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Locus of Control, Risk Orientation, and Decision Making Among U.S. Army Aviators

David R. Hunter
Artis, LLC

John E. Stewart
U.S. Army Research Institute

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Authorized and approved for distribution:

BARBARA A. BLACK, Ph.D.
Research Program Manager
Training and Leader Development Division

MICHELLE SAMS, Ph.D.
Director

Technical review by

Robert J. Pleban, U.S. Army Research Institute
Peter Legree, U.S. Army Research Institute

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This report was developed under the Small Business Innovative Research Program Phase I. The goal of the research was to develop a set of web-based prototype scales that would assess hazardous events, locus of control, safety-related attitudes, and risk orientation among U.S. Army Aviators. New measurement scales with an Army focus were developed that were modeled after civilian scales. These scales were: Army Hazardous Events Scale, Army Locus of Control Scale, Army Safety Attitudes Scale, and Army Aviation Scenarios Scale. In four surveys the scales were administered to samples of Army Aviators and their responses were used to conduct a preliminary evaluation of the scales. All the scales were found to exhibit good psychometric reliability and several of the sub-scales from the measures were significantly correlated with self-reported accident involvement.

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David R. Hunter
Artis, L.L.C.

John E. Stewart
U.S. Army Research Institute

ARI Fort Rucker Research Element
Scott E. Graham, Chief

U.S. Army Research Institute for the Behavioral and Social Sciences
2511 Jefferson Davis Highway, Arlington, VA 22202-3926

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LOCUS OF CONTROL, RISK ORIENTATION, AND DECISION MAKING AMONG U.S. ARMY AVIATORS

EXECUTIVE SUMMARY

Research Requirement:

This project was conducted under the Army Small Business Innovative Research Program, Phase I. The goal of the research was to develop a set of web-based prototype scales that would assess hazardous events, locus of control, safety-related attitudes, and risk orientation among U.S. Army Aviators. Previous research among civil aviators has shown that these constructs are related to involvement in aviation accidents. However, these relationships have not been demonstrated among Army Aviators or other military pilots.

Procedure:

A review of the literature pertaining to the measurement of these constructs was conducted, and similar scales that measured these constructs among civilian pilots were examined. New measurement scales were developed that were modeled after the civilian scales, but were re-worded to make them appropriate for Army Aviators. These new scales were: (1) Army Hazardous Events Scale. (2) Army Locus of Control Scale, (3) Army Safety Attitudes Scale, and (4) Army Aviation Scenarios. The scenario-based items provided for a unique multi-dimensional assessment of the control construct. These new scales were administered in a series of four independent surveys to a sample of Army Aviators via a web-based survey.

Findings:

Data were collected on the four surveys from an aggregate total of approximately 565 cases. The data suggest that the items comprising the Army Hazardous Events Scale (Army-HES) are measuring events that, though not everyday occurrences, do occur at sufficient frequency as to be of potential use as a surrogate measure for accident involvement in future research. Scores from the Army-HES were associated with self-reported prior accident involvement for some, but not all, of the analyses.

Significant associations were found between sub-scales from the Army Locus of Control Scale and accident involvement. Consistent with previous research in the civil setting, Aviators who had a more Internal control orientation experienced fewer accidents than Aviators who were low on that construct. In addition, a Resignation component, identified through principal component analysis, was found to be associated accident involvement.

Analysis of the Army Safety Attitudes Scale resulted in the identification of six interpretable components. No significant relationships were found between the component scale scores and the two accident criteria; however, a significant relationship was found between two of the component scale scores and the Army-HES.

Ten scenarios depicting situations that Army Aviators might experience were developed. For each of these scenarios 17 questions relating to each scenario were used to measure locus of control constructs at a greater level of specificity than that provided by the Army Locus of Control scale. The Global Locus of Control item from the scenario-based measures differentiated significantly between recent accident and no-accident groups. The effect was in the expected direction, such that Aviators who have not been in accidents believe more strongly that they are in control. Two of the multidimensional items differentiated significantly between the career accident and no-accident groups. These two items assessed the perceived impact of Professionalism and Crew Management Skills on the outcome of the scenario.

Overall, the goal of the research effort, which was to develop a set of prototype measures, was accomplished. Further, the initial analyses of these scales suggest they may be related to accident involvement. However, additional research is needed to refine and better assess the construct validity of the new scales.

Utilization and Dissemination of Findings:

After further refinement, these new scales could be utilized as diagnostic and outcome measures. With respect to the diagnosis function, they might be used by, for example, Aviation Safety Officers as a means of monitoring safety-related psychological components in their units, and could serve as a warning flag, indicating a need to implement safety interventions. Following such intervention programs, the scales could then be utilized to assess the effectiveness of the intervention. Preliminary data from this report were briefed to managers of the Army Aviation Safety Officer Course (U.S. Army Aviation Combat Readiness Center) on 31 March 2009.

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LOCUS OF CONTROL, RISK ORIENTATION, AND DECISION MAKING AMONG U.S. ARMY AVIATORS

Introduction

The prevention of accidents is a constant concern both in the civilian and military sectors, and there is a large body of research (some of which is summarized here) that deals with the role of the human factor in accident causality. As electromechanical systems have been improved, the relative contribution of human factors in accidents has increased to where it is typically reported that approximately 80% of aviation accidents have a human error component (Jensen & Benel, 1977; Wiegmann & Shappell, 1997). There is also some indication that the changing nature of conflicts has increased the need to reduce accidents. According to the U.S. Army Field Manual 100-14 (1998), the proportion of casualties arising from accidents (75%) from the 1990-1991 conflicts in southwest Asia is substantially larger than in previous, more conventional wars in which accidents accounted for about 50% of casualties

Aviation accidents are always a topic of special concern, perhaps because of the financial costs involved in loss of airframes, but also because of the potential for multiple human fatalities arising out of a single event. Concerns over unacceptable accident rates among general aviation in the civil sector have led in recent years to many studies of potential factors that might place pilots at increased risk of accident involvement. Some of those studies have dealt with the role of locus of control, attitudes, risk perception, and risk tolerance and their relationships to accident involvement. Preliminary studies from the civil sector have indicated that measures of these constructs have the potential to identify pilots at increased accident risk. With that knowledge, individuals might elect to seek more training, modify flight plans, or take other actions to reduce their risk. Within the military services, knowledge of the relationships among these variables might allow leaders to monitor trends in variables indicative of increased risks and to take appropriate proactive action.

This report describes the results of an Army Small Business Innovative Research (SBIR) Phase I effort. The objective of this effort was the development of a set of measures to assess locus of control and risk orientation among U.S. Army Aviators. Previous efforts to understand accident causality among Army Aviators have not included these constructs, although they have been shown to be relevant to civil accident involvement. The impetus for this effort, therefore, was the need to understand how these constructs might be related to accident involvement in a military setting. This initial effort was undertaken to develop the prototype scales that could then be used in a broader assessment of their relationship to safety in Army Aviation and to identify areas in which training and other interventions could potentially make an impact on safety. In addition to a simple conversion of existing civil scales to a military context, an innovative approach was taken in the disaggregation of the locus of control construct into multiple, specific facets. In addition, realistic Army Aviation scenarios were created to generate highly concrete assessments of locus of control, in contrast to previous research that used more global, non-specific measures. This report covers only the development and limited assessment of the prototype measures, since the Phase II effort to fully validate the measures was not funded.

Review of the Literature

Locus of Control

The construct of perceived personal control that is at the heart of this effort is derived from the social learning theory formulated by Rotter (1954). In that theory, Behavior Potential (BP) is expressed as a function of Expectancy (E) and Reinforcement Value (RV), as shown in the following equation: BP = *f*(E & RV)

Expectancy is the subjective probability that a given behavior will lead to a particular outcome, while the Reinforcement Value refers to the desirability of that outcome. From this theory Rotter (1966) developed his measure of generalized expectancy, usually called Locus of Control (LOC). Although many researchers have attempted to use this generalized measure to predict specific behaviors, Rotter (1975, p. 62) noted that the scale "…was developed not as an instrument…to allow for a very high prediction of some specific situation, such as achievement or political behaviour, but rather to allow for a degree of prediction of behaviour across a wide range of potential situations." Rotter is very clear in referring to the scale as a *generalized* measure of internality-externality. However, he further notes that, "A narrower or more specific generalized expectancy should allow greater prediction for a situation of the same subclass" (Rotter, 1975, p. 59). Many researchers have pursued that approach with the result that there is a plethora of locus of control instruments tailored to specific situations. (See Furnham & Steele, 1993, for a review).

Closely related, but less well-explored in an aviation setting, is attribution theory (Heider, 1958) which imputes both motives and expectancies to the participants in varying situations. This theory is particularly relevant in the current instance, inasmuch as it addresses the concept of the self-serving bias (SSB) or optimistic bias, which is consistently reported in studies in which pilots (and others) are asked to estimate their skill level or likelihood of an accident relative to others. Clearly, as Stewart (2006, 2008) points out, there is some degree of overlap of this construct with sense of personal control.

Driving and LOC. Since it has been suggested (Hoyt et al, 1973; Phares, 1976) that externality, as measured by Rotter's scale of Internality-Externality is related to a lack of caution, it is reasonable to assume that there should be a relation between driving accidents and this construct. This assumption has been tested in a number of studies. Arthur, Barrett, and Alexander (1991) conducted a meta-analysis of studies of accident involvement and found that the mean correlation between overall LOC and accident involvement was 0.196. This result was based on 13 independent samples, and a total of 1,909 subjects. Of the various measures included in their meta-analysis, only one (regard for authority among professional drivers) had a higher correlation with the criterion of accident involvement.

While those results were statistically significant, the magnitude of the relationship was rather small. However, this may be due to the fact that the conventional Rotter I-E scale was used in those studies. As noted above, that scale is a measure of generalized expectancy, which may not predict specific behaviors well.

Among the specialized LOC scales that have been developed are some directed at driving. Montag and Comrey (1987) reported on a study of two specialized scales of Driving Internality (DI) and Driving Externality (DE), in which they compared 200 normal and 200 accident-involved drivers. The means (and all but four of the individual items) were significantly different for the two groups. Correlations of the DI and DE scales with a dichotomous accident criterion were -.324 and .259, respectively.

Lajunen and Summala (1995) also used the Montag Driving Externality and Internality Scales. They reported a correlation between DE and driving aggression of .27 ($p < .001$). They concluded that, "Internals, i.e. drivers seeing themselves as responsible for traffic safety and capable of influencing it, saw themselves as alert and careful drivers who try to predict possible risks in traffic. Externality (i.e. the tendency to see traffic accidents as matters of chance or as some other drivers' fault), appeared to correlate, although weakly, with self-reported aggressive behavior and risk-taking." (p. 311).

In reviewing the research linking LOC and driver accident involvement, Ozkan and Lajunen (2005, p. 535) noted, "it seems that the original two-factor structure based on internality and externality is too simple for catching different attributions of causes behind traffic accidents….Studies about locus of control conducted in other application areas (e.g. health behaviour) have shown that the most accurate results can be achieved by tailoring the constructs more specifically to the targeted behaviours rather than by using general measures of locus of control." To address this limitation, they constructed a 16-item multidimensional traffic locus of control scale (T-LOC). Factor analysis yielded a 4-factor solution: Other Drivers, Self, Vehicle and Environment, Fate. Self-reported accidents correlated ($r = .14$) with Self, as did aggressive violations ($r = .20$), and errors ($r = .25$). All these correlations were statistically significant ($p < .01$).

While these results, like the majority of the literature, suggest that having an internal orientation is desirable, in the sense that it is associated with fewer accidents or potentially hazardous actions, some caution is needed. As Ozkan and Lajunen (2005, p. 542) note, "The main problem in a highly internal locus of control orientation in traffic is that it may increase risky driving, because an over-confident and optimistic driver believes in his/her ability to avoid an accident in every case."

Aviation and LOC. Wichman and Ball (1983) explored LOC and Self-Serving Bias (SSB) among general aviation (GA) pilots. SSB refers to the tendency for individuals to rate themselves as superior to others, or being at less risk of experiencing some adverse event. Wichman and Ball suggested that the SSB serves to protect and maintain one's self-esteem. They also suggested a relationship to the fundamental attribution error – in which one makes dispositional attributions rather than situational attributions. Wichman and Ball administered the original Rotter LOC measure along with four questions regarding SSB to three samples of GA pilots. As predicted, pilots felt their individual chances of having an accident were below average, that they were above average in flying skill, and that they were above average in how safe a pilot they were. Further, internals (as measured by the LOC scale) tended to hold stronger self-serving biases than externals. They concluded, "Aviators with more experience and exposure develop stronger self-serving biases. These people tend also to be more internal in locus of control. So their way of handling dangers is not just to make light of them, but to actively do something about reducing the dangers." (Wichman & Ball, 1983, p. 509).

