19, 34	B	A	A	B	C	C
5, 20, 35	A	C	C	A	B	B
6, 21, 36	B	C	A	A	B	C
7, 22	B	A	B	A	C	C
8, 23	C	B	C	B	A	A
9, 24	C	A	B	B	C	A
10, 25	C	B	B	C	A	A
11, 26	A	B	C	C	A	B
12, 27	A	C	C	B	A	B
13, 28	A	C	A	C	B	B
14, 29	C	B	B	A	C	A
15, 30	B	A	A	B	C	C

Table 4. Order of grenades requested from the box using cold weather gloves.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	A	B	C	C	A	B
2, 17, 32	A	C	C	B	A	B
3, 18, 33	C	A	B	B	C	A
4, 19, 34	C	B	C	B	A	A
5, 20, 35	B	A	A	C	B	C
6, 21, 36	C	B	B	C	A	A
7, 22	A	C	C	A	B	B
8, 23	C	B	B	C	A	A
9, 24	B	A	B	A	C	C
10, 25	C	A	B	B	C	A
11, 26	A	C	C	B	A	B
12, 27	B	C	A	A	B	C
13, 28	A	C	A	C	B	B
14, 29	C	B	B	A	C	A
15, 30	B	A	A	B	C	C

Tables 5–8 present the order in which the grenades were presented to the Soldiers one by one for them to identify. Soldiers identified the grenade type without looking at it. Soldiers were instructed to either keep their eyes closed or turn their hat around to cover their eyes during the trials. Data collectors recorded the number of correct grenades chosen and which grenade was chosen if incorrect.

Table 5. Order of grenades presented one by one using cold weather gloves.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	C	B	B	A	C	A
2, 17, 32	A	B	C	C	A	B
3, 18, 33	C	B	C	B	A	A
4, 19, 34	A	C	C	A	B	B
5, 20, 35	C	B	B	C	A	A
6, 21, 36	B	C	A	A	B	C
7, 22	B	C	A	A	B	C
8, 23	B	A	A	C	B	C
9, 24	A	C	C	B	A	B
10, 25	B	A	A	B	C	C
11, 26	B	A	B	A	C	C
12, 27	C	A	B	B	C	A
13, 28	B	A	A	B	C	C
14, 29	A	C	A	C	B	B
15, 30	A	C	C	A	B	B

Table 6. Order of grenades presented one by one using NBC gloves.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	A	C	C	B	A	B
2, 17, 32	A	B	C	C	A	B
3, 18, 33	C	B	B	A	C	A
4, 19, 34	C	B	B	C	A	A
5, 20, 35	A	C	A	C	B	B
6, 21, 36	C	B	C	B	A	A
7, 22	B	C	A	A	B	C
8, 23	C	B	B	C	A	A
9, 24	C	A	B	B	C	A
10, 25	B	A	A	C	B	C
11, 26	C	A	B	B	C	A
12, 27	A	C	C	B	A	B
13, 28	B	A	A	B	C	C
14, 29	A	C	C	A	B	B
15, 30	B	A	B	A	C	C

Table 7. Order of grenades presented one by one using Nomex gloves.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	A	C	C	A	B	B
2, 17, 32	B	C	A	A	B	C
3, 18, 33	B	A	A	C	B	C
4, 19, 34	C	B	C	B	A	A
5, 20, 35	A	B	C	C	A	B
6, 21, 36	B	A	B	A	C	C
7, 22	C	B	B	C	A	A
8, 23	B	A	A	B	C	C
9, 24	A	C	A	C	B	B
10, 25	C	B	B	A	C	A
11, 26	B	C	A	A	B	C
12, 27	A	C	C	B	A	B
13, 28	B	A	A	B	C	C
14, 29	A	C	C	A	B	B
15, 30	C	A	B	B	C	A

Table 8. Order of grenades presented one by one using bare hands.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	C	B	B	C	A	A
2, 17, 32	B	C	A	A	B	C
3, 18, 33	A	C	C	A	B	B
4, 19, 34	B	A	A	B	C	C
5, 20, 35	C	B	B	A	C	A
6, 21, 36	C	A	B	B	C	A
7, 22	C	B	B	C	A	A
8, 23	B	A	A	C	B	C
9, 24	C	B	C	B	A	A
10, 25	A	C	A	C	B	B
11, 26	A	C	C	B	A	B
12, 27	B	A	B	A	C	C
13, 28	A	B	C	C	A	B
14, 29	C	A	B	B	C	A
15, 30	A	C	C	B	A	B

2.4.7 Visual Differentiation Using Normal Vision, Night Vision Goggles, NBC Mask, and Tinted Eye Protection

Soldiers were positioned in front of a table, presented with the grenade types in a box that contained two of each type grenade, and asked to quickly hand the data collector the requested grenade in the order presented in tables 9–13. Data collectors recorded the number of correct grenades chosen and which grenade was chosen if incorrect.

