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Michael D. Matthews , Jarle Eid , Bjorn Helge Johnsen & Ole Christian Boe

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A Comparison of Expert Ratings and Self-Assessments of Situation Awareness During a Combat Fatigue Course

Michael D. Matthews

United States Military Academy, West Point, New York

Jarle Eid and Bjorn Helge Johnsen

University of Bergen, Bergen, Norway

Ole Christian Boe

Royal Norwegian Army Academy, Oslo, Norway

The current study compared expert-observer ratings of situation awareness (SA) with subjective self-ratings of SA in Norwegian military academy cadets during a summer combat survival course. The cadets ($N=30$) completed an 8-day combat survival course characterized by sleep and food deprivation, continuous operations, and altered circadian entrainment cues. Results indicated that self-ratings of SA did not correlate consistently with expert-observer SA ratings, and self-ratings were consistently higher than expert-observer ratings. The results are congruent with expected effects of these extreme conditions on cognition and self-awareness, demonstrate a pronounced self-enhancement bias and suggest that subjective measures of SA are not likely to provide valid estimates of SA under extreme conditions.

Cognitive psychology constructs are increasingly being applied to field settings to help explain and improve the performance of people engaged in high-stakes, stressful jobs. Measuring such constructs in the laboratory is challenging

The interpretations of the findings included in this manuscript represent those of the authors and not necessarily those of the U.S. Army or the Norwegian Navy or Army.

Correspondence should be addressed to Michael D. Matthews, Department of Behavioral Sciences and Leadership, Cullum Rd., Building 601, Room 281, U.S. Military Academy, West Point, NY 10996. E-mail: lm6270@usma.edu

enough, but developing psychometrically sound and user-acceptable metrics to evaluate cognition in the field is even more daunting. Laboratory experiments in cognition confer the advantage of good internal validity but may suffer in external validity. Field studies of cognition, in contrast, may offer good external validity, but internal validity is often difficult to establish. Furthermore, measures of constructs that may be valid in laboratory experiments may not be useable in field settings for a variety of reasons. This may be particularly true in the extremely stressful training environments that characterize much military training. This study addresses the issue of assessing situation awareness (SA) under extremely stressful and challenging training conditions.

Situation awareness is a construct that links a variety of component cognitive processes to decision making. Endsley (1988) defined SA as “the perception of elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future” (p. 97). Building on attention, perception, and memory processes, SA is viewed as a necessary but not sufficient condition for effective decision making. The construct has proven valuable in understanding and predicting performance in a variety of fast-paced, high-stakes environments where the consequences for a less-than-optimal decision may prove costly in dollars or lives. Examples include aviation (e.g., Endsley & Bolstad, 1994) and the military (e.g., French, Matthews, & Redden, 2004).

Because of significant changes in technology and doctrine, the success of modern combat operations depends more than ever on fast and accurate decision making. Sophisticated information technology and command and control systems are now found in all aspects of military operations, including infantry forces (French et al., 2004). These technologies enable military forces to occupy larger areas of territory and are leading to a flatter command and control structure. This, in turn, places greater responsibility than ever before on lower echelon leaders. This is particularly challenging to infantry forces, who, compared to equivalent Navy and Air Force echelons, demonstrate the least reliable communication with subordinates, the least tactical flexibility, and the most decentralized command doctrine (Gorman, 1999). Together, these changes in technology and doctrine make SA an attractive construct in understanding command decision making and training effective decision making in leaders at all echelons of command.

A significant challenge in SA research has been the development of psychometrically sound but user-acceptable metrics. French et al. (2004) reviewed SA measures that have been used in infantry settings. Valid and reliable methods have been developed for highly scripted and controlled settings such as infantry combat simulations. For example, the Situation Awareness Global Assessment Technique (SAGAT), originally developed for analysis of pilot SA, has demonstrated good psychometric qualities in a variety of such applications (French & Hutchinson, 2002; Strater, Endsley, Pleban, & Matthews, 2001). A related technique, the Critical Information Knowledge Assessment (CIKA) procedure, has been used

to assess infantry SA in free-play infantry training (Redden & Blackwell, 2002), virtual environments (Redden, 2002), and gaming environments (Redden, Elliott, Turner, & Blackwell, 2004). However, measures like SAGAT are often more difficult to apply in field training settings, where the location, conditions, and outcome of missions are more difficult to predict and control, and such measures are sometimes viewed as disruptive in simulations (French & Hutchinson, 2002). In field settings, expert ratings of leader SA or subjective self-assessments are often relied on.