Hunter (2002a) evaluated the contribution of LOC in aviation accident involvement by constructing an Aviation Safety Locus of Control (ASLOC) scale. A significant correlation (r = -0.20) was found between the number of hazardous events (i.e., close-calls) experienced by pilots and the Internality score from the ASLOC. Pilots who were lower in perceived internal control tended to experience more hazardous aviation events, compared to more strongly internal pilots. Hunter concluded that the scale might be employed as a self-awareness exercise for pilots wishing to explore potential aspects of their personality that could place them at greater risk for accident involvement.

The ASLOC was subsequently used in two other studies. Joseph and Ganesh (2006) administered the ASLOC to a sample of 101 Indian pilots (51 civil, 50 military). In accord with previous research, they found that pilots were significantly more internal. In addition, civil pilots had significantly higher internal ASLOC scores than military pilots. Helicopter pilots were significantly different from other pilots (transport and fighter) on internal and external scores. No significant correlations between demographic variables (age, flight hours, etc.) and ASLOC scores were obtained.

Vallee (2006) administered the ASLOC, a risk perception scale, and the hazardous events scale (HES; Hunter, 1995) to 57 pilots in the United Kingdom. She found risk perception was influenced by LOC, and that pilots were generally internal.

Risk Orientation

Risk orientation may be addressed both through the measurement of attitudes towards a variety of activities, states, or processes, and through the measurement of risk perception and risk tolerance. These constructs are, of course, related and overlap to some degree, however, it may be instructive to consider and to measure them separately.

Attitudes. There is an extensive body of research that deals with the relationship between attitudes and behavior (c.f., Ajzen 2001; Albarracın , Johnson & Zanna 2005). Particularly relevant to the current effort are studies that have assessed the linkage between attitudes and performance in motor vehicles and aircraft. For reviews of the large body of research on the correlates of risky driving behavior, including attitudes, see Jonah (1986) and Arthur, Barrett, and Alexander (1991).

In a unique longitudinal study of attitudes and driving safety, Iversen (2004) initially measured three attitudes: Attitude towards rule violations and speeding, Attitude toward the careless driving of others, Attitude towards drinking and driving. These attitudes, and driving behavior subsequent to the first administration, were then measured again after a 12-month period. The results "showed that the three attitude dimensions measured at the first survey were quite successful in predicting risky driving behaviours at the second data collection point and accounted for 52% of the total variance in behaviour. The most important of the three dimensions was the drivers' attitude towards rule violations and speeding." (Iverson, 2004, p.

147) Although the longitudinal aspect of the Iversen (2004) study was unique, the finding of a relationship between attitudes and risky behavior among drivers is typical of a large portion of the research in this area.

In aviation, the role of attitudes has received particular attention since the study of the causes of aircraft accidents conducted by Jensen and Benel (1977) and the subsequent publication of a series of guides and training material by the Federal Aviation Administration (FAA, 1991) in which the role of what were termed "Hazardous Thought Patterns" were discussed. Those documents included a self-report scale that pilots could use to identify their personal hazardous thought patterns (i.e., macho, anti-authoritarian, impulsive, resigned, and invulnerable). Although the validity of the measurement instrument was not established, the documents nevertheless served to stir interest in the impact that pilot attitudes might have on behavior.

O'Hare (1990) assessed general aviation (GA) pilots' perception of risks and hazards and found that pilots who proceeded with a computerized flight into risky weather conditions had significantly higher scores on a measure of "personal invulnerability." Pilots in this study exhibited self-serving bias in self-ratings of skill, judgment, and likelihood to take risks.

Citing the psychometric limitations of the ipsative self-assessment instrument contained in the FAA publications, Hunter (2004) described two scales to measure hazardous attitudes, and presented construct validation results. The new scales were the Aviation Safety Attitude Scale (ASAS), a 27-item Likert scale originally administered as part of a national probability sample survey of pilots (Hunter, 1995), and the New Hazardous Attitudes Scale (N-HAS), a 88-item Likert scale originally developed by Holt et al. (1991).

Construct validation was demonstrated through correlation of the new scales with a number of other measures, including: Thrill and Adventure Seeking (Zuckerman, 1994), Aviation Safety Locus of Control (Hunter, 2002a), Hazardous Events Scale (Hunter, 1995), two measures of risk perception, and three measures of risk tolerance. Hunter (2004) concluded that the two new measures were superior to the ipsative FAA scale, and should be used in lieu of that scale in any future research.

At a theoretical level, the role of attitudes and their relationship to behavior has been addressed through the theory of reasoned action and the theory of planned behavior (TPB, Ajzen & Fishbein, 2005). This powerful theory provides a basis for understanding how attitudes act to influence behavior. The application of this theory was clearly demonstrated by Elliott, Armitage, and Baughan (2003) in a study of drivers' compliance with speed limits. In that study, attitude, subjective norm, and perceived control were positively associated with behavioral intention. Intention and perceived control were positively associated with subsequent behavior. This relationship is clearly in accord with TPB. The TPB is particularly useful, since it provides a framework for developing theory-based interventions to change behavior. While intervention development is outside the scope of the current project, ultimately some type of intervention will likely be needed, if the research indicates that attitudes are related to risky behavior of interest to the Army.

Risk perception and risk tolerance. Reflecting a general concern over the confounding of these two constructs, Hunter (2006) differentiated them as following:

> *One explanation for behavior that leads to an accident or incident is that the person did not perceive the risk inherent in the situation, and hence did not undertake avoidance or other risk-mitigating actions. Another explanation is that when individuals correctly perceive the risks involved in a situation, some may elect to continue because the risk is not considered sufficiently threatening. Those individuals would be described as having a greater tolerance or acceptance of risk, compared to the mainstream. (p. 135)*

In keeping with that distinction, Hunter (2002b) reported on the development and evaluation of two scales that assessed pilots' perceptions of risk and three scales to assess pilots' risk tolerance. The risk perception scales used a Likert format and assessed pilots' perceptions of the risks across a variety of flying and non-flying situations. In a subsequent evaluation of the risk perception scales (Hunter, 2006), he found significant, negative correlations between measures from the Risk Perception-- Self scale and previous involvement in hazardous events. This indicated that "those participants who had been in more hazardous aviation events (a) tended to rate the scenarios as lower in risk, and (b) had a more inaccurate estimate of the safety of general aviation" (p. 142)

Optimistic and ability biases in pilots. The self-serving bias (SSB) is a topic of considerable importance, such that The Journal of Social and Clinical Psychology devoted an entire issue (1996, 15) to the topic. Weinstein and Klein (1996) in their introduction to the special issue on unrealistic optimism noted, "Probably the single biggest gap in research on this topic is the absence of information about the behavioral implications of optimistic biases. Do optimistic biases really result in unnecessary harm?" (p. 7). For an integrated review of this concept and LOC, focusing on applications in an aviation setting, see Stewart (2006).

As noted earlier, O'Hare (1990) found that pilots exhibited a self-serving bias, in that they considered themselves to be more skilled and less likely to be in an accident than the typical pilot. Similar results were obtained by Wilson and Fallshore (2001) who administered a questionnaire to 57 pilots in a university training program and 103 GA pilots attending Federal Aviation Administration (FAA) seminars. Pilots were asked to rate their chances of experiencing an accident due to inadvertent flight into instrument meteorological conditions (IMC) while under visual flight rules (VFR) and their ability to avoid or successfully fly out of such conditions. Wilson and Fallshore found that pilots were overly optimistic about chances of experiencing VFR into IMC accident, and were overconfident in ability to avoid and successfully fly out of IMC (judged with regard to "pilots with similar background").

The finding of self-serving bias is widespread. In a meta-analysis of perceived control and the optimistic bias, Klein and Helweg-Larsen (2002, p. 438), found that, "numerous studies report a positive relationship between perceptions of control and the optimistic bias." Additionally, from an extensive review of the literature, Helweg-Larsen and Shepperd (2001, p. 85) concluded that, "A consistent finding within the optimistic bias literature is that greater perceived control over an event or its outcome is associated with greater optimistic bias."

Clearly this is an issue of considerable relevance to the current effort, and the relationships between perceptions of control, in particular the implications of extreme levels of internality on optimistic bias and safety-related behavior, should be explored. Given the large amount of data that will be collected under this project, particularly in Phase II, it may be possible to test some hypotheses regarding curvilinear relationships between level of internality and degree of optimistic bias. From these data it may be possible to identify individuals who would be termed "realists" (O'Brien, 1984), based on their possessing an optimal level of internality and externality.

Based upon the results obtained from the review of the literature, a plan for the development of new measurement scales was devised which centered upon increased specificity of the measures, relative to the population and setting for which they were intended. Specifically, the literature strongly suggests that specific measures of the constructs, in particular the sense of personal control, provide higher validity than generalized measures. Accordingly, the new measures were designed such that they utilized Army Aviation terminology, examples, and scenarios, rather than more general aviation terminology and settings. There is, of course, a large degree of commonality between civil and military aviation; however military aviation has unique missions, equipment, and terminology not found in civil settings. Therefore, while the existing measurement scales developed for civil settings could be used as a general guide, they would need to be re-written so as to put them into a military context.

In addition, the success of multi-dimensional measures of the control construct suggests that this approach may also provide increased validity. Therefore, the planned effort included the development of a scale that provided for the disaggregation of the control dimension into a number of specific dimensions. All of these scales were to be administered via the web, in a series of surveys designed to evaluate the large number of potential items for each scale and to perform an initial assessment of their relationships to safety-related criteria.

Procedure

Development of New Measures

A set of new measures modeled after similar measures developed and validated for GA pilots was developed incorporating the terminology of U.S. Army Aviators and the circumstances under which they operate. These new measures included:

Army Hazardous Events Scale. In this scale, Aviators indicate how many times during the previous 24 months they experienced potentially hazardous events (such as running low on fuel). Potential responses were: none (0), 1, 2, 3, 4 or more. Appendix A contains the 86 draft items created for this scale. The 36 items that were selected for retention in the abbreviated scale are marked.

Army Locus of Control Scale. In this scale Aviators indicate how strongly they agree or disagree with a number of statements regarding the extent to which the outcome of events is determined by internal and external factors (for example, skill versus luck). This scale used a traditional Likert-scale format. The 89 draft items created for this scale are shown in Appendix B.

Army Safety Attitudes Scale. This scale also uses the traditional Likert format to measure the extent to which Aviators agree or disagree with a number of statements regarding issues and beliefs relevant to aviation safety. See Appendix C for the 83 draft items created for this scale.

Army Aviation Scenarios. This measure consists of a set of scenarios, each of which describes in one paragraph a situation that an Army Aviator might experience. The scenarios were created based on the personal experiences of the first author, reviews of accident reports, and input from active duty Aviators. The scenarios were written so as to provide enough information for most Aviators to be able to imagine such a situation, but were left open-ended with respect to the outcome of the situation. After reading the scenario, Aviators are asked to indicate the extent to which the outcome of the situation depicted in the scenario would be under their personal control (a measure of internal locus of control). In addition, a series of questions regarding each scenario are then presented to disaggregate the Aviator's core sense of locus of control into more specific components (e.g., actions by others, luck, the individual's skill and attitudes). Questions are also presented to assess the perceived risk in the situation and the probability of a successful outcome. By asking parallel questions regarding the Aviator's perception of the outcome if the typical Aviator from their unit were the pilot in command in the situation, a differential risk perception measure may be generated that may be used to assess their self-serving bias or sense of personal invulnerability. Initially, over 30 scenarios were developed. However, because of the time required of participants to read and consider a scenario and then answer the 17 accompanying questions, it was determined that only 10 scenarios could be used in this first evaluation. These 10 scenarios and the 17 questions for each scenario are given in Appendix D.

Administration of Measures

To minimize the time demands placed upon participants, each of these new instruments were administered in separate surveys. In addition to the items comprising the new scales described above, each survey also contained 21 questions that assessed the participants' military and civilian aviation experience and qualifications, their accident involvement, and other basic demographic information. Following the first survey, which included the items addressing involvement in hazardous aviation events, an abbreviated Army Hazardous Events Scale (Army-HES) was included with the remaining three surveys.

The surveys were designed to be administered via a secure web server operated by Army Research Institute. The survey instruments were approved by the Army Survey Control Office, and the research protocol was approved by the Army Research Institute Human Use Committee. Participation was voluntary and anonymous. No personally identifying information was collected, and no data were reported at a level that might allow for the identification of individual respondents. Invitations to participate in a survey were sent via email directly from the Army Research Institute Survey Office to the randomly selected participants. For survey 1, invitations were sent to approximately 800 Aviators. Because of a miscommunication it was not possible to determine the mix of officers and warrant officers invited to participate in this survey.

In the subsequent surveys (survey 2, survey 3, and survey 4), invitations were sent to non-overlapping, independent samples of 1000 warrant officers and 200 commissioned officers for each survey. Invitations to these three surveys were sent out simultaneously.