Table 9. Order of grenades requested when normal vision is used.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	B	A	A	B	C	C
2, 17, 32	B	A	B	A	C	C
3, 18, 33	C	B	B	C	A	A
4, 19, 34	A	C	C	B	A	B
5, 20, 35	B	A	A	B	C	C
6, 21, 36	A	C	C	A	B	B
7, 22	A	B	C	C	A	B
8, 23	C	A	B	B	C	A
9, 24	A	C	C	A	B	B
10, 25	C	B	C	B	A	A
11, 26	B	A	A	C	B	C
12, 27	B	C	A	A	B	C
13, 28	C	B	B	A	C	A
14, 29	B	C	A	A	B	C
15, 30	A	C	A	C	B	B

Table 10. Order of grenades requested when ENVG are worn.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	A	B	C	C	A	B
2, 17, 32	C	A	B	B	C	A
3, 18, 33	C	B	B	A	C	A
4, 19, 34	B	A	A	C	B	C
5, 20, 35	B	A	B	A	C	C
6, 21, 36	B	A	A	B	C	C
7, 22	C	A	B	B	C	A
8, 23	A	C	C	B	A	B
9, 24	C	B	B	C	A	A
10, 25	A	C	C	A	B	B
11, 26	C	B	B	C	A	A
12, 27	A	C	C	B	A	B
13, 28	B	C	A	A	B	C
14, 29	C	B	C	B	A	A
15, 30	A	C	A	C	B	B

Table 11. Order of grenades requested when AN/PVS-14s are worn.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	A	C	A	C	B	B
2, 17, 32	B	A	A	C	B	C
3, 18, 33	A	C	C	B	A	B
4, 19, 34	B	C	A	A	B	C
5, 20, 35	A	C	C	A	B	B
6, 21, 36	C	B	B	A	C	A
7, 22	B	A	A	B	C	C
8, 23	B	A	B	A	C	C
9, 24	A	B	C	C	A	B
10, 25	B	C	A	A	B	C
11, 26	B	A	A	B	C	C
12, 27	C	B	C	B	A	A
13, 28	C	B	B	C	A	A
14, 29	C	A	B	B	C	A
15, 30	A	C	C	A	B	B

Table 12. Order of grenades requested when tinted eye protection is worn.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	B	A	A	B	C	C
2, 17, 32	A	C	C	B	A	B
3, 18, 33	B	A	B	A	C	C
4, 19, 34	B	C	A	A	B	C
5, 20, 35	A	C	C	B	A	B
6, 21, 36	A	C	A	C	B	B
7, 22	C	B	C	B	A	A
8, 23	C	A	B	B	C	A
9, 24	C	B	B	C	A	A
10, 25	B	A	A	C	B	C
11, 26	A	B	C	C	A	B
12, 27	A	C	C	A	B	B
13, 28	C	A	B	B	C	A
14, 29	C	B	B	C	A	A
15, 30	C	B	B	A	C	A

Table 13. Order of grenades requested when the NBC mask is worn.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	A	C	C	A	B	B
2, 17, 32	A	C	C	B	A	B
3, 18, 33	B	C	A	A	B	C
4, 19, 34	B	A	B	A	C	C
5, 20, 35	B	C	A	A	B	C
6, 21, 36	C	B	C	B	A	A
7, 22	B	A	A	B	C	C
8, 23	B	A	A	B	C	C
9, 24	C	B	B	A	C	A
10, 25	B	A	A	C	B	C
11, 26	A	C	C	A	B	B
12, 27	A	C	A	C	B	B
13, 28	C	B	B	C	A	A
14, 29	A	B	C	C	A	B
15, 30	C	A	B	B	C	A

Tables 14–18 present the order in which the grenades were presented to the Soldiers one by one for them to identify. Data collectors recorded the number of correct grenades chosen and which grenade was chosen if incorrect.