One metric for measuring SA in field settings is the Situation Awareness Behavioral Rating Scale, or SABARS (Strater et al., 2001). The SABARS was developed from a series of in-depth interviews with infantry subject-matter experts and consists of ratings of behaviors and actions thought to be important in the establishment of SA. For example, to develop and maintain SA, a squad leader must communicate effectively with team members and higher command. Strater et al. reported that, in an immersive simulation of infantry combat, SABARS differentiated between experienced and inexperienced platoon leaders. Matthews, Eid, Johnsen, Meland, and Talcott (2004) found that SABARS predicted effective communication and performance ratings of squad leaders involved in a Norwegian combat survival course.

Though SABARS may be useful in evaluating SA in field settings, it is still limited by the number of leaders or soldiers that an expert observer can effectively monitor during an exercise. Because field training exercises are characterized by lengthy movements over difficult terrain, most observers cannot be expected to evaluate more than a single participant. This makes the SABARS somewhat laborious to use and limits the number of participants on whom SA ratings may be obtained. One approach to expanding the utility of SABARS would be to have soldiers involved in an exercise to rate themselves on the SABARS items. Because the items are linked to specific actions (e.g., "utilized scouts to obtain information"), it is possible that accurate self-ratings could be obtained, assuming that participants are capable of sufficient self-insight and self-monitoring skills. If this is the case, SABARS could be employed to assess SA in all participants in a field training exercise, not just a few key leaders.

A review of previous literature in infantry SA measurement offers only mixed support of the reliability and validity of subjective measures of SA. Strater et al. (2001) directly compared SAGAT, SABARS, and a subjective SA measure and found that the latter did not predict decision making or differentiate between experienced and inexperienced platoon leaders. On the other hand, Matthews, Beal, and Pleban (2002) described the development and initial validation of another subjective self-rating of infantry SA, the Mission Awareness Rating Scale (MARS). Matthews et al. found that MARS differentiated among four methods of simulating night vision goggles in a simulation of night infantry combat operations. The MARS has been found to be predictive of the success of West Point (Matthews & Beal, 2002) and Norwegian military cadets during summer training exercises

(Matthews & Eid, 2003). It also is significantly related to dispositional optimism in the same sample of Norwegian cadets (Eid, Matthews, Johnsen, & Meland, 2005). The Situation Awareness Rating Technique (SART), a well-known subjective measure used in a variety of domains (Jones, 2000), has been used in infantry field training exercises and has shown promise as an alternative SA metric for situations where more obtrusive measures, such as SAGAT, are inappropriate (French et al., 2004).

A critical aspect of infantry operations is the extreme physical and emotional stress that is placed on soldiers involved in combat. Infantry operations are characterized by uncertainty, the risk of death or significant injury, and physical and mental fatigue (Holder, 1999). This raises the question of to what extent measures of cognitive processes, developed in laboratory settings, simulations, or relatively stress-free field exercises, generalize to actual combat operations. The validity of SA measures derived and tested in relatively stress-free simulation and training settings may be questioned with respect to generality in more intense settings.

There is reason to believe that subjective SA measures would be vulnerable to distortion under extreme conditions of stress, food, and sleep deprivation. For example, Vaitl et al. (2005) recently reviewed the impact of sleep deprivation on a variety of cognitive and affective outcomes. Common cognitive consequences of sleep deprivation include diminished volitional potential, attentional narrowing, memory disturbances, and general cognitive impairment. It could be argued that these effects of sleep deprivation would substantially impair a soldier's ability to accurately monitor his or her actions and thoughts under extreme conditions and hinder his or her ability to provide accurate subjective self-assessments of SA. Disruptions of circadian rhythms may also contribute to cognitive and affective deficits that may impact the ability of a person to accurately self-monitor his or her own actions and intentions, particularly in military environments (Westcott, 2005). Because subjective SA measures are based on the assumption that people understand the situations they find themselves in, and that this understanding is consciously available (R. M. Taylor, 1990), the combined effects of sleep deprivation, stress, and circadian disruption make the use of subjective SA measures in extreme environments and conditions suspect.