Results

Overview of Respondent Background

As noted above, each of the four surveys contained a common set of demographic questions, which are summarized in Tables 1-4. As shown in Table 1 the samples consisted predominantly of warrant officers, who were approximately equally divided between unit pilots, instructor pilots, and standardization instructor pilots (Table 2). Since the samples were limited to Aviators holding a rotary-wing rating, the predominance of rotary-wing civil ratings (as shown in Table 3) is not surprising. In addition to the civil rotary-wing ratings, from 20 to 30% of the participants also held a civil airplane (fixed-wing) rating.

Table 4 presents the civil and military aviation experience of the participants, and their age. Each of the samples was predominantly (approximately 97%) male, and fewer than ten participants across all the samples reported that they were members of the Army National Guard. Overall the samples for the four surveys were quite similar, although the sample for survey 1 had substantially more senior warrant officers (i.e., CW5). In contrast to the other samples, the modal position for survey 1 was Standardization Instructor Pilot, as compared to the other samples where the modal position was Unit Pilot. Reflecting the higher proportion of senior warrant officers, the mean total military flight time for survey 1 was higher (2600 hr) than the means for the other surveys (approximately 2000 hr).

Table 1
Pay Grade

Grade	Survey 1 Sample % (N =76)	Survey 2 Sample % (N = 189)	Survey 3 Sample % (N = 204)	Survey 4 Sample % (N = 232)
W-1	—	.5	—	—
CW2	22.4	28.6	28.4	31.4
CW3	31.6	27.6	28.9	25.4
CW4	28.9	20.4	23.0	25.4
CW5	14.5	7.7	4.9	7.2
O-1	—	—	—	.4
O-2	—	1.5	.5	1.7
O-3	—	9.2	8.3	4.7
O-4	1.3	2.6	2.9	2.1
O-5	1.3	1.5	2.5	1.7
O-6	—	.5	.5	—

Table 2
Current Position

	Survey 1 Sample %	Survey 2 Sample %	Survey 3 Sample %	Survey 4 Sample %
Unit Pilot	21.8	24.5	22.5	23.6
Aviation Platoon Leader	—	3.6	1.5	3.8
Maintenance Test Pilot	16.7	14.3	11.8	15.6
Unit Trainer	1.3	2.0	2.5	2.5
Instructor Pilot	20.5	10.7	14.7	9.3
Aviation Safety Officer	5.1	9.7	7.8	8.9
Standardization Instructor Pilot	23.1	11.7	14.2	13.5
Aviation Staff Officer	6.4	9.2	4.9	5.1
Aviation Company Commander	—	2.6	4.4	1.3
Aviation Battalion Commander & Above	1.3	1.5	1.5	1.3
Other	3.8	10.2	14.2	15.2

Table 3
FAA Ratings Held by Respondents

FAA Rating or Certificate	Survey 1 Sample %	Survey 2 Sample %	Survey 3 Sample %	Survey 4 Sample %
Rotary-Wing Private Pilot	11.5	17.4	20.2	14.7
Rotary-Wing Commercial Pilot	53.1	46.9	57.6	38.1
Rotary-Wing Airline Transport	2.1	0.8	0.4	1.9
Rotary-Wing Instrument Rating	50.0	45.7	57.2	35.3
Rotary-Wing Flight Instructor	7.3	1.9	4.5	4.9
Rotary-Wing Instrument Flight Instructor	3.1	1.2	1.2	0.9
Fixed-Wing Private Pilot	10.4	12.4	19.3	10.0
Fixed-Wing Commercial Pilot	7.3	7.8	9.1	5.1
Fixed-Wing Airline Transport	—	—	0.4	0.2
Fixed-Wing Instrument Rating	6.3	7.8	9.1	5.8
Fixed-Wing Multi-Engine Rating	7.3	6.2	8.2	4.7
Fixed-Wing Flight Instructor	—	2.3	0.4	1.2
Fixed-Wing Instrument Flight Instructor	1.0	1.2	—	0.5
Type-Rating for any aircraft	7.3	3.1	4.9	1.4

Table 4

Military and Civilian Flight Experience (Hours)

	Survey 1 Sample			Survey 2 Sample			Survey 3 Sample			Survey 4 Sample		
	N	M	SD	N	M	SD	N	M	SD	N	M	SD
Total Military Flight Hours	73	2602	1981	197	2019	1377	205	2104	1493	236	2013	1378
Recent Military Flight hours	75	479	430	197	457	318	205	510	361	236	462	312
Total Civilian flight hours	76	238	893	196	110	493	203	122	547	236	82	392
Recent Civilian Flight Hours	76	38.8	186.9	196	4.1	22.6	202	3.5	14.3	236	5.3	23.9
Years as Army Aviator	78	13.9	8.6	195	10.6	7.2	204	10.3	6.8	235	10.2	6.8

Survey 1 – Army Hazardous Events Scale (Army-HES)

Participant Characteristics

The first survey was designed to provide the data required to perform an initial evaluation of the large number of potential items for the Army-specific HES, with the goal of reducing the length of the scale. All members of the mostly male (88%) sample held an Army Rotary-Wing rating and approximately 16% also held a fixed-wing rating. No respondents indicated that they were members of the National Guard. As shown in Table 5, relatively few respondents had not been on at least one combat tour.

Table 5
Combat Experiences of Survey 1 Participants

Number of Combat Tours	Frequency	%
None	10	13.2
One tour	24	31.6
Two tours	26	34.2
Three or more tours	16	21.1

Item Selection for Reduced-Length Scale

Using the data from this administration, items were ranked on the proportion of non-zero responses. Generally, those items were chosen for inclusion in the reduced-length scale for which 20% or more of the respondents had a non-zero response, indicating that they had experienced the indicated event at least once during the previous 24 months. However, a few items were included based on their content; for example, addressing an issue such as crew coordination. This resulted in a final Army-HES consisting of the 36 items shown in Appendix A. The following analyses are based on the 36-item scale; and, this scale was included with the other three surveys.

Accident Involvement

Approximately 3% of respondents reported having been in an aviation accident in a military aircraft within the previous 24 months, and 30% reported that they had been in such an accident at some point in their career. One respondent (1.3%) reported having been in an aviation accident in a civil aircraft within the previous 24 months, and 4 (5.3%) reported having been in a civil aviation accident at any time.

The mean Army-HES scores for 21 respondents who had been in a military accident at some time in their career (M = 30.38, SD = 19.89) was compared to 48 respondents who had never been in a military accident (M=18.75, SD = 14.68), using one-way Analysis of Variance (SPSS Version 9). The Levene test for homogeneity of variance produced a non-significant F(1, 67) of 1.38 (p = .25). The two groups differed significantly (F(1, 67) = 7.34, p = .01, η_p^2 = .10), with pilots who had been in an accident reporting more hazardous events. Because there were so few respondents who had been in a recent military aviation accident or in a civilian accident, those data were not analyzed.

Discussion of Survey 1 Results

The primary purpose of this first survey was to screen out items from the extensive list of items describing possible hazardous events. The data collected during this survey allowed us to achieve that goal, and produce a prototype scale consisting of the 36 items identified in Appendix A. Because of the heterogeneous nature of these items, no index of internal consistency (e.g., Coefficient Alpha) was computed. Arguably, a more appropriate measure of scale reliability would be a stability index (e.g., test-retest reliability) that may be addressed in future research efforts.

Since no other standardized scales were administered, assessment of construct validity is problematic. However, one indication that the Army-HES is serving its intended function as a surrogate measure for accident involvement is the correlation between the Army-HES and self-reported previous accident involvement. The mean Army-HES scores for respondents who had been in a military accident at some time in their career was significantly greater than the scores of respondents who had never been in a military accident. The fairly strong relationship between these two measures[1] supports the use of Army-HES as a surrogate criterion for accident involvement in future analyses.

[1] An η_p^2 of 0.10 equates to a medium to large effect (Cohen, 1988).

Survey 2 - Army Locus of Control Scale (Army-LOC)

This survey contained 89 items constructed to assess locus of control, a 36-item Army Hazardous Events Scale (Army-HES), and 21 demographic questions. As noted above, email invitations to participate were sent to 1,000 warrant officers and 200 commissioned officers. Approximately 200 pilots had completed some or all of the survey as of the closing date.

Participant Characteristics

Warrant officers comprised 85% of this sample, with captains (O-3) comprising most of the commissioned officer sample. All of the respondents held an Army rotary-wing rating, and 18% also held an Army fixed-wing rating. The modal position held by respondents was “Unit Pilot”; however, responses were spread fairly evenly among a number of responses to this question. Approximately 97% of the respondents were male, 3 respondents (1.5%) indicated that they were in the National Guard, and no respondents reported any outside employment as a pilot. Due to a programming error, data on the age of the respondents and their combat experiences were not captured.

Army Hazardous Events Scale (Army-HES)

Participants completed a 36-item scale that assessed the number of hazardous military aviation events that they had experienced in the previous 24 months. Scores for this scale were computed by summing all the responses. Scores ranged from 0 to 75, with a mean of 23.3 (*SD* = 16.46)

Locus of Control Scale Construction

As noted above, respondents completed 89 items constructed to assess several dimensions surrounding sense of personal control. These dimensions include personal efficacy, influence by others, influence by fate, and the element of luck or chance. The principal purpose of this administration was to obtain data to allow for an initial assessment of the items, with the goal of creating one or more short scales, suitable for use in future research in combination with other measures. Two general approaches to achieving this goal were taken: (a) an *a prior*i approach in which two experienced aviation psychologists assigned each item to the internal or external category prior to the administration; and, (b) an empirical approach in which various methods, including correlation of the items with each other, correlation with the Army Hazardous Events Scale, and principal component analysis were used to determine the number of scales and their constituent items.

The a priori scale construction. Prior to the administration of the items, two experienced aviation psychologists independently reviewed all the draft items and assigned them to one of the two categories: internal or external. The two reviewers agreed completely on all items, and assigned 38 items to the internal category and 48 items to the external category. For three items neither reviewer could determine an appropriate category.

Internal consistency. In order to construct shorter, more parsimonious scales, an Internality Sum Score and an Externality Sum Score were created by summing the responses to the 38 items assigned to the internality category and the 48 items assigned to the externality category. Then, each individual item was correlated with the corresponding Sum Score. These correlations were sorted, and the 15 items with the highest item-total correlation were chosen to form the *a priori* Internality and Externality scales[2]. See Appendix E for the items constituting each of these scales. The 15-item Internality Scale had an *Alpha* = .83; while the 15-item Externality Scale had an *Alpha* = .92.

Analysis of the a priori scaled items. The 15 items comprising the Internality and Externality scales were summed to create the scale scores. Mean scores for the Internality and Externality scales were 54.94 (*SD* = 6.92) and 33.00 (*SD* = 8.27), respectively. Scores for these two scales were correlated with the Army-HES and with the flight and military experience variables. These correlations are shown in Table 6.

Table 6
Correlations of the A Priori Internality and Externality Scales with Army-HES and Demographic Variables (N = 189)

	Internality	Externality	Army-HES	Years as an Army Aviator	Total Mil Flight Hours	Recent Mil Flight Hours	Total Civ Flight Hours
Internality	1.00						
Externality	-.51**	1.00					
Army-HES	-.11	.10	1.00				
Years as an Army Aviator	.12	-.08	-.11	1.00			
Total Mil Flight Hours	.09	-.12	.08	.82**	1.00		
Recent Mil Flight Hours	-.04	-.02	.37**	-.03	.27**	1.00	
Total Civ Flight Hours	.10	-.10	--	.26**	.23**	.06	1.00
Recent Civ Flight Hours	-.11	--	-.01	.16*	.16*	-.04	.23**

* p < .05
** p < .01

Accident Involvement

Approximately 9% of respondents reported having been in an aviation accident in a military aircraft within the previous 24 months, and 68 respondents (34.7%) reported that they had been in such an accident at some point in their career. No respondents reported having been in an aviation accident in a civil aircraft within the previous 24 months, and only 3.3% reported having been in a civil aviation accident at any time. Because so few respondents reported having been in a civil aviation accident, those data were not analyzed further in this or the other surveys.

[2] The selection of 15 items as the maximum number of items here and in the other surveys was arbitrary, and was based on the authors' desire to have a relatively short scale, that still preserved good internal reliability. Future studies might address the question of optimal scale length more formally.