Table 14. Order of grenades presented one by one when NBC mask is worn.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	C	B	B	C	A	A
2, 17, 32	B	C	A	A	B	C
3, 18, 33	C	B	C	B	A	A
4, 19, 34	B	A	B	A	C	C
5, 20, 35	A	C	C	A	B	B
6, 21, 36	B	A	A	B	C	C
7, 22	C	A	B	B	C	A
8, 23	C	B	B	C	A	A
9, 24	A	C	A	C	B	B
10, 25	A	B	C	C	A	B
11, 26	A	C	C	B	A	B
12, 27	C	B	B	A	C	A
13, 28	B	A	A	C	B	C
14, 29	A	C	C	B	A	B
15, 30	C	A	B	B	C	A

Table 15. Order of grenades presented one by one when tinted eye protection is worn.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	A	B	C	C	A	B
2, 17, 32	A	C	C	A	B	B
3, 18, 33	B	A	A	B	C	C
4, 19, 34	A	C	A	C	B	B
5, 20, 35	C	A	B	B	C	A
6, 21, 36	C	B	B	A	C	A
7, 22	B	C	A	A	B	C
8, 23	C	B	C	B	A	A
9, 24	B	A	A	B	C	C
10, 25	C	B	B	C	A	A
11, 26	B	A	A	C	B	C
12, 27	B	A	B	A	C	C
13, 28	A	C	C	B	A	B
14, 29	B	C	A	A	B	C
15, 30	A	C	C	A	B	B

Table 16. Order of grenades presented one by one when AN/PVS-14s are worn.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	B	A	A	B	C	C
2, 17, 32	C	B	B	C	A	A
3, 18, 33	A	C	C	B	A	B
4, 19, 34	C	A	B	B	C	A
5, 20, 35	C	B	C	B	A	A
6, 21, 36	B	A	B	A	C	C
7, 22	A	C	A	C	B	B
8, 23	C	A	B	B	C	A
9, 24	A	C	C	B	A	B
10, 25	A	C	C	A	B	B
11, 26	B	A	A	C	B	C
12, 27	C	B	B	C	A	A
13, 28	B	C	A	A	B	C
14, 29	A	B	C	C	A	B
15, 30	C	B	B	A	C	A

Table 17. Order of grenades presented one by one when ENVG are worn.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	B	A	A	B	C	C
2, 17, 32	C	B	B	C	A	A
3, 18, 33	B	C	A	A	B	C
4, 19, 34	A	C	C	B	A	B
5, 20, 35	A	C	C	A	B	B
6, 21, 36	B	A	A	B	C	C
7, 22	C	A	B	B	C	A
8, 23	A	C	C	A	B	B
9, 24	C	B	B	A	C	A
10, 25	B	A	A	C	B	C
11, 26	A	C	A	C	B	B
12, 27	C	B	C	B	A	A
13, 28	B	A	B	A	C	C
14, 29	A	B	C	C	A	B
15, 30	B	C	A	A	B	C

Table 18. Order of grenades presented one by one when normal vision is used.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	B	C	A	A	B	C
2, 17, 32	A	C	C	B	A	B
3, 18, 33	A	C	C	B	A	B
4, 19, 34	C	A	B	B	C	A
5, 20, 35	A	B	C	C	A	B
6, 21, 36	C	B	C	B	A	A
7, 22	C	B	B	C	A	A
8, 23	B	A	B	A	C	C
9, 24	B	A	A	C	B	C
10, 25	C	B	B	A	C	A
11, 26	A	C	A	C	B	B
12, 27	A	C	C	A	B	B
13, 28	C	A	B	B	C	A
14, 29	B	A	A	B	C	C
15, 30	C	B	B	C	A	A

2.4.8 Differentiation While Experiencing a Cognitive Load

While operating a robot performing a reconnaissance mission, Soldiers were requested to identify the grenade type which was handed to them by the data collector. The order of presentation of the grenades can be found in table 19. Data collectors recorded the number of correct grenades chosen and identified which grenade was chosen if incorrect.

Table 19. Order of grenades presented one by one when Soldier is operating a robot.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	B	A	A	C	B	C
2, 17, 32	C	A	B	B	C	A
3, 18, 33	B	A	B	A	C	C
4, 19, 34	B	A	A	B	C	C
5, 20, 35	C	B	B	C	A	A
6, 21, 36	C	B	B	C	A	A
7, 22	A	C	C	B	A	B
8, 23	A	B	C	C	A	B
9, 24	C	B	B	A	C	A
10, 25	C	A	B	B	C	A
11, 26	C	B	C	B	A	A
12, 27	A	C	A	C	B	B
13, 28	A	C	C	B	A	B
14, 29	B	C	A	A	B	C
15, 30	A	C	C	A	B	B

2.4.9 Differentiation After Physical Exertion

Soldiers conducted a series of 3- to 5-s rushes with a kneeling firing position assumed after each of the three rushes. Immediately following the completion of this course, Soldiers were asked to hand the data collector the requested grenade from a box inside a trash bag containing six different grenades (two of each type) using tactile identification. The order of grenades requested can be found in table 20. Data collectors recorded the number of correct grenades chosen and which grenade was chosen if incorrect.