Moreover, the well-established propensity of people to show a self-enhancement effect in self-ratings (e.g., S. E. Taylor & Brown, 1988) may affect the accuracy of self-assessed SA. Kwan, John, Kenny, Bond, and Robbins (2004) distinguished between a social comparison view of the self-enhancement effect, based on Festinger's (1954) social comparison theory, and a self-insight view, traceable to Allport's (1937) notions on self-insight. The latter view is most relevant when comparing self-ratings of SA to more objective ratings obtained by well-trained expert observers. Conditions that might impair a person's ability to experience accurate self-insight, such as extreme stress and sleep and circadian disruption would, according to this view, diminish correlations of self-assessments with those obtained from expert-observers.

The purpose of the present study was to compare observer and self-ratings of SA in a challenging and demanding field training setting. More specifically, we examined SA in cadets at the Royal Norwegian Naval and Army academies who were involved in stressful combat fatigue courses. These courses involved physically, cognitively, and ethically challenging missions over an 8-day period during which cadets were not allowed to sleep and food intake was drastically limited. Moreover, these exercises were conducted from late May through mid-June, when Norway experiences extremely long daylight periods followed by a short, dusk-like night. In short, these conditions presented a unique opportunity for researchers to compare SA ratings by well-rested and experienced expert-observers with subjective self-assessments made under unusually challenging and extreme environmental, personal, and training conditions. Based on known effects of sleep deprivation on cognition and the self-enhancement effect, it was predicted there would be little correlation between the two ratings, coupled with a tendency for self-assessments to be higher than expert-observer assessments.

METHOD

Participants

Twelve cadets from the Royal Norwegian Army Academy and 18 cadets from the Royal Norwegian Navy Academy served as research participants. All were male and had just completed the first-year course of study at their respective institution. They ranged in age from 20 to 39, with a mean of 25 years. All had between 1 and 4 years of prior service enlisted experience in the Norwegian military.

Materials

Situation awareness was assessed using SABARS, which was translated into Norwegian for the current study and then back-translated to ensure translation accuracy. The specific questions included in SABARS were based on interviews with infantry subject-matter experts (see Matthews et al., 2004) and focused on the specific types of infantry missions conducted in the field exercises. This version of SABARS consisted of 18 actions or behaviors plus an overall rating of each participant's global SA. Observer/controllers (O/Cs) rated the squad leader on each of the 19 items using a 5-point scale, with the following response options: *very poor*, *poor*, *borderline*, *good*, and *very good*. The self-SABARS was a parallel form of the SABARS, requesting respondents to rate themselves on the same 19 behaviors and actions and using the same response scale. The SABARS items are provided in Table 1.

TABLE 1
SABARS Items

-
1. Solicits information from subordinates
 2. Communicates key information to squad members
 3. Asks for pertinent information during initial mission briefing
 4. Assigns tasks to squad members based on ability
 5. Communicates his situation assessment to squad members
 6. Locates self at vantage point to observe main effort at the objective
 7. Deploys squad to maintain good communication
 8. Utilizes scouts tactically to gather information
 9. Utilizes a leader's recon to assess terrain and situation and to finalize plan
 10. Establishes multiple courses of action in advance of the objective
 11. Communicates courses of action with squad members
 12. Uses maps to route-find and monitor progress toward objective
 13. Maintains appropriate squad security posture throughout mission
 14. Conducts appropriate battle damage assessment after actions on the objective
 15. Identifies likely areas of enemy contact and listening post/observation post sites and communicates this to squad members
 16. Seeks confirmation of information received
 17. Selects the appropriate type and amount of equipment and ammunition for the mission
 18. Maintains knowledge of time constraints and mission event timing
 19. Overall situation awareness rating (situation awareness is the squad leader's ability to perceive and understand what is going on during the mission and to predict what is about to occur in the near future)
-

Notes. Self-SABARS items are in parallel form. A 5-point Likert scale ranging from *very poor* to *very good* was used in the ratings.