The participants who reported having been in a military accident during the previous 24 months were compared to the participants who had not been in an accident in terms of their mean Internality and Externality scores and their Army-HES scores. The means and standard deviations for these scores are shown in Table 7. The mean scores of the two groups differed significantly on Internality ($F(1,186) = 7.23$, $p = .01$, $\eta_p^2 = .04$) and on the Army-HES ($F(1,181) = 13.32$, $p = .001$, $\eta_p^2 = .07$). Both of these differences were in the expected direction. Aviators who had experienced an accident were less internal and had experienced more hazardous events than those Aviators who had not experienced an accident.[3]

Similar results were obtained in comparisons of the means (shown in Table 8) for the Aviators who had been in an accident at any time in their career to the Aviators who had never experienced an accident. Both Internality ($F(1,187) = 3.75$, $p = .02$, $\eta_p^2 = .02$) and Army-HES ($F(1,182)$ 5.90, $p = .02$, $\eta_p^2 = .03$) differed significantly between the two groups (see Table H-2).

Table 7
Means of Army-HES and A Priori Army-LOC Scales for Recent Accident Status Groups

	Accident			No Accident		
Scales	N	Mean	S.D.	N	Mean	S.D.
Army-HES	17	36.82	20.55	166	22.00	15.42
Internality	18	50.83	9.11	170	55.40	6.58
Externality	18	34.05	10.99	170	32.93	7.92

Table 8
Means of Army-HES and A Priori Army-LOC Scales for Career Accident Status Groups

	Accident			No Accident		
Scales	N	Mean	S.D.	N	Mean	S.D.
Army-HES	65	27.31	17.87	119	21.23	15.23
Internality	67	53.64	6.70	122	55.67	6.99
Externality	64	34.10	8.32	125	32.55	8.16

Table 9
Means and Standard Deviations for the Army-LOC Component Scores

Components	# of items	N	Minimum	Maximum	Mean	SD
Luck	15	194	15	61	33.15	8.39
Externality	15	192	18	56	33.86	7.34
Internality	15	198	30	73	56.06	6.69
Accident Causality	15	199	32	68	49.51	6.85
Fate	9	192	11	41	24.50	5.45
Resignation	9	192	19	41	30.32	4.09

[3] The results of all ANOVA analyses, including those that did not reach the level of statistical significance ($p < .05$) established for this research, are provided in Appendix H.

Principal Component Analysis of Item Responses

In addition to the *a priori* scale approach described above, a principal components analysis was also conducted. Inspection of the scree plot suggested a six-component solution that accounted for 40.8% of the variance was appropriate. These six components were extracted and rotated, using Varimax to simple structure. Sample items with the highest loadings on each of the six components are shown below:

- Component 1 – Luck
  - Successful flying is partly a matter of good luck
  - Sometimes you just have to depend on luck to get you through
- Component 2 – Externality
  - Most of the time accidents are caused by things beyond the Aviator's control
  - No matter what I do, I’m likely to have an accident
- Component 3 – Internality
  - I am in control of my life
  - I believe I have control over my own destiny
- Component 4 – Accident Causality
  - Most accidents are due to Aviators’ carelessness
  - If I have an accident, It’s because I was not careful enough
- Component 5 – Fate
  - I'll die when it's my time to go, but not before
  - You don't go until your number is up
- Component 6 – Resignation
  - No matter how hard Aviators try to prevent them, there will always be accidents
  - If I try hard enough, I can get out of any situation

Scores for each of these components were generated by unit-weighted summation of the responses for the items that defined the components. If more than 15 items defined a component, then only the 15 items with the highest loadings were used in computing the component scores. Reversed scoring was used for the items that had a negative component loading. Subtracting the item value from 6 effected the reversal. Means and standard deviations for these six scores are given in Table 9. The coefficient alpha reliability indices for these six scales were: .89, .87, .85, .82, .81, and .60, for the Luck, Externality, Internality, Accident Causality, Fate, and Resignation components, respectively. The items constituting these scales are listed in Appendix F. These scores were correlated with the total Army-HES score and flight time and military experience variables. These correlations are shown in Table 10.

Table 10

Correlations of Army-LOC Component Scores with Army-HES and Demographic Variables (N = 193)

	Luck	Externality	Internality	Accident Causality	Fate	Resignation	Army-HES	Years as an Army Aviator	Total Mil Flight Hours
Luck	1.00								
Externality	.72*	1.00							
Internality	-.34**	-.40**	1.00						
Accident Causality	-.29**	-.37**	.55**	1.00					
Fate	.62**	.50**	-.23**	-.15*	1.00				
Resignation	.31**	.38**	-.33**	-.26**	.22**	1.00			
Army-HES	.06	.19**	-.11	-.08	-.07	.13	1.00		
Years as an Army Aviator	-.02	-.19**	.03	.12	-.10	-.13	-.11	1.00	
Total Mil Flight Hours	-.07	-.17*	-.04	.09	-.15*	-.11	.08	.82**	1.00
Recent Mil Flight Hours	.01	.08	-.06	-.03	-.03	-.05	.37**	-.03	.27**

* $p < .05$
** $p < .01$

The Army-LOC component scores of participants who reported having been in a military accident during the previous 24 months were compared to the participants who had not been in an accident, using ANOVA. Three of the component scores significantly differentiated between the two recent accident status groups: Internality ($F(1,186) = 4.91$, $p = .03$, $\eta_p^2 = .03$), Accident Causality ($F(1,187) = 3.93$, $p = .05$, $\eta_p^2 = .02$), and Resignation ($t = 2.39$, $p = .028$)[4]

For the career accident status groups, only Resignation ($F(1,188) = 13.58$, $p = .01$, $\eta_p^2 = .07$) significantly differentiated between the groups who reported an accident at some time during their career, and those who did not.

Means and standard deviations of the Army-LOC component scores for these groups are given in Table 11 and Table 12 for the recent and career accident status analyses, respectively. Corresponding ANOVA comparisons are given in Tables H3 and H4.

[4] Prior to conducting all Analyses of Variance, a Levene Test for Homogeneity of Variance was conducted to ensure that the data met the assumptions of ANOVA. For all other analyses a non-significant F for the Levene Test was obtained. However, for Resignation, a significant Levene Test ($F(1,187) = 4.611$, $p = .033$) was observed. Therefore, a t-test (not assuming equal variances) was conducted, which produced the results shown. For comparison, both the t-test and ANOVA results are given in Table H3.

Table 11
Means and Standard Deviations of Army-LOC Component Scores for Recent Accident Status Groups

	Accident			No Accident		
Component	N	Mean	SD	N	Mean	SD
Luck	18	33.55	8.47	173	33.19	8.42
Externality	17	35.94	9.74	172	33.77	7.05
Internality	18	52.77	8.81	170	56.46	6.46
Accident Causality	18	46.38	7.76	171	49.78	6.83
Fate	18	25.05	6.97	171	24.43	5.31
Resignation	18	33.22	5.56	171	30.01	3.78

Table 12
Means and Standard Deviations of Army-LOC Component Scores for Career Accident Status Groups

	Accident			No Accident		
Component	N	Mean	SD	N	Mean	SD
Luck	66	33.78	7.80	126	32.91	8.69
Externality	66	35.09	7.13	124	33.32	7.38
Internality	66	54.80	6.89	123	56.77	6.63
Accident Causality	66	48.84	7.29	124	49.83	6.79
Fate	65	25.07	5.60	125	24.24	5.40
Resignation	66	31.80	4.18	124	29.58	3.83

Discussion of Survey 2 Results

A priori scales. Consistent with expectations and prior research on similar civil aviation scales, there was a substantial negative correlation (r = -.509) between the a priori Internality and Externality scales. The mean Internality scale score for the group that reported having been in a recent (previous 24 months) military aviation accident (M = 50.8, SD = 9.11) differed significantly (F (1,186) = 7.23, p = .01, η_p^2 = .04) from the group that had not experienced a recent accident (M = 55.4, SD = 6.58). Differences between these groups on the Externality scale score were not significant.

Respondents were also asked whether they had experienced a military aviation accident at any time during their career. The difference between mean Internality scale scores for these two groups (accident versus no-accident during career) approached, but did not achieve statistical significance (F (1,187) = 3.75, p = .05, η_p^2 = .02). Differences between these groups on the Externality scale score were not significant. Both of these scales were slightly, but not significantly correlated with the Army-HES.

Principal component analysis scales. Principal component analysis of the item responses resulted in interpretable components that were consistent with previous research on Locus of Control scales (Hunter, 2002a). As with the *a priori* scales, the mean component scores for the groups that had reported involvement in recent and career aviation accidents were compared with the groups that did not report such accident involvement. Comparing the recent accident status groups, significant differences were obtained for three of the seven components. These components were:

- Internality (F (1,186) = 4.91, p = .028, η_p^2 = .03)
    - Accident group M = 52.78, SD = 8.82
    - No-Accident group M =56.46, SD = 6.46
- Accident Causality (F (1,187) = 3.93, p = .049, η_p^2 = .02)
    - Accident group M = 46.39, SD = 7.77
    - No-Accident group M = 49.79, SD = 6.83
- Resignation (F (1, 187) = 10.57, p = .001, η_p^2 = .05)
    - Accident group M = 33.22, SD = 5.57
    - No-Accident group M = 30.02, SD = 3.78

Aviators who had a more internal orientation were less likely to have been in a recent accident. This was also true of Aviators who indicated that the causes of accidents lay primarily with their actions. However, Aviators who agreed with the items indicative of resignation tended to have more accidents.

On the Resignation component, the career accident group (M = 31.80 SD = 4.19) also differed significantly (F (1,188) = 13.58, p =.0001, η_p^2 = .07) from the group that had not experienced an accident during their careers (M = 29.58 SD = 3.83). Differences between these two groups on the Internality component approached, but did not achieve statistical significance (F (1,187) = 3.68, p= .06, η_p^2 = .02). Scores on the Externality component were significantly (r = .192) correlated with Army-HES. The positive correlation indicates that higher Externality scores are associated with involvement in more hazardous aviation events.

Army-HES. The mean Army-HES score for the group that reported having been in a recent (previous 24 months) military aviation accident (M = 36.82, SD = 20.55) differed significantly (F (1,181) = 13.32 p = .0001, η_p^2 = 07) from the group that had not experienced a recent accident (M = 22.01, SD = 15.42). Similarly, the mean Army-HES score for the group that reported having been in a military aviation accident at any point during their career (M = 27.31, SD = 17.88) differed significantly (F (1,182) = 5.896, p = .016, η_p^2 = .03) from the group that had not experienced an accident (M = 21.24, SD = 15.24). For both comparisons, having experienced more hazardous events was associated with increased involvement in accidents.

Survey 3 - Army Safety Attitudes Scale (Army-SA)

Survey 3 contained 83 items constructed to assess attitudes related to safety, the 36-item Army Hazardous Events Scale (Army-HES), and 21 demographic questions. Approximately 200 pilots had completed some or all of the survey as of the closing date for the research effort.

Participant Characteristics

All respondents held an Army rotary-wing rating. In addition, 14.9% of respondents also held an Army fixed-wing rating. The sample was predominantly (96.4%) male, 85.3% of the respondents were warrant officers, and 3 (1.5%) of the respondents were in the Army National Guard. Five respondents (2.5%) reported that they were employed as a pilot outside the Army.

Accident Involvement

Of the respondents, 6.3% reported having been in a military aviation accident in the previous 24 months, while 27.8% reported having been in a military aviation accident at some point in their career. No respondents indicated they had been in a civil aviation accident in the previous 24 months, while 3 respondents (1.5%) reported they had been in a civil aviation accident at some point in their life.

Army Hazardous Events Scale (Army-HES)

Participants completed a 36-item scale that assessed the number of hazardous military aviation events that they had experienced in the previous 24 months. Scores for this scale were computed by summing all the responses. Scores ranged from 0 to 90, with a mean of 27.7 (*SD* = 19.41)

Attitude Scale Construction

The data were analyzed using a principal components analysis. Inspection of the scree plot suggested a six-component solution that accounted for 35.9% of the variance. These six components were rotated using Varimax to simple solution. Sample items with the highest loadings on each of the six components are shown below:

- Component 1: Impulsivity
  - I follow the motto, “Nothing ventured, nothing gained”
  - I like making turns steeper than 60 degrees, just to see if I can do it
- Component 2: Anxiety
  - I feel uncomfortable flying VFR when the visibility is very low
  - I feel very vulnerable to accidents
- Component 3: Self-Confidence
  - I deal with stress very well
  - I feel comfortable flying at night
- Component 4: Safety Orientation
  - I am a very cautious pilot

- I am very skillful on controls
- Component 5: Denial
    - A successful flight is solely due to good planning and good execution
    - I am so careful that I will never have an accident
- Component 6: Weather Anxiety
    - I am capable of instrument flight (negative weight)
    - I often feel stressed when flying in or near weather

Summing the unit-weighted responses for the items comprising each scale generated component scores. Only the first 15 items were used for the Impulsivity component scale, which was defined by more than 15 items. The Anxiety component scale and Self-Confidence component scales consisted of 10 items each, while the Safety Orientation component scale had 11 items, and the Denial and Weather Anxiety component scales each had 7 items. Reversed items were created for those items with negative component weights by subtracting the item values from six. Coefficient *Alpha* for these six scales was .87, .83, .73, .76, .66, and .70 for component 1 through component 6, respectively. Means and standard deviations for these component scores are given in Table 13. See Appendix G for a listing of the items comprising these scales.