Table 20. Order of grenades requested after completion of the 3- to 5-s rushes.

	Iteration					
Roster	**1**	**2**	**3**	**4**	**5**	**6**
1, 16, 31	C	B	B	A	C	A
2, 17, 32	A	C	C	A	B	B
3, 18, 33	B	A	B	A	C	C
4, 19, 34	C	B	C	B	A	A
5, 20, 35	A	B	C	C	A	B
6, 21, 36	A	C	C	B	A	B
7, 22	B	C	A	A	B	C
8, 23	B	A	A	B	C	C
9, 24	A	C	A	C	B	B
10, 25	B	A	A	B	C	C
11, 26	B	C	A	A	B	C
12, 27	C	A	B	B	C	A
13, 28	B	A	A	C	B	C
14, 29	A	C	C	A	B	B
15, 30	C	B	B	C	A	A

After completing the first part of the grenade identification trial, the Soldiers completed a course that required them to execute a variety of individual movements and to assume a variety of positions while maneuvering through, under, and around urban obstacles, such as doorways, stairs, and rooms. They were required to perform these military operations in urban terrain (MOUT) individual maneuver techniques (IMTs) as quickly as possible. They proceeded through two rooms, ascended a flight of stairs, exited the building to an upper deck, assumed a standing firing position, reentered the building, descended the stairs, proceeded through the two rooms, and conducted another grenade identification trial while under the physical load created by these maneuvers. The order of the grenades that was handed to them can be found in table 21. Data collectors recorded the number of correct grenades chosen and identified which grenade was chosen if incorrect.

Table 21. Order of grenades presented one by one after completion of the MOUT IMT.

Roster	Iteration					
	1	**2**	**3**	**4**	**5**	**6**
1, 16, 31	B	A	A	C	B	C
2, 17, 32	A	B	C	C	A	B
3, 18, 33	C	A	B	B	C	A
4, 19, 34	B	A	B	A	C	C
5, 20, 35	A	C	C	B	A	B
6, 21, 36	B	A	A	B	C	C
7, 22	A	C	C	A	B	B
8, 23	C	A	B	B	C	A
9, 24	A	C	C	B	A	B
10, 25	C	B	B	C	A	A
11, 26	A	C	A	C	B	B
12, 27	C	B	B	A	C	A
13, 28	C	B	C	B	A	A
14, 29	C	B	B	C	A	A
15, 30	B	C	A	A	B	C

3. Results

3.1 Demographics

The Soldiers ranged in rank from E4 to E6. The participants' military occupational specialties included infantry, ranger, medic, and combat engineer. Their ages ranged from 21 to 47 years. The average time in the military was 65 months. One Soldier was red/green color blind and four wore prescription lenses.

Details of the Soldiers' responses to the demographics questionnaire can be found in appendix A.

3.2 Training

Soldiers rated the training as very good. In addition, after training, they reported expectations that the XM106 grenade would be easy to distinguish because of its smooth, flat top compared to the ring or indentation around the top of the M83 grenades. Soldiers, overall, felt that the task of distinguishing between grenades would be fairly easy to perform under most conditions.

Details of the Soldiers' responses to the training questionnaire can be found in appendix A.

3.3 Tactile Differentiation Using Gloves and Bare Hands

The results for the two tasks performed by the Soldiers (choosing the specified grenade from the box and identifying the grenade presented to them) are shown by each handwear condition in table 22.

Table 22. Tactile differentiation using gloves and bare hands results.

Handwear	Soldier Picks Correct Grenade (%)	Soldier Identifies Grenade Presented (%)
None (bare hands)	99.1	99.1
Nomex gloves	98.6	99.1
NBC gloves	99.1	99.1
Cold weather gloves	100	99.1

The errors made for each condition are shown in tables 23–26. The first bold column represents the grenade that was supposed to be picked or identified, and the rows represent which errors, by grenade type, were made.

Table 23. Grenade identification errors for Soldiers using bare hands.