Procedure

Cadets were assigned to squads consisting of eight to nine cadets each and remained with their assigned squad for the duration of the exercise. The role of squad leader, however, rotated across different missions the squads completed. Multiple missions or "lanes" were run concurrently as individual squads rotated through them. To maintain the elements of surprise and challenge, information about forthcoming missions/lanes was not made available to the squads prior to beginning a component mission. As noted previously, these exercises were conducted in late May through mid-June, a season consisting of daylight in excess of 20 hours, with night consisting of a twilight period with little or no darkness as would be experienced in lower latitudes. Cadet participants were not allowed to eat during the exercise, with the exception of one mission on approximately the fourth training day that involved killing and eating a chicken. No sleep was allowed, and cadets observed sleeping were immediately roused by training

personnel. Because squads were small and under constant observation, lengthy unauthorized sleep was not possible; thus sleep deprivation among cadets across squads was constant. Cadet squads engaged in continuous operations and missions throughout the duration of the exercise. Participants were treated in accordance with human participant guidelines and could choose not to complete the SABARS instrument but were required to complete the course as a prerequisite for graduation from their academy. However, all participants who were asked to complete the instruments did so.

An experienced officer was assigned to each squad for the duration of the course and served as the O/C. Prior to the beginning of the exercises, these officers were given the chance to preview the SABARS instruments and clarify any questions they had, if any, about specific items. Because this version of the SABARS was specifically developed for these missions by Norwegian officers (see Matthews et al., 2004), all items on the SABARS were relevant to the mission and were easily understood by the O/Cs. Over the course of the 8-day training exercises, many missions were conducted, and a different cadet was assigned the role of squad leader for each mission. The missions selected for inclusion in the current study were infantry missions that involved the movement toward and securing of an objective.

Prior to the beginning of the designated missions, the O/C showed the squad leader the self-SABARS and told the squad leader that he would be asked to evaluate his own performance using the instrument following completion of the mission and offered the squad leader a chance to ask questions about the instrument. Immediately upon completion of the mission, the O/C completed his rating of the squad leader and the squad leader independently completed the self-SABARS.

RESULTS

Table 2 summarizes the main findings of the study. Of the 19 items, significant Pearson product-moment correlation coefficients were found between SABARS and self-SABARS ratings for six items.¹ The magnitude of the statistically significant correlations ranged from .39 to .55, thus accounting for between 15 and 30% of the variance (based on the use of r^2) for those items. With the exception of SABARS 13 (“maintains appropriate squad security posture”), these correlations

¹The statistical inferences reported here do not include the Bonferroni correction. Applying this correction, only the correlation for SABARS item 10 remained significant at the .05 level. Given the relatively small number of subjects in this field study, however, the authors believe that there is value in looking for general trends and patterns using the uncorrected probability values. Clearly, taking into account the adjusted p values only strengthens the conclusions of the current study that sleep deprivation under these challenging conditions largely invalidates using self-report methods of measuring SA in the field.