Table 13
Means and Standard Deviations for Army-SA Component Scores

Component	N	Minimum	Maximum	Mean	SD
Impulsivity	205	17	50	31.12	7.34
Anxiety	207	13	47	26.76	5.93
Self-Confidence	208	21	49	39.04	4.46
Safety Orientation	208	32	54	44.99	3.98
Denial	206	21	48	35.21	4.96
Weather Anxiety	205	7	28	15.42	3.63

Table 14 presents the intercorrelations among the Army-SA component scores, demographic variables, and the Army-HES. Significant correlations were obtained between the Army-HES and two of the Army-SA component scores: Impulsivity and Denial. The positive correlation between Army-HES and Impulsivity indicates that Aviators who agreed with statements indicating an impulsive style of responding to situations experienced more hazardous events. The correlation between Army-HES and Denial was negative, indicating Aviators who do not engage in Denial tend to experience fewer hazardous events. Interestingly, experience, as measured both by total years as an Army Aviator and total military flight hours, was positively correlated with both Self-Confidence and Safety Orientation.

Table 14

Intercorrelations Among Measures (N = 184 to 208)

Component	Impulsivity	Anxiety	Self-Confidence	Safety Orientation	Denial	Weather Anxiety	Army-HES	Years as an Army Aviator	Total Mil Flight Hours
Impulsivity	1.00								
Anxiety	-.02	1.00							
Self-Confidence	-.24**	-.35**	1.00						
Safety Orientation	-.32**	-.02	.35**	1.00					
Denial	.05	-.05	.19**	.21**	1.00				
Weather Anxiety	.30**	.25**	-.32**	-.15*	.03	1.00			
Army-HES	.27**	.14	.05	-.05	-.18*	.11	1.00		
Years as an Army Aviator	-.13	-.17*	.31**	.23**	.11	-.09	-.15*	1.00	
Total Mil Flight Hours	-.04	-.13	.36**	.23**	.13	-.04	.10	.80**	1.00
Recent Mil Flight Hours	.17*	.06	.22**	.08	.04	.17*	.54**	-.02	.31**

* $p < .05$

** $p < .01$

The relationship between the Army-SA component scores and accident involvement was investigated for both recent accident status and career accident status. Table 15 presents the means for the recent accident status groups, while Table 16 presents the means for the career accident status groups. None of the component scores differ significantly between for either the recent or career accident status groups. Results of the ANOVAs for these comparisons are given in Table H5 and Table H6.

Table 15

Means of Army-SA Component Scores and Army-HES for Recent Accident Status Groups

	Accident			No Accident		
Component or Scale	N	Mean	SD	N	Mean	SD
Impulsivity	13	28.76	5.58	190	31.26	7.37
Anxiety	13	26.69	5.89	189	26.84	5.85
Self-Confidence	13	39.23	3.87	189	39.02	4.53
Safety Orientation	13	45.30	4.76	189	44.97	3.96
Denial	13	35.84	4.86	191	35.17	5.00
Weather Anxiety	13	14.92	3.06	190	15.50	3.67
Army-HES	13	29.07	13.87	174	27.59	19.78

Table 16
Means of Army-SA Component Scores and Army-HES for Career Accident Status Groups

	Accident			No Accident		
Component or Scale	N	Mean	SD	N	Mean	SD
Impulsivity	57	30.78	6.94	146	31.23	7.44
Anxiety	55	25.98	5.27	147	27.14	6.02
Self-Confidence	56	39.66	4.01	146	38.80	4.65
Safety Orientation	57	44.52	3.67	145	45.17	4.12
Denial	57	35.43	4.64	147	35.13	5.12
Weather Anxiety	57	15.87	3.63	146	15.30	3.63
Army-HES	52	25.71	18.13	135	28.46	19.89

Discussion of Survey 3 Results.

Principal component analysis. Principal component analysis of the item responses resulted in six interpretable components. Some of these components were similar to components (e.g., impulsivity) identified in previous research on civil scales (Hunter, 2004). The mean component scores for the groups that had reported involvement in recent and career aviation accidents were compared with the groups that did not report such accident involvement. None of these comparisons produced significant results.

Army-HES. Although, as noted above, none of the component scores were significantly associated with accident status, the Army-HES was significantly correlated with both the Impulsivity component (r = .272, p = .001) and the Denial component (r = -.176, p = .05). Interpretation of these results is problematic, since the Army-HES did not significantly differentiate between the accident status groups for either career or recent accident status.

Survey 4 - Scenario-Based Measures

This survey contained 10 scenarios depicting situations that an Army Aviator might experience. For each of the 10 scenarios, there were 17 questions regarding that scenario. These questions were designed to measure a variety of Locus of Control and Risk Orientation constructs. In addition, the survey included the 36-item Army Hazardous Events Scale (Army-HES), and 21 demographic questions. Approximately 250 pilots had completed some or all of the survey as of the closing date for the research effort.

Participant Characteristics

All respondents held an Army rotary-wing rating, and 17.2% of respondents also held an Army fixed-wing rating. The sample was predominantly (96.9%) male and one respondent (0.4%) was in the Army National Guard. One respondent reported that they were employed as a pilot outside the Army.

Army Hazardous Events Scale (Army-HES). Participants completed a 36-item scale that assessed the number of hazardous military aviation events that they had experienced in the previous 24 months. Scores for this scale were computed by summing all the responses. Scores ranged from 0 to 94, with a mean of 24.9 (*SD* = 18.93).

Scenario-Based Scales

Participants were presented with ten scenarios that described situations that an Army Aviator might experience. An example of one such scenario is:

While on a single-ship resupply mission to an outpost located in a mountainous region deteriorating weather conditions reduce horizontal visibility to less than one mile, making recognition of landmarks and location of the outpost difficult. GPS is unserviceable on this aircraft, forcing the crew to rely upon visual navigation. After an extensive search, the crew locate the outpost and begin their approach. However, as they descend toward the LZ which is on the side of a steep hill, high winds blow clouds across their flight path and they lose sight of the LZ and visual contact with the ground.

After reading each scenario, participants responded to 17 questions regarding that specific scenario. These questions were designed to assess locus of control at a global level and when disaggregated into several dimensions. The questions also assessed self-serving bias, and the level of risk perceived in the scenario by the participant:

- *Self-Serving Bias*
    - Q1. Compared to other pilots you know, how well would you be able to handle this situation if you were the pilot in command (PIC)?
        - Response Scale: 1 (Much better than most)....5 (Much worse than most)

- *Global Locus of Control*

  - Q2. How strongly do you agree or disagree with the following statement: If I were the pilot in command in this situation, the outcome would be determined by my personal skills, knowledge, and abilities (SKA).
    - Response Scale: 1 (Strongly agree) ...... 5 (Strongly disagree)

  - Q3. Thinking about this situation, how much of the outcome would be under your personal control?
    - Response Scale: 1 (very little) ………10 (almost all)

- *Multi-Dimensional Locus of Control (M-LOC)*

  - How much of the outcome in this situation would be determined by:
    - Response Scale: 1-very little………..10-very much
  - Q4. Your personal knowledge and skills
  - Q5. Your attitudes
  - Q6. Your determination
  - Q7. Your professionalism
  - Q8. Your airmanship
  - Q9. Your crew management skills
  - Q10. Your crewmembers' performance
  - Q11. The changes in weather
  - Q12. Actions by others (enemy, ground troops, other aircraft crews)
  - Q13. Luck

- *Risk Perception*

  - Q14. If you were placed in this situation tomorrow (as PIC), how risky do you think it would be?
    - Response Scale: 1-very little risk…10-very high risk

  - Q15. If a typical Aviator from your unit were placed in this situation tomorrow (as PIC), how risky do you think it would be?
    - Response Scale: 1-very little risk…10-very high risk

  - Q16. How likely is it that you would be able to complete this mission successfully and without an incident/accident?
    - Response Scale: 1 -very unlikely…..10-absolutely certain of completion

  - Q17. How likely is it that the typical Aviator from your unit would be able to complete this mission successfully and without an incident/accident?
    - Response Scale: 1 -very unlikely…..10-absolutely certain of completion

As an initial approach to analyzing these items, the mean responses for each individual to each of the 17 items across all 10 scenarios were computed. The descriptive statistics for these ten scores are presented in Table 17. These 17 scores were then correlated with the Army-HES and demographic variables, as shown in Table 18.

Table 17
Descriptive Statistics for the Averaged Scenario Questions

Item #	Description	N	Minimum	Maximum	Mean	S.D.
Q1	Self-serving bias	238	1.00	5.00	2.35	.56
Q2	Global locus of control – SKA*	239	1.00	4.90	1.79	.55
Q3	Global locus of control	235	1.60	10.00	7.58	1.32
Q4	M-LOC – Knowledge and skills**	232	1.00	10.00	3.44	1.76
Q5	M-LOC – Attitudes	235	1.20	9.40	3.73	1.40
Q6	M-LOC – Determination	235	1.70	10.00	7.79	1.17
Q7	M-LOC – Professionalism	236	1.10	10.00	6.82	1.73
Q8	M-LOC – Airmanship	235	1.80	10.00	6.65	1.82
Q9	M-LOC – Crew Management Skills	235	1.00	10.00	6.80	1.95
Q10	M-LOC – Crewmembers Performance	234	1.00	10.00	7.48	1.20
Q11	M-LOC – Weather	236	1.00	10.00	7.21	1.51
Q12	M-LOC – Others	234	2.60	10.00	7.52	1.43
Q13	M-LOC – Luck	234	1.00	8.70	5.03	1.48
Q14	Personal Risk	235	1.40	10.00	6.26	1.33
Q15	Average pilot risk	231	1.50	10.00	6.69	1.33
Q16	Personal Likelihood of Success	234	1.80	10.00	6.76	1.29
Q17	Average pilot likelihood of success	232	2.70	10.00	6.33	1.32

*Skills, Knowledge, and Abilities.

**M-LOC= Multidimensional LOC Scale.

Table 18

Intercorrelations of Scenario Scores, Army-HES and Demographic Measures (N = 204 to 236)

	Army-HES	Years as Army Aviator	Total Mil Flight Hours	Recent Mil Flight Hours	Q1	Q2	Q3	Q4	Q5	Q6
Years as an Army Aviator	-.17*	1.00								
Total Military Flight Hours	.03	.77**	1.00							
Recent Military Flight Hours	.57**	-.14*	.23**	1.00						
Q1	-.08	-.31**	-.48**	-.20**	1.00					
Q2	.01	-.12	-.17**	-.07	.43**	1.00				
Q3	-.12	.12	.14*	-.04	-.37**	-.40**	1.00			
Q4	.01	-.10	-.06	.07	.13	.00	-.15*	1.00		
Q5	.04	-.02	-.06	.07	.06	.09	-.18**	.30**	1.00	
Q6	-.03	.09	.12	.04	-.40**	-.49**	.75**	-.09	-.13	1.00
Q7	-.06	.09	.09	-.04	-.23**	-.23**	.40**	-.06	.10*	.56**
Q8	-.08	.03	-.02	-.01	-.12	-.17**	.34**	.05	.18**	.46**
Q9	-.02	.19**	.15*	.00	-.25**	-.25**	.35**	-.12	.19**	.51**
Q10	-.05	.09	.20**	.07	-.42**	-.44**	.63**	-.03	-.05	.81**
Q11	-.03	.08	.11	-.01	-.23**	-.24**	.36**	-.05	.09	.57**
Q12	.01	.02	-.05	-.04	-.05	-.18**	.28**	-.02	.16*	.42**
Q13	.03	-.18**	-.10	.12	.00	.03	.01	.37**	.43**	.04
Q14	-.06	-.07	-.11	-.11	.24**	-.02	-.01	.17*	.06	-.05
Q15	.06	.07	.16*	.03	-.20**	-.17**	.17**	.14*	-.03	.20**
Q16	-.08	-.00	-.01	-.02	-.28**	-.22**	.40**	-.18**	-.16*	.40**
Q17	-.22**	-.14*	-.27**	-.19**	.16*	-.02	.15*	-.16*	-.04	.11

* $p < .05$

** $p < .01$

Table 18 (Continued)

Intercorrelations of Scenario Scores, Army-HES and Demographic Measures (N = 204 to 236)

	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
Q7	1.00									
Q8	.79**	1.00								
Q9	.69**	.66**	1.00							
Q10	.57**	.55**	.56**	1.00						
Q11	.56**	.50**	.50**	.54	1.00					
Q12	.41**	.47**	.43**	.39**	.77**	1.00				
Q13	.08	.20**	.09	.09	.22**	.18**	1.00			
Q14	-.06	.01	.03	-.04	.04	.13*	.16*	1.00		
Q15	.09	.06	.15*	.19**	.16*	.07	.20**	.75**	1.00	
Q16	.31**	.30**	.28**	.38**	.33**	.23**	-.05	-.15*	.00	1.00
Q17	.14*	.20**	.15*	.10	.18**	.24**	-.07	.00	-.31**	.71**

* $p < .05$

** $p < .01$

Accident Involvement

Involvement in a military aviation accident within the previous 24 months was reported by 6.4% of respondents, and 29.2% reported having been in such an accident at some time previously. No one reported having been in a civil aviation accident within the previous 24 months, and 5 respondents (2.1%) reported having been in a civil accident at some time previously.