Bare Hands	Soldier Picks Grenades			Soldier Identifies Grenades		
	M83	M83 w/PS	XM106	M83	M83 w/PS	XM106
M83	—	—	0	—	—	0
M83 w/PS	—	—	2	—	—	0
XM106	0	0	—	0	2	—

Table 24. Grenade identification errors for Soldiers using Nomex gloves.

Nomex Gloves	Soldier Picks Grenades			Soldier Identifies Grenades		
	M83	M83 w/PS	XM106	M83	M83 w/PS	XM106
M83	—	—	0	—	—	0
M83 w/PS	—	—	2	—	—	0
XM106	0	1	—	0	2	—

Table 25. Grenade identification errors for Soldiers using NBC gloves.

NBC Gloves	Soldier Picks Grenades			Soldier Identifies Grenades		
	M83	M83 w/PS	XM106	M83	M83 w/PS	XM106
M83	—	—	0	—	—	0
M83 w/PS	—	—	2	—	—	2
XM106	0	0	—	0	0	—

Table 26. Grenade identification errors for Soldiers using cold weather gloves.

Cold Weather Gloves	Soldier Picks Grenades			Soldier Identifies Grenades		
	M83	M83 w/PS	XM106	M83	M83 w/PS	XM106
M83	—	—	0	—	—	0
M83 w/PS	—	—	0	—	—	0
XM106	0	0	—	1	1	—

For each of the handwear conditions, the Soldiers made the errors shown in tables 23–26 for either picking the grenades from the box or identifying the grenade presented to them.

3.4 Visual Differentiation Using Normal Vision, Night Vision Goggles, NBC Mask, and Tinted Eye Protection

The results for the two tasks performed by the Soldiers (choosing the specified grenade from the box and identifying the grenade presented to them) are shown by each eyewear condition in table 27.

Table 27. Visual differentiation using normal vision and eyewear results.

Eyewear	Soldier Picks Grenade (%)	Soldier Identifies Grenade Presented (%)
None (normal vision)	100	100
ENVG	100	100
AN/PVS-14	100	100
BLEPS	100	100
NBC mask	100	100

3.5 Differentiation While Experiencing a Cognitive Load

The result for the task performed by the Soldiers (identifying the grenade presented to them) is shown in tables 28 and 29.

Table 28. Visual differentiation for Soldiers during a cognitive load.

Soldier Identifies Grenade Presented
91.7%

Table 29. Grenade identification errors for Soldiers experiencing a cognitive load.

Bare Hands	Soldier Identifies Grenades M83 or M83 w/PS
XM106	5

3.6 Differentiation After Physical Exertion

The results for the two tasks performed by the Soldiers (choosing the specified grenade from the box and identifying the grenade presented to them) are shown by each handwear condition in table 30.

Table 30. Tactile differentiation after physical exertion.

Soldier Picks Grenade	Soldier Identifies Grenade Presented
95.8%	98.1%

After physical exertion, the Soldiers made the errors shown in table 31 for either picking the grenades from the box or identifying the grenade presented to them.

Table 31. Grenade identification errors after physical exertion.

Bare Hands	Soldier Picks Grenades			Soldier Identifies Grenades		
	M83	M83 w/PS	XM106	M83	M83 w/PS	XM106
M83	—	—	0	—	—	0
M83 w/PS	—	—	7	—	—	1
XM106	0	2	—	0	3	—

For the total discriminations between the prototype and baseline grenades, the mean percent correct after exertion was 96.4%. The percent correct without prior exertion (bare hands, unaided vision) was 99.3%. A paired samples *t*-test indicates that the difference between the means was statistically significant, $t(35) = 3.05$, $p = 0.004$, Cohen's $d = 0.618$.

4. Conclusions

Soldiers identified the XM106 from the M83 grenades easily and effectively in most cases. Soldiers made slightly more errors with handwear than they did with eyewear, indicating that visual identification of the grenades was easier than tactile identification. Although the identification rate with handwear seems acceptable, it is still a safety problem if the Soldier does not visually confirm the grenade selection prior to employment. There were slightly more errors after physical exertion when Soldiers were differentiating between the M83 w/PS and the XM106. The percent of incorrect grenade identifications for the XM106 grenade during the cognitive load trials was higher than trials without the additional cognitive load. This may be due to the fact that grenade identification was a secondary task during the operation of the robot and of less concern to the Soldier than operating the robot. Soldiers were allowed to use visual identification during cognitive trials and both visual and tactile identification during physical exertion trials, so it is evident that degradation does occur under these loads even when Soldiers could see the devices.