TABLE 2
Correlations Between Self-SABARS and Expert-Observer SABARS Ratings

| Item | Mean (SD) ^a 1 = Self-SABARS | N | t(df) ^a | Correlation ^b |
|-----------|--|----|--------------------|--------------------------|
| SABARS 1 | 1 = 3.60 (0.77) | 30 | 2.86 (58)** | .26 |
| | 2 = 3.03 (0.76) | 30 | | |
| SABARS 2 | 1 = 3.30 (0.79) | 30 | .51 (58) | .20 |
| | 2 = 3.17 (1.18) | 30 | | |
| SABARS 3 | 1 = 3.41 (0.73) | 29 | 2.99 (56)** | .06 |
| | 2 = 2.82 (0.76) | 29 | | |
| SABARS 4 | 1 = 3.87 (0.73) | 30 | 2.82 (58)** | .36 |
| | 2 = 3.17 (1.15) | 30 | | |
| SABARS 5 | 1 = 3.60 (0.86) | 30 | 3.30 (58)** | .01 |
| | 2 = 2.70 (1.12) | 30 | | |
| SABARS 6 | 1 = 3.37 (0.96) | 30 | 2.72 (58)** | -.26 |
| | 2 = 2.67 (1.03) | 30 | | |
| SABARS 7 | 1 = 3.03 (0.76) | 30 | 2.41 (58)* | -.17 |
| | 2 = 2.50 (0.94) | 30 | | |
| SABARS 8 | 1 = 2.80 (1.21) | 30 | .70 (58) | .53** |
| | 2 = 2.57 (1.36) | 30 | | |
| SABARS 9 | 1 = 2.70 (1.21) | 30 | .66 (58) | .24 |
| | 2 = 2.50 (1.14) | 30 | | |
| SABARS 10 | 1 = 2.93 (0.91) | 30 | 2.11 (58)* | .55** |
| | 2 = 2.37 (1.16) | 30 | | |
| SABARS 11 | 1 = 2.83 (0.70) | 30 | .93 (57) | .44* |
| | 2 = 2.59 (1.27) | 29 | | |
| SABARS 12 | 1 = 4.00 (0.98) | 30 | 2.39 (58)* | -.16 |
| | 2 = 3.37 (1.07) | 30 | | |
| SABARS 13 | 1 = 3.52 (1.02) | 29 | 4.30 (57)** | -.41* |
| | 2 = 2.37 (1.03) | 30 | | |
| SABARS 14 | 1 = 3.28 (0.88) | 29 | 5.07 (56)** | -.04 |
| | 2 = 2.03 (0.98) | 29 | | |
| SABARS 15 | 1 = 2.64 (0.95) | 28 | 2.58 (56)* | .39* |
| | 2 = 2.03 (0.85) | 30 | | |
| SABARS 16 | 1 = 3.03 (0.87) | 29 | 1.87 (56) | .07 |
| | 2 = 2.55 (1.09) | 29 | | |
| SABARS 17 | 1 = 3.46 (0.88) | 28 | 1.72 (56) | -.34 |
| | 2 = 3.00 (1.14) | 30 | | |
| SABARS 18 | 1 = 3.76 (0.77) | 29 | 3.45 (57)** | -.05 |
| | 2 = 2.97 (0.96) | 30 | | |
| SABARS 19 | 1 = 3.48 (0.78) | 29 | 3.04 (57)** | .44* |
| | 2 = 2.77 (1.00) | 30 | | |

Notes. ^aDifference between means significant at the .05* or .01** levels. ^bCorrelations significant at the .05* or .01** levels.

were positive in direction and of moderate (see Hays, 1963) strength. Five of the statistically significant correlations involved tactically critical tasks (SABARS 8, “utilizes scouts tactically to gather information”; SABARS 10, “establishes

multiple courses of action in advance of the objective”; SABARS 11, “communicates courses of action with squad members”; SABARS 13; and SABARS 15, “identifies likely areas of enemy contact and listening post/observation post sites and communicates this to squad members”). SABARS 19, “overall situation awareness,” was also significant. The 13 items that did not correlate significantly involved a range of different actions, but several (items 1, 2, 3, 5, 7, and 16) dealt with gathering and disseminating information rather than basic tactical operations. It is possible that frequently practiced and routinized tasks, like using scouts, may be more accurately performed and assessed than communications-laden tasks that may require greater concentration and deliberative effort.