Two sets of analyses were conducted that compared the Aviators who had been in an accident to those who had not been in an accident. For recent accident status, the means (Shown in Table 19) for both Global LOC (Question 2)($F(1, 231) = 4.93$, $p = .03$, $\eta_p^2 = .02$) and the Army-HES ($F(1,206) = 4.47$, $p = .04$, $\eta_p^2 = .02$) were significantly different for the two recent accident status groups. For the career accident status analysis, the mean scores (shown in Table 20) for Professionalism ($F(1, 230) = 10.51$, $p = .001$, $\eta_p^2 = .04$), Crew Resource Management Skills ($F(1, 230) = 9.32$, $p = .01$, $\eta_p^2 = .04$), and Average Pilot Likelihood of Success ($F(1, 228) = 7.874$, $p = .01$, $\eta_p^2 = .03$) were found to be significantly different for the status groups. ANOVA results for all comparisons are found in Table H7 and H8, for the recent and career accident status groups, respectively.

Table 19
Means of Scenario Measures for Recent Accident Status Groups

		Accident Group			No-Accident Group		
Item #	Description	Mean	N	SD	Mean	N	SD
Q1	Self-serving bias	2.46	15	.42	2.34	217	.57
Q2	Global locus of control – SKA	2.09	15	.53	1.76	218	.54
Q3	Global locus of control	7.56	15	1.25	7.59	216	1.32
Q4	M-LOC – Knowledge/skills	3.13	14	1.50	3.47	215	1.78
Q5	M-loc – Attitudes	3.93	15	1.42	3.71	216	1.40
Q6	M-LOC – Determination	7.68	15	1.20	7.82	216	1.17
Q7	M-LOC – Professionalism	7.56	15	1.98	6.78	217	1.71
Q8	M-LOC – Airmanship	7.39	15	2.16	6.61	216	1.79
Q9	M-LOC – Crew Management Skills	7.59	15	2.09	6.76	217	1.94
Q10	M-LOC – Crew Performance	7.40	15	1.33	7.50	216	1.19
Q11	M-LOC – Weather	7.08	15	2.25	7.23	218	1.45
Q12	M-LOC – Others	7.83	14	1.55	7.51	217	1.43
Q13	M-LOC – Luck	5.19	14	1.50	5.02	217	1.49
Q14	Personal Risk	6.40	15	.87	6.26	218	1.36
Q15	Average Pilot Risk	6.93	15	1.07	6.68	214	1.35
Q16	Personal Likelihood of Success	6.72	15	1.30	6.78	217	1.29
Q17	Average Pilot Likelihood of Success	6.02	14	1.29	6.35	216	1.33

Table 20
Means of Scenario Measures for Career Accident Status Groups

Item #	Description	Accident			No Accident		
		N	Mean	S.D.	N	Mean	SD
Q1	Self-serving bias	68	2.24	.51	164	2.39	.58
Q2	Global locus of control - SKA	68	1.76	.52	165	1.80	.56
Q3	Global locus of control	67	7.81	1.17	164	7.50	1.36
Q4	M-LOC – Knowledge and skills	66	3.26	1.65	163	3.52	1.80
Q5	M-LOC – Attitudes	68	3.71	1.38	163	3.73	1.42
Q6	M-LOC – Determination	67	7.93	1.09	164	7.76	1.20
Q7	M-LOC – Professionalism	68	7.39	1.51	164	6.60	1.77
Q8	M-LOC – Airmanship	67	7.00	1.72	164	6.52	1.85
Q9	M-LOC – Crew Management Skills	68	7.41	1.66	164	6.56	2.02
Q10	M-LOC – Crewmembers performance	67	7.65	1.06	164	7.43	1.24
Q11	M-LOC – Weather	68	7.45	1.57	165	7.12	1.48
Q12	M-LOC – Others	66	7.73	1.45	165	7.45	1.42
Q13	M-LOC – Luck	67	4.75	1.53	164	5.14	1.46
Q14	Personal Risk	68	6.25	1.29	165	6.27	1.36
Q15	Average pilot risk	68	6.90	1.28	161	6.61	1.34
Q16	Personal Likelihood of Success	68	6.70	1.24	164	6.81	1.32
Q17	Average pilot likelihood of success	67	5.95	1.44	163	6.49	1.25
	Army-HES	58	25.81	21.38	150	24.70	18.01

Discussion of Survey 4 Results

Summated scales. For recent accident status, only Global Locus of Control (Question 2) differentiated significantly between the accident and non-accident status groups. The effect is in the expected direction (i.e., Aviators who have not been in accidents believe more strongly that they are in control.) although the magnitude of the difference is small.

Comparing the career military accident status groups, three of the scales produced significant results. These were: Professionalism (Q 7), Crew Management Skills (Q 9), and Average Pilot Likelihood of Success (Q 17). Question 7 and Question 9 address locus of control. In both cases, Aviators who have had accidents rated these elements as significantly higher in impact than Aviators who had not had an accident. This is an interesting outcome, since it raises the possibility that the impact of these concepts have been over-emphasized to Aviators. That is, if an Aviator strongly believes that Professionalism and good Crew Management Skills will keep them accident-free, then they may ignore other components with greater impact.

Question 17 was intended as a risk perception question. The design logic was that if Aviators thought that the average pilot could succeed, they would discount the risk in situations – leading to more accidents and hazardous events. However, it does not seem to have worked that way, raising the question of exactly what construct this question is measuring. Pilots who had never been in an accident believed that the average pilot had a higher likelihood of succeeding in the situations than did pilot who had been in an accident at some point in their career. This is opposite to the expected relationship, and an explanation for this finding is not readily apparent.

Army-HES. There was a significant correlation ($r = -.224$, $p < .001$) between Army-HES and the responses to Question 17 (Average pilot likelihood of success). Since Question 17 is scaled from 1 (low likelihood of success) to 10 (high likelihood of success), the negative correlation indicates that Aviators who believed that the average pilot had a high likelihood of success experienced fewer hazardous events. Army-HES scores for the recent accident (M = 35.69 SD = 22.24) and non-accident (M = 24.30 SD = 18.58) status groups differed significantly (F (1,206) = 4.47, p=.04, $\eta_p^2 = .02$). This is consistent with the results described above for the analysis of career accident involvement for this question.

Conclusions

Research Goals Achieved

The objective of this effort was to develop a set of prototype scales to measure hazardous events, locus of control, and risk orientation among U.S. Army Aviators. That objective has been achieved, through the development of a suite of prototype measures modeled after civil scales. Moreover, the new scales may have substantially greater validity than the civil scales in a military setting because the measures of the constructs are situated in an Army Aviation context and use Army Aviation terminology and missions.

Army Hazardous Events Scale. Data were collected on the Army-Hazardous Events Scale as part of all four surveys for an aggregate total of approximately 565 cases. Analysis of these data suggests that the items comprising that scale are measuring events that, though not everyday occurrences, do occur at sufficient frequency as to be of potential use as a surrogate measure for accident involvement in future research. The Army-HES may also prove useful for other Army applications, such as evaluating the impact of safety-oriented training programs. A limited demonstration of construct validity is available by examination of the relationships between the Army-HES and the recent and career accident data from each of the four surveys.

- Survey 1:
    - For recent accident status, too few Aviators reported a recent accident to permit statistical analysis.
    - For career accident status, the Army-HES was significantly different for Aviators who had been in an accident, compared to those who had not. (F (1, 67) = 7.34, p=.01, η_p^2 = .10).

- Survey 2:
    - For recent accident status, the Army-HES was significantly different for the two recent accident status groups. (F 1,181) = 13.32, p= .001, η_p^2 = .07)
    - For career accident status, the Army-HES was significantly different for Aviators who had been in an accident, compared to those who had not. (F (1,182) = 5.90, p = .02, η_p^2 = .03).

- Survey 3:
    - For recent accident status, no significant difference was obtained.
    - For career accident status, no significant difference was obtained.

- Survey 4:
    - For recent accident status, a significant difference (F (1,206) = 4.47, p= .04, η_p^2 = .02) between the recent accident status groups was obtained.
    - For career accident status groups, no significant difference was obtained.

It is unclear why such a large variation in results among the four surveys was observed. Further analyses, beyond the scope of the present effort, will be required to explore possible explanations (for example, differences in experience) for the results. For the present, the results must be taken as only tentative support for the construct validity of the Army-HES measure.

Army Locus of Control Scale. Two approaches, one using *a priori* scales and the other using component-analysis derived scales, were used in the analysis of the Army Locus of Control items. Both of these approaches produced results that demonstrated a significant relationship between locus of control constructs and accident involvement.

The mean *a priori* Internality scale scores differed significantly for the recent accident status analysis (F (1,186) = 7.23, p = .01, η_p^2 = .04), and approached, but did not achieve statistical significance (F (1,187) = 3.75, p= .054, η_p^2 = .02) for the career accident status analysis. In both cases, Aviators with more Internal orientation had fewer accidents. Differences between the accident and no-accident groups for both of those analyses on the Externality scale score were not significant, although scores on this component were significantly correlated (r = .192) with Army-HES. In this case higher scores on the Externality component were associated with involvement in more hazardous aviation events.

Three of the scales derived from the principal component analysis of the item responses were found to be significantly different for the recent accident and no-accident groups. These components were Internality, Accident Causality, and Resignation. A general internal orientation was associated with fewer accidents. In addition, a specific internal orientation with regard to the causes of accidents was also found to be associated with fewer accidents. However, Aviators with high scores on the Resignation component tended to have more accidents.

Resignation was also found to differ significantly for the career accident status groups. Differences between the career accident status groups for the Internality component approached, but did not achieve statistical significance, and the Accident Causality component was not significantly different in this comparison.

Aviators became less external as a function of total military flight hours for the Externality component scale (r = -.166) and for the Externality a priori scale (r = -.115). A similar relationship was noted for years of Army Aviation experience. However, no association (e.g., correlations approximately zero) was found between the Internality scale and either of these variables. The implication is that Internality is more stable across time and experience than Externality, which may be more malleable.

Overall, these results provide support for the construct validation of the Army Locus of Control Scale. Further, they replicate the results found for the relationships between this construct and accident involvement for civil pilots (Hunter, 2002a).

Army Safety Attitudes Scale. Principal component analysis of the item responses resulted in six interpretable components that were generally similar to components (e.g., impulsivity) identified in previous research on civil scales (Hunter, 2004). None of the component scores for these six components were found to differ significantly for either the recent military accident status or career military accident status groups.

However, the Army-HES was significantly correlated with both the Impulsivity component ($r = .272$, $p = .001$) and the Denial component ($r = -.176$, $p = .05$). Interpretation of these results is difficult, since, as noted in the discussion of the Army-HES above, for this sample the Army-HES did not differentiate between the recent or career accident status groups. Whether this reflects a shortcoming of the scales or some peculiarity of this particular sample cannot be determined at present. However, it is curious that for the other samples significant relationships were generally noted between the Army-HES and accident status, while for this sample the correlation between accident status and Army-HES is approximately zero.

Overall, the data provide a mixed result regarding the relationships between the scales and accident involvement. While no significant relationships were found between the component scale scores and the two accident criteria, a significant relationship was found between two of the component scale scores and the Army-HES. Clearly, additional research is needed to clarify these relationships and better establish the construct validity of the Army Safety Attitudes Scale.

Army Aviation Scenario-Based Measures. The Army Scenario-Based Measures were intended to measure locus of control constructs at an even greater level of specificity than that provided by the Army Locus of Control scale. It was also intended to provide a mechanism to assess Aviators' risk perception and self-serving bias.

Regarding the locus of control constructs, global locus of control from the scenario-based measures differentiated significantly between recent accident and no-accident groups. The effect was in the expected direction, such that Aviators who have not been in accidents believe more strongly that they are in control, although the magnitude of the difference was small. None of the multidimensional locus of control scales differentiated significantly between the recent accident status groups. However, two of the multidimensional items did differentiate significantly between the career accident and no-accident groups. These two items assessed the perceived impact of Professionalism and Crew Management Skills on the outcome of the scenario.