5. Recommendations

While tactile and visual identification of the XM106 is high when it is the only task being performed, Soldiers are more likely to be under cognitive and physical loads when they have to identify a grenade in combat. Training should emphasize the physical differences (tactile and visual) between the XM106 and M83 smoke grenades as well as the safety and importance of being able to differentiate the XM106 from the other smoke grenades to ensure safe employment of the XM106. During combat, all attempts should be made to provide each Soldier only one type of smoke grenade so that misidentification does not occur.

Appendix A. Demographics

This appendix appears in its original form, without editorial change.

MOS

09S – 14
11B – 8
12B – 1
15T – 1
31B – 1
68D – 1
68W – 1
68X – 1
74D – 1
88M – 2
OCS – 1
NR – 4

RANK

E4 – 10
E5 – 19
E6 – 3
OCS – 3
NR – 1

DUTY POSITION

Air Aslt Instructor – 1
Crew Chief – 1
Driver – 1
Instructor – 1
Medic – 1
OCS – 7
Combat Engr - 1
NR – 12
Pathfinder Instructor - 1
Ranger Instructor – 2
Support – 1
Team leader – 4
Training – 1
Cbrn NCO – 1
NCOIC – 1

AGE

28 years (mean)

1. How long have you served in the military? 54 months (mean)

2. How long have you had an infantry-related job? 79 months (mean)

3. How long have you been a fire team leader? 21 months (mean)

4. How long have you been a squad leader? 38 months (mean)

5. How long have you been deployed overseas? 21 months (mean)

6. How long have you been deployed in a combat area? 14 months (mean)

7. With which hand do you most often write? 32 Right 4 Left

8. With which hand do you most often fire a weapon? 33 Right 3 Left

9. Do you wear prescription lenses? 29 Yes 7 No

10. If yes, which do you wear most often? 3 Glasses 3 Contacts 1 NR

11. Which is your dominant eye? 28 Right 7 Left 1 Both

12. Do you have any vision related problem? 4 Yes 31 No 1 NR
If so, what? Red/green color blind (1), farsighted (1), near-sighted (1), astigmatism (1)

13. Have you ever used a robotic system? 1 Yes 28 No 7 NR
If so, what type? Davinci (1)

14. Please describe the conditions under which you used the robotic system.
Surgical (1)

15. Using the scale below, please rate your skill level for each of the following activities.

None	Beginner	Intermediate	Expert
1	2	3	4

ACTIVITY	MEAN RESPONSE
Operating ground unmanned vehicles	1.21
Operating aerial vehicles	1.07
Target detection and identification	1.44
Playing commercial video games	2.68
Training with Army video simulations	2.11

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Appendix B. XM106 Training and End of Experiment Questionnaire

This appendix appears in its original form, without editorial change.

1. Using the scale below, please rate the training that you received on how to distinguish between the grenades.

1	2	3	4	5	6	7
Extremely bad	Very bad	Bad	Neutral	Good	Very good	Extremely good

MEAN RESPONSE
6.06

Comments	**Responses**
Great training!	1
Robot training was great – the instructor was very good. Grenade training was also good.	1
Excellent training to do, especially with lower enlisted and junior officers.	1
Very good training. I feel the different stations helped to prove that with all types of situations, i.e., vision and touch, were covered thoroughly and all smoke grenades could be determined correctly.	1
The training was really good and helped distinguish the difference between the smoke grenades.	1
Really good training on training the differences between grenades by touch.	1
Identification of grenades was very detailed and in depth.	1
Feel comfortable distinguishing M83 and XM106 grenades.	1
Simple instructions on differences and how to look and feel for them.	1
Quick easy tips and distinction between each type was clear.	1
Training on grenades was simple because the differences in distinguishing aren't too different from one another. We still had time to orient ourselves to the grenades.	1
Explained well and in detail – good job.	1
I was given very clear and concise and effective instruction on the distinguishing characteristics of the grenades.	1
Good and clear instructions on how to determine differences.	1
Easy and understandable instructions.	1
The training was brief and to the point. He quickly demonstrated the differences and repeated it a couple of times in order to ensure we remembered. It was kept simple so that only pertinent information was given.	1
The trainer was thorough in his explanations of the experiment as well as the expectations of us.	2
The initial training was detailed, though short. Getting the answers out quickly was slightly tough because I got tongue-tied.	1
It gets very repetitive but it helps because it becomes muscle memory of how to distinguish between the different grenades.	1
Tests seemed pertinent to what we will face in the field. Cold weather gloves are in need of change – hard to determine by touch with them.	1