In comparing the means of expert and self-ratings of SABARS items, self-ratings of SABARS were higher than expert-observer ratings on all 19 items, with significantly higher self-ratings on 13 of the items, as summarized in Table 2. Moderate effect sizes were observed for the statistically significant items, with η^2 ranging from .10 for SABARS 10 to .34 for SABARS 14. This is suggestive of a consistent and fairly strong self-enhancement effect and is congruent with studies in other contexts showing this positive cognitive illusion (Krueger, 1998; Robins & John, 1997; S. E. Taylor & Brown, 1984). It is noteworthy that this illusion persists even under conditions of extreme sleep and food deprivation coupled with the stress of completing difficult and taxing military maneuvers.

The O/C-rated SABARS questionnaire showed a robust Cronbach’s alpha value of .94, suggesting that the instrument taps into a single, unidimensional construct. The corresponding Cronbach’s alpha for the self-SABARS ratings, though still fairly high at .82, suggests somewhat lower consistency for the self-ratings of SA. It may be reasonable to infer that under extreme conditions, respondents are less consistent in their self-ratings than they may be if well rested and relatively stress free.

DISCUSSION

In interpreting the results, it should be noted that the expert-observers in the current study were experienced Navy and Army officers. Moreover, they were well rested and fed during the course of the exercise. They were intimately familiar with the terrain and missions involved in the exercise and were employed as faculty at their respective military academies. Thus, though the SABARS instrument involves some degree of subjective judgments, even for the expert-observers, their combination of experience, knowledge of the missions and tasks at hand, and their relatively well-rested state suggest that their ratings are of higher validity than the self-ratings made by the cadets in the study. For these reasons, it is reasonable to view the O/C SABARS ratings as an appropriate benchmark to which to compare the validity of self-SABARS ratings.

Taken as a whole, the results have both practical and theoretical implications. On a practical note, the results suggest that self-assessments of SA are not particularly accurate under the extremely stressful conditions in play in the current study. For scientists interested in studying SA in challenging field settings or actual combat this suggests that self-assessments are not the answer to the criterion problem encountered in measuring SA or other intervening cognitive constructs in the field. Researchers must be willing to adapt more established and psychometrically valid SA metrics, such as SAGAT, to these settings and/or utilize expert-observer metrics such as SABARS. Indeed, Endsley et al. (2000) suggested modifications to SAGAT that may make it more applicable in these settings.

An interesting extension of the current study would be to examine the effects of sleep deprivation on experienced leaders who are required to make performance ratings of others while they, themselves, are sleep deprived. The current study clearly shows that relatively inexperienced officer trainees are not good at monitoring their own behavior. But how might sleep deprivation affect the judgment of more experienced leaders? It is common for combat-deployed soldiers and their leaders to endure long periods of restricted sleep periods. While in this state, they must process information, communicate effectively with others, and otherwise employ higher cognitive processes in regulating their own and others' behaviors. The biological substrate of sleep deprivation and stress may play out in many ways (see Hancock & Szalma, 2008), but the current study suggests that it may have a major impact on self-monitoring and subsequent decision making. Such effects on commanders or other leaders could have important implications for mission effectiveness.

The theoretical implications of the research pertain to the effects of stress and deprivation on cognitive and affective processes. Given the well-established effects of sleep deprivation, stress, and circadian rhythm disruption on cognitive performance and of the pervasive tendency of humans to inflate self-ratings, it should not be surprising that expert-observer and self-ratings of SA did not correlate consistently in the current study and that the cadets showed perhaps unrealistically high self-ratings of their performance. The degree of the self-enhancement effect observed in the current study is somewhat surprising given the strong Norwegian ethic of modesty (Silvera & Seger, 2004), which should act to diminish the self-enhancement effect in this population. Perhaps extreme deprivations and stress may interact with cultural norms and further distort self-evaluations. It would be informative to design a study with sleep deprivation and culture as independent variables. This would allow researchers to determine whether these variables interact in their effects on the expression of the self-enhancement effect.

The current study is unique in examining SA measurement under extreme conditions. Combat and combat training are difficult enough, but when coupled with sleep and food deprivation, it appears that the ability of individual participants to

self-monitor performance may be substantially compromised. This in turn suggests that researchers studying groups performing in similar circumstances, such as police, fire, or emergency room personnel, must take great care in the selection of psychological measures that require self-assessment.

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