Contrary to prior research, the items that assessed perceived personal risk did not differentiate between the recent or career accident status groups. However, the item that assessed the likelihood of success in the scenario for an average pilot was associated with career accident status. Aviators who had never experienced an accident rated the likelihood of success in the scenarios significantly higher than the Aviators who had experienced an accident. Arguably, the question may represent some sort of expectation of success. That is, if an Aviator expects the average pilot to succeed, then they modify their behavior in some way that leads to fewer accidents or, as noted below, fewer hazardous events. This explanation is, of course, simply speculation at this point.

Overall, the use of scenario-based items, particularly the attempt to disaggregate the control dimensions, seems to be an avenue of research that should be pursued further. Although the present results are mixed with respect to construct validation, the results from the multidimensional items and from the item assessing likelihood of success for average pilots suggest avenues of research not available using conventional format scales.

Application of Results

Because the goal of this effort was limited to developing a set of prototype measures, it is premature to suggest detailed applications for the results. Arguably, the present results are intriguing with respect to the relationships between the various scales and the accident and hazardous events criteria. However, before the scales could be used operationally, more research on the relationships and refinement of the scales is needed. Once those activities have been completed, the scales could find application in the assessment of these constructs as a means of assessing effectiveness of programs aimed at improving aviation safety through a variety of training or self-awareness interventions. They might also be used by, for example, Aviation Safety Officers as a means of monitoring safety-related psychological components in their units, and could serve as a warning flag, indicating a need to implement safety interventions.

Future Efforts

Although substantial progress has been made during this Phase I effort, additional efforts will be needed to:

- Conduct additional analyses on the present data to further explore scoring procedures and scale construction alternatives. In particular, profile analysis (as suggested by a reviewer) for the data from Survey 4 should be explored.
- Perform construct validation using standardized measures and assess the interrelationships among the scales. This activity represents the minimum generally accepted practice for the psychometric evaluation of new scales.
- Further refine the items and scales and develop a better normative base for future evaluations. Following the initial evaluation of the scales, they should be administered to a large, representative sample of aviators in order to provide a firm normative base for future comparisons. In addition, the results from the initial administrations of the scales, particularly the comments received from participants, may serve as the bases for improvements.
- Develop additional scenarios that are targeted toward scout and attack helicopter pilots. The present scenarios are almost exclusively oriented toward lift operations, and pilots whose duties do not include that mission reported difficulties in completing these items.
- Explore techniques to modify these constructs through training or other interventions so as to reduce accident risk and/or improve unit-level measures. In such an effort the measures created under this first Phase effort could be used as indices of the extent of behavioral (hazardous events) and psychological (attitudes, risk perception, control orientation) impact of the training/intervention.

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Appendix A
Army Hazardous Events Scale

For the following questions, participants were asked to think back over their military flights for the last 24 months and indicate how many times each of these events had happened to them, when they were one of the pilots (regardless of status) of the aircraft at the time of the event.

The response alternatives were:

a. None (0)
b. 1 time
c. 2 times
d. 3 times
e. 4 or more times

Items marked with a * were retained for use in the abbreviated version of the scale, following the item analysis described earlier. These items were included with all subsequent surveys.

H1. Run so low on fuel that you were seriously concerned about making it to an airfield/heliport or refueling point before you ran out?*

H2. Made a precautionary or forced landing at an airfield/heliport other than your original destination? *

H3. Made a precautionary or forced landing away from an airfield/heliport? *

H4. Been forced to perform an abrupt maneuver to avoid an obstacle? *

H5. Become so disoriented that you had to land or call ATC for assistance in determining your location?

H6. Had a mechanical failure that jeopardized the safety of your flight? *

H7. Had an engine quit because of fuel starvation, either because you ran out of fuel or because of an improper pump or fuel tank selection?

H8. Flown into areas of instrument meteorological conditions, when you were not on an instrument flight plan? *

H9. Turned back or diverted to another airport because of bad weather while on a VFR flight? *

H10. Experienced icing so severe that you had to divert or change altitude?

H11. Noticed that you were significantly undershooting your approach to landing?

H12. Attempted to hover in ground effect and discovered you had insufficient power?

H13. Experienced vertigo so severe that you had to pass control of the aircraft to the other pilot? *

H14. Taken off when you knew you were over the maximum gross weight limit for the conditions?

H15. Had a crewmember become ill or incapacitated during flight, to the extent that they could not fully perform their duties? *

H16. Penetrated a gun-target line without clearance?

H17. Lost visual contact with the ground because of dust or snow while landing or taking off (brown-out)? *

H18. Descended below the MDA while on an instrument approach without having the airfield in sight?

H19. Descended more than two dots below the glideslope while on an ILS approach?

H20. Drifted more than two dots to the left or right of course while inside the outer marker on an ILS approach? *

H21. Failed to complete the before-landing checklist while landing at an airfield/heliport?

H22. Experienced an in-flight fire or smoke in the cabin?

H23. Failed to follow ATC/tower instructions?

H24. Taken off without clearance from a controlled airfield/heliport?

H25. Entered or crossed an active runway without clearance?

H26. Had cargo shift while in-flight?

H27. Landed without clearance at a controlled airfield/heliport?

H28. Experienced an electrical failure during night flight?

H29. Lost one or more of your primary flight instruments (gyro failure, altimeter failure, etc.) during instrument flight? *

H30. Experienced wake turbulence from other aircraft that resulted in near loss-of-control?

H31. Lost cyclic authority while hovering (lateral load exceeded)?

H32. Lost anti-torque authority while hovering?

H33. Attempted to hover out of ground effect, and discovered you had insufficient power? *

H34. Noticed that you were drifting significantly to one side during your approach to landing?

H35. Discovered live ordnance left on board after a flight?

H36. Grazed trees (or other objects) while flying low-level?

H37. Struck an object with the main rotor while hovering?

H38. Experienced a near mid-air collision? *

H39. Experienced a near collision while taxiing or hovering?

H40. Nearly collided with the ground or some object while flying? *

H41. Had your aircraft slide after landing on a slope or smooth rocks? *

H42. Unexpectedly had your aircraft tip significantly after landing on a slope?

H43. Experienced a hard landing?

H44. Executed a go-around after encountering brown-out or white-out conditions during the last portion of your approach to landing? *

H45. Made a zero-visibility take-off in which you immediately lost visual contact with the ground while pulling pitch because of brown-out or white-out? *

H46. Came close to hitting terrain or some other obstacle after inadvertently entering instrument meteorological conditions?

H47. Narrowly avoided a wire-strike? *

H48. Followed an instruction meant for another aircraft because of confusion over call signs?

H49. Became so fatigued while flying that you had difficulty remaining alert and performing your duties? *

H50. Were asked by a ranking passenger to perform an action that you believed was contrary to the safety of flight? *

H51. Became so ill during a flight that you could not perform your duties?

H52. Struck a large bird while in flight? *

H53. Experienced much worse weather enroute or at your destination than was forecast? *

H54. Made a significant navigation error that could have taken you into rising terrain, an enemy-controlled area, or otherwise seriously jeopardized the aircraft/mission?

H55. Experienced a failure of your night vision device during a critical phase of flight (for example, while on approach to an LZ or while maneuvering low-level)? *

H56. Had a significant dispute with the other pilot regarding what course of action should be taken? *

H57. Found that you and the other pilot had a very different mental picture of what was going on in or around the aircraft (for example, your position relative to friendly and enemy forces, the location of the next navigation fix)? *

H58. Flown with a pilot, outside of a training situation, who did not seem to have the skills needed to fly the aircraft and accomplish your mission? *

H59. Encountered turbulence so severe that you had significant difficulty maintaining control of the aircraft?

H60. Discovered after a flight that some important part of the aircraft had been damaged without your being aware of it?

H61. Had a weapon accidentally discharge in your aircraft?

H62. Had the other pilot perform some action that was completely unexpected and might have jeopardized the safety of your flight? *

H63. Been forced to perform a go-around because of dust/brownout in the landing area?

H63. Experienced a wire strike?

H65. Had a radio communications failure that jeopardized the safety of your flight? *

H66. Discovered during a flight that you did not have the correct frequencies and/or callsigns required for communication with ground personnel? *

H67. Lost communications with another member of the crew during some critical phase of flight? *

H68. Realized afterward that you had followed the wrong procedure for an emergency or near emergency situation?

H69. Discovered that neither you nor the other pilot had the controls?

H70. Misinterpreted some statement or request by the other pilot or a crewmember leading to an unsafe condition? *

H71. Exceeded the airspeed, power, or RPM limitations of your aircraft?

H72. Had the other pilot misunderstand some statement or request that you made, leading to an unsafe condition? *

H73. Noticed that the other pilot or a crewmember was doing something wrong, but did not correct them?

H74. Experienced a lightning strike on the aircraft during flight?

H75. Discovered during a flight that you did not have the correct maps for your route and/or destination?

H76. Experienced a smoke or fire indicator that was not a false alarm?

H77. Allowed a non-rated person to fly the aircraft?
H78. Had a hard landing resulting in a maintenance inspection before flight could continue?

H79. Taken off without checking the weather and/or NOTAMS?

H80. Discovered that a cowling or hatch was not secured prior to flight?

H81. Inadvertently moved the control (cyclic, collective, or control wheel) when you were not the pilot flying the aircraft? *

H82. Had a flight control bind or stick?

H83. Performed more than two unsuccessful approaches to landing at the same location during a single mission?

H84. Performed unauthorized aerobatics, return to target maneuvers, or buzzed ground vehicles? *

H85. Made a serious error in reading or interpreting an instrument, but later realized your mistake?

H86. Performed a terrain (low-level) flight without having documented all the hazards on your maps? *

Appendix B
Army Locus of Control Scale

This scale uses the traditional Likert-format, in which participants indicate how strongly they agree or disagree with each statement by choosing one of the following options:

a. Strongly Agree
b. Agree
c. Neither agree nor disagree
d. Disagree
e. Strongly Disagree

LC1. If Aviators follow all the rules and regulations, they can avoid many aviation accidents.

LC2. Accidents are usually caused by unsafe equipment and inadequate maintenance.

LC3. Aviators should be reprimanded if they periodically neglect to use safety devices (for example, seat belts, checklists, etc.) that are required by Army Regulations.

LC4. Accidents and injuries occur because Aviators do not take enough interest in safety.

LC5. Avoiding accidents is a matter of Luck.

LC6. Most accidents and incidents can be avoided if Aviators use proper procedures.

LC7. Most accidents and injuries cannot be avoided.

LC8. Most accidents are due to Aviators' carelessness.

LC9. Most Aviators will be involved in accidents or incidents which result in aircraft damage or personal injury.

LC10. Aviators should be punished if they have an accident or incident while "horsing around".

LC11. Most accidents that result in injuries are largely preventable.

LC12. Aviators can do very little to avoid minor incidents while flying their missions.

LC13. Whether people get injured or not is a matter of fate, chance, or Luck.

LC14. Aviators' accidents and injuries result from the mistakes they make.

LC15. Most accidents can be blamed on poor command oversight.

LC16. Most injuries are caused by accidental happenings outside people's control.

LC17. People can avoid getting injured if they are careful and aware of potential dangers.

LC18. It is more important to complete a mission than to follow a safety precaution that costs more time.

LC19. There is a direct connection between how careful Aviators are and the number of accidents they have.

LC20. Most accidents are unavoidable.

LC21. No matter how hard Aviators try to prevent them, there will always be accidents.

LC22. There are so many dangers in this world that you never know how or when you might be in an accident.

LC23. Most Aviators never think about safety during their flights.

LC24. In the end, whether I am in an accident depends on my skills and abilities.

LC25. If you keep your wits about you, success is always possible.

LC26. I’d rather be Lucky than good.

LC27. Sometimes you get the bear, sometimes the bear gets you.

LC28. Stuff just happens.

LC29. Some people are just destined to be in an accident.

LC30. If I get in a difficult situation, it is my own behavior that determines if I make it out OK.

LC31. No matter what I do, if I am going to have an accident, I will have an accident.

LC32. Getting regular training and practice is the best way for me to avoid an accident.

LC33. I am in control of my life.

LC34. When I make a mistake, I am to blame.

LC35. Luck plays a big part in determining whether you will be in an accident.

LC36. My success in aviation is largely a matter of good fortune.

LC37. If I take care of myself, I can avoid accidents.

LC38. The main thing that affects my safety is what I myself do.

LC39. No matter what I do, I’m likely to have an accident.

LC40. If it’s meant to be, I will be safe and not have an accident.

LC41. If I take the right actions, I can avoid accidents.

LC42. Regarding safety, I can only do what the Army tells me to do.

LC43. Whether or not I get into an accident depends mostly on how good a pilot I am.

LC44. To a great extent, what happens to me in life is outside my control.

LC45. If I get what I want, it is because I worked for it.

LC46. It is my ability and determination that will determine whether I am in an accident.