Comments	Responses
I would go after the lower enlisted with not that much time in service to take these tests just because they haven't figured the military out yet.	1
There should be more difference between M83 and m83 with confidence clip.	1

2. What were the easiest and hardest features of the grenades to distinguish between?

Comments	Responses
EASIEST	
It all seemed easy to me.	1
M83 had the lip on top, whereas the XM106 was smooth and the confidence clip was easy to distinguish because of using the spoon you could "feel" the clip on the top.	1
Indentations/ridge on top.	3
The grooves on the tops of the grenades.	2
Ridges on the top and bottom.	1
XM106.	2
The easiest feature between the M83 and XM106 is the ridges on the top of the canister and the color of the canister. The clip was easily distinguishable on the M83 with it.	1
Ridges on top of grenades for distinguishing between XM106 and M83 with or without confidence clip.	2
Using night vision, the XM106 was still easy to pick out.	1
The smooth top of the XM106 was very easy to recognize by touch. Even with gloves on it was easy.	2
The smooth top on the XM106 and the shine of its top, the texture, the smooth corners of the top and color made it very easy to distinguish from both M83s. Plus the M83s had a different feel to them.	1
The easiest to identify was the XM106. It had the smooth surface which was different from the others.	4
The XM106 is flat on the top of the body and on the thumb clip it has a clip.	1
The easiest feature to distinguish between grenades was the flatness on top of the XM106 compared to the M83.	5
Between the XM106 and the other two, the flat surface versus the ridged surface.	1
M83 – pins rattle. M83 with confidence clip – clip was easy to identify.	1
The M83 with confidence clip was easy as well.	1
The M83 has a ridge on the top of the body. The M83 with clip has the same features as the M83 but on the thumb release there is a safety clip.	1
The easiest was the grooved top on the M83 and M83 with confidence clip.	1
Colors of grenades. Feel of grenades without gloves, XM106 feels smoother than the M83s.	1

Comments	Responses
Color between the XM106 and M83s by sight. Top indentation between the same by feel.	1
Color and indentation on top edge.	2
The color difference between the M83 and XM106.	1
Plain eye sight was the easiest.	1
Smooth top, color, confidence clip, and Nomex gloves.	1
Knowing what to look and feel for.	1
Using your own senses to identify grenades – bare hands and normal vision.	1
Telling the difference barehanded.	1

Comments	Responses
HARDEST	
Nothing at all/ nothing hard.	5
Safety clip.	3
The confidence clip on the M83.	3
Clip was sometimes hard to distinguish with gloves.	2
The hardest feature to distinguish was the confidence clip on the M83, but still that was not very difficult.	1
Distinguishing between M83 with confidence clip and M83 without due to the clip's size but overall, not difficult at all.	5
The hardest was in a rush situation, without looking, if the Soldier did not feel the top and only looked for confidence clip, a mistake could be made between the XM106 and M83.	1
Trying to use the PVS-14 night vision and distinguishing between an M83 and M83 with confidence clip because of the blurred vision. I would have to resort to touching them.	1
Telling the difference between the two M83s with the cold weather gloves.	2
It was harder to tell which grenade was the M83 and which had the confidence clip when using gloves, although it was figured out after a few additional seconds.	1
The M83 with night vision.	1
Using the MOPP gloves to identify between the M83 and M83 with confidence clip.	2
M83 with and without confidence clip – if the pin was horizontal it would feel like a confidence clip when you slide your thumb over it.	1
Seeing the confidence clip on the M83, distinguishing between the two by sight due to the same color and small variation.	1
Little harder to distinguish M83 and M83 with clip visually in low light conditions.	1
The hardest was to distinguish between the M83 and M83 with confidence clip, especially with the different gloves on.	1
The hardest was to distinguish with thick gloves on whether there was a confidence clip present or not.	1
Wearing the cold weather gloves.	2

Comments	Responses
When using cold weather gloves it is hard to feel. When using night vision goggles, make sure to focus them first.	1
NBC gloves – the rubber gets caught on the safety clip.	1
General comments.	