LC47. I am careful to check everything on the aircraft before I depart on a mission.

LC48. Often there is no way to protect myself from the effects of bad Luck.

LC49. Much of the time when I am successful, it is because I am Lucky.

LC50. I believe I have control over my own destiny.

LC51. The decisions made by other people will largely determine if I am in an accident.

LC52. Whether or not I get into an accident is mostly a matter of Luck.

LC53. Whether or not I get into an accident depends mostly on other people.

LC54. Whether or not I get into an accident depends mostly on things that I cannot control, like the weather.

LC55. I do not really believe in Luck.

LC56. My success is mainly a matter of chance.

LC57. Chance has a lot to do with avoiding accidents.

LC58. Being at the wrong place at the wrong time is what causes accidents.

LC59. You cannot control your destiny.

LC60. Bad Luck is what gets many pilots into trouble.

LC61. If something is meant to happen there is nothing you can do to change it.

LC62. The idea that Luck determines what happens to you is ridiculous.

LC63. You are responsible for the things that happen to you in your life.

LC64. If I have an accident, it’s because I didn’t try hard enough.

LC65. If I have an accident, It’s because I was not careful enough.

LC66. If I try hard enough, I can get out of any situation.

LC67. Safety is due to effort, not Luck.

LC68. Accidents could be eliminated, if pilots made more of an effort.

LC69. Chance has nothing to do with being safe.

LC70. If I have a close call, it just means I have to work harder next time.

LC71. I feel completely in control, all the time.

LC72. I never blame others for my problems.

LC73. I have little influence over the things that happen to me.

LC74. I am superstitious.

LC75. Accidents are really beyond anybody’s control – they just happen.

LC76. I can prepare myself to deal with the mistakes of others.

LC77. When a person fails, it is almost always their own fault.

LC78. A person’s destiny determines what happens to them

LC79. At some point a person must accept the inevitable and face their fate calmly

LC80. I feel that there is some higher power looking out for me

LC81. There are no problems that cannot be overcome with enough effort

LC82. If I had an accident, it would be the result of bad Luck.

LC83. I'll die when it's my time to go, but not before.

LC84. In a tight situation, I trust to fate.

LC85. In flying, what will be, will be.

LC86. Most of the time accidents are caused by things beyond the Aviator's control.

LC87. Sometimes you just have to depend on Luck to get you through.

LC88. Successful flying is partly a matter of good Luck.

LC89. You don't go until your number is up.

Appendix C
Army Safety Attitudes Scale

This scale uses the traditional Likert-format, in which participants indicate how strongly they agree or disagree with each statement by choosing one of the following options:

a. Strongly Agree
b. Agree
c. Neither agree nor disagree
d. Disagree
e. Strongly Disagree

SA1. A successful flight is solely due to good planning and good execution.

SA2. Aviation weather forecasts are usually accurate.

SA3. Aviators should have more control over how they fly.

SA4. Careful route planning and attention to navigation determines whether or not I will get lost.

SA5. Even when I know that my chances are limited I try my Luck.

SA6. I always feel I have complete control over the aircraft.

SA7. I always worry about an accident when I'm flying.

SA8. I am a very capable pilot.

SA9. I am a very careful pilot.

SA10. I am a very cautious pilot.

SA11. I am capable of instrument flight.

SA12. I am so careful that I will never have an accident.

SA13. I am very skillful on controls.

SA14. I deal with stress very well.

SA15. I do not have much sympathy for adventurous decisions

SA16. I do not like to put something at stake; I would rather be on the safe side.

SA17. I express my opinion even if most people have opposite views.

SA18. I feel comfortable flying at night.

SA19. I feel like yelling at people who don't clear the runway fast enough when I'm on final approach.

SA20. I feel uncomfortable flying VFR when the visibility is very low.

SA21. I feel very vulnerable to accidents.

SA22. I figure nothing can happen to me in an aircraft that I cannot handle.

SA23. I find it easy to understand the weather information I get before flights.

SA24. I fly enough to maintain my proficiency.

SA25. I follow the motto, “Nothing ventured, nothing gained.”

SA26. I have a thorough knowledge of my aircraft.

SA27. I know aviation procedures very well.

SA28. I know how to get help from ATC if I get into trouble.

SA29. I like making turns steeper than 60 degrees, just to see if I can do it.

SA30. I like to see how close I can cut things.

SA31. I might dip into my fuel reserve to avoid a fuel stop and save time.

SA32. I never feel stressed when flying.

SA33. I often feel stressed when flying in or near weather.

SA34. I really hate being delayed when I fly on a trip.

SA35. I really worry about having to make an emergency landing.

SA36. I really worry about mid-air collisions.

SA37. I really worry about running out of fuel.

SA38. I tend to imagine the unfavorable outcomes of my actions.

SA39. I will follow the regulations even if they inconvenience me, because it's the right thing to do.

SA40. I would duck below minimums to get home.

SA41. I would like to act in my boss's job some time so as to demonstrate my competence, despite the risk of making mistakes.

SA42. I'm quite cautions when I make plans and when I act on them

SA43. If a task seems interesting, I will choose to do it even if I am not sure whether I will manage it.

SA44. If I could cut off a lot of time on a cross country flight by taking a short cut through a restricted area, I'd do it.

SA45. If I fly VFR on top, I feel sure I can find a hole in the clouds to come back down through.

SA46. If I hear other pilots discussing a maneuver that can be done on my aircraft, I'll try it out.

SA47. If I want to fly somewhere, I want to do it now.

SA48. If the weather is marginal, I don't mind waiting at the airport until it clears up.

SA49. If you don't push yourself and the aircraft a little, you'll never know what you could do.

SA50. I'm basically an impatient pilot.

SA51. In a congested area, I figure that if I keep the correct altitude and heading I'll get through safely.

SA52. In a tight situation, I believe in doing anything rather that doing nothing.

SA53. In an uncontrolled area with lots of traffic, I worry about the possibility of a mid-air collision.

SA54. In flying it's better to be safe than sorry.

SA55. In my work I only set small goals so that I can achieve them without difficulty.

SA56. It is riskier to fly at night than during the day.

SA57. It is very unlikely that an Aviator of my ability would have an accident.

SA58. My decisions are always made carefully and accurately.

SA59. Sometimes I feel like the aircraft has a mind of its own.

SA60. Sometimes I feel that I have very little control over what happens to the aircraft.

SA61. Speed is more important than accuracy during an emergency.

SA62. The rules and regulations controlling flying are much too strict.

SA63. The thoroughness of my preflight mostly determines the likelihood of my having mechanical trouble with the aircraft.

SA64. There are few situations I couldn't get out of.

SA65. Usually, your first response is the best response.

SA66. When I fly a well-maintained aircraft, I feel sure that nothing will really go wrong with it.

SA67. When I'm in a tough spot, I figure if I make it, I make it, and if I don't, I don't.

SA68. While flying at night, I worry about not seeing navigation landmarks and getting lost.

SA69. You should decide quickly and then make adjustments later.

SA70. Getting the mission accomplished always outranks safety.

SA71. Cutting a few corners on safety to get the job done is OK.

SA72. My first duty is to get the mission accomplished, even if I have to bend the rules a bit.

SA73. Being too worried about safety is the mark of a poor pilot.

SA74. I prefer not to file and fly on instruments.

SA75. Whenever possible, I avoid instrument flight

SA76. To get the job done, you have to bend the rules occasionally

SA77. I think you can plan too much for a flight

SA78. When things start to go bad, it is best to simply stick to your original plan.

SA79. Commanders don't really understand what it takes to get the mission done

SA80. Showing off a little in the aircraft is just part of being a great pilot

SA81. The pilot should not question what he is told by the pilot in command.

SA82. The crew in the back of the aircraft should not bother the pilots with suggestions or comments.

SA83. Flying low-level is really not as dangerous as pilots are told.

Appendix D
Army Aviation Scenarios

The following ten scenarios were presented to participants, one scenario at a time. Participants were asked to read the scenario, and then complete the 17 items that assessed their global and specific locus of control, perceived risk, and self-serving bias.

Situation 1:

While on a single-ship resupply mission to an outpost located in a mountainous region deteriorating weather conditions reduce horizontal visibility to less than one mile, making recognition of landmarks and location of the outpost difficult. GPS is unserviceable on this aircraft, forcing the crew to rely upon visual navigation. After an extensive search, the crew locates the outpost and begins their approach. However, as they descend toward the LZ which is on the side of a steep hill, high winds blow clouds across their flight path and they lose sight of the LZ and visual contact with the ground.

Situation 2:

The crew is the second ship of a three-ship formation. They are heavily loaded with troops and supplies and are performing a combat assault into a long, but narrow LZ, surrounded by tall trees. Because of the layout of the LZ, the lead ship directs the formation into trail as they line up for approach. There has been frequent enemy contact in this area, and the previous flight earlier in the day received light enemy automatic weapons fire as they were on final, descending through 200 feet. No one was injured, however one of the aircraft suffered slight damage with several rounds passing through the tail section. All the crews are very alert and ready for action, and the lead passes the word to keep the formation tight so they can provide mutually-supportive covering fire. The initial approach is uneventful, however just as the lead ship begins to flare for landing, a flock of large birds, frightened by the noise and rotor wash, erupts from the trees on the right and head across the LZ, directly into the path of the lead ship. In response, the lead ship flares abruptly, and the second ship must take extreme action to avoid a mid-air collision.

Situation 3:

The unit maintenance officer has asked the crew to fly one of the aircraft back to the depot for some maintenance that cannot be performed at the field site. The crew chief has noticed a slight elevation in the oil temperature over the last several flights and the maintenance officer thinks a more detailed inspection of the engine may be required. There is a layer of low clouds along the route of flight extending from about 400 AGL to 5,000 MSL. Therefore, the PC elects to fly VFR on top. Approximately 40 minutes into the 75 minute flight they notice that the engine oil temperature has risen and is now just below the red line. They have also begun to notice a slight vibration and the crew chief reports a high-pitched whine coming from the area of the engine deck. The nearest airfield with an instrument approach is 35 minutes away

Situation 4:

Following an uncontained engine failure which resulted in the loss of both engines, the crew makes a successful emergency landing in a small clearing on the top of one of the many steep hills in this area. The crew exit the aircraft with only minor injuries before it is consumed by a post-crash fire. They have only the minimum survival equipment and no radio. Weather conditions are deteriorating, the temperature is 25 degrees F., and low clouds with possible snow are moving into the area, which may seriously delay the search by rescue aircraft. There are numerous small bands of hostile combatants known to inhabit the area, and the nearest friendly force is 15 KM away.

Situation 5:

The crew is conducting a routine VIP flight from your home airfield to another airfield about 150 miles away. Weather was forecast to be marginal VFR or IMC along the route of flight, so they have filed an instrument flight plan and are now cruising at 6,000 feet in the clouds. They expect to execute an ILS approach upon your arrival. Current conditions at the destination are 600 foot ceiling, and 1 mile visibility, with winds out of the east at 12 kts. The CP has been flying in the unit for about a year, and is fully qualified. There are no indications of mechanical malfunctions in the aircraft.

Situation 6:

While flying a routine day mission in good weather, the #2 engine chip light flashes on then off, then repeats 30 seconds later. The crew identifies a good emergency landing area and begins the proper emergency procedure to land. Just before landing, a crewmember reports a fire in the #2 engine.

Situation 7:

A crew receives a mission change with a request to locate and attempt to recover a downed UAV. The crew hovers at 30 feet, slowly moving across an area of mixed sparse vegetation and loose sand. After about 20 minutes of searching the crew notice the downed UAV lying on the ground in a cleared area. As they hover over next to the UAV to recover it, the aircraft enters brown out conditions and all visual contact with the ground is lost.

Situation 8:

You are flying through areas of marginal visibility at 500 feet, under a 600 foot ceiling while the CP is performing navigation and radio comms duties. You glance down to check the engine instruments for a moment, and then hear the CP cry out, "Tower ahead". You look up to see that you are headed directly toward a radio/TV antenna approximately 300 meters directly ahead. The top of antenna is in the clouds, and supporting guy wires can barely been seen spreading out to either side. You immediately begin an abrupt evasive maneuver.

Situation 9:

You come to a hover at approximately 60 feet over a confined area barely able to accommodate your aircraft. You begin to slowly maneuver downward into the landing area, using guidance from the CP, and your crew chief. At approximately 40 feet the crew chief yells, "Don't come back", just as you hear a loud bang, and the aircraft begins to spin rapidly to the right.

Situation 10:

It is 0200 hours when the crew is called for an urgent MEDEVAC mission for a seriously wounded Soldier at a forward base. The sky is clear, and there is a full moon providing excellent illumination of the countryside. As they arrive at the pickup location in the center of a shallow valley, they find that a layer of fog has formed in the valley, with the tops at around 800 feet AGL. Troops on the ground report