Comments	Responses
It was an overall awesome experience. It's nice to know our equipment gets this much attention and goes through such rigorous testing.	1
Overall, Soldiers should have little if any difficulty differentiating between the grenades.	1
Overall it was good.	1
Good experiment; enjoyed it thoroughly.	1
Overall, easily distinguished between XM106 and M83.	2
Pretty thorough testing between differences.	1
Pretty easy.	1
None were really all that difficult but at first touch/glance.	1
The training in different settings (i.e., protective mask, night vision, etc.) was effective.	1
The trainer moving the canisters in the box was effective from learning where you dropped them.	1
Even though there's differences between smoke grenades, the design and training was very helpful in distinguishing the difference.	1
Even with all of the gloves, if I immediately grabbed with any finger on top or slid it up the side to the top, I could feel the ridge and smooth edges and easily distinguish between them.	1
Cadre and training were good.	1
Although a simple task, the training is necessary even though it's nearly impossible to mistake the XM106.	1
XM106 was faster.	1
Best distinguishing features of the XM106 was the color and the flat top.	1
The ridge on top of the two M83s was surprisingly easy to feel even with gloves.	1
The different gloves slowed down the process of identification but ultimately I was still able to correctly identify.	1
Only complaint was cold weather gloves were too bulky for touch identification.	1
You need to constantly rearrange the grenades in the boxes since once I knew where they were, I knew where to grab.	1
Next time use a black garbage bag because you can see through the orange one before you start the task.	1
The M83 and M83 with confidence clip are a little hard to tell apart with thick gloves, while the XM106 is not.	1
The night vision that we used when on a normal setting is very blurred when up close trying to tell what grenades you are looking at.	
Night vision was a little blurry, hard to distinguish M83 and M83 with	1

Comments	Responses
confidence clip.	
The night vision goggles helped me easily find the XM106 by vision alone but I had to also use touch when possible to properly and quickly identify the M83 and M83 with confidence clip.	1
I wear excessively large glasses so the sunglasses did not fit very tough to see the confidence clip or not on the M83 with such precise focus on the night vision goggles. And the mask was uncomfortable.	
Distinguishing confidence clip can be tricky.	1
I really had to double and triple check to make sure I was grabbing the right grenade with regards to the M83 and M83 with confidence clip.	1

3. What are your overall comments on your ability to distinguish between the grenades?

Comments	Responses
Excellent training.	1
Very good training.	1
Night vision was pretty easy as well.	1
I feel like I am thoroughly trained and ready to tell the difference between all three smoke grenades in any situation.	3
For me it was actually very easy. It might change in combat due to a higher stress level.	1
It is easy, plus there is always at least one thing that will identify the difference between the grenades.	1
Distinguishing the grenades was not difficult.	8
Can identify all three now.	1
Thought it was very easy no matter what you wore.	1
Rather easy to learn and do.	1
Easy if you know what to look and feel for.	1
They are very easy to distinguish, but I believe if we are able to throw a live one to see the smoke effect, it would greatly impact training.	1
The XM106 smooth top and the color was a very good indicator of what it was. The confidence clip on the M83 grenades was a difference there as well.	1
I believe in combat I would be able to tell the difference and would rather use the XM106 if it produced the smoke quicker.	1
The XM106 was very easily distinguishable from the other two. The M83 and M83 with confidence clip were easy to distinguish visually and took a few more seconds to verify when using touch. Overall, the grenades were all pretty easy to distinguish because of their different features.	1
With a little bit of time and muscle memory, it became easier to distinguish between the two.	1
It was fairly easy to tell which grenades were which, especially with the XM106.	1
It wasn't even a challenge to distinguish between the XM106 and M83	1

Comments	Responses
with confidence clip because of the feel and other factors. The XM106 was actually easier to spot using night vision because it shined on top.	
Was able to identify most, if not all, grenades successfully.	1
I think I had a good concept overall. Once you learn the characteristics of the grenades, there should be no doubt of which one to choose.	1
No problem when not using gloves.	1
Being able to use both hands was helpful in addition to no time constraints.	1
Awkward at first, but repetition is the key.	1
Fairly simple to tell the difference between the three. The only problem may be discerning the M83 from the M83 with safety clip.	1
When testing for recognition, use a black non-see through trash bag and maybe a large ammunition box so you have to search for the grenades not just pick up one out of the ones you just put down.	1
Naming them so similarly – it's tough to get the names squared away so quickly, but overall, the grenades were pretty distinct. The colors of the two M83s is toughest.	1
Only trouble spot was locating clip through night vision when outside focal range.	1
Difficult at times with gloves on and	1
The NBC gloves and the Nomex gloves were too thick to determine the correct grenade clip.	1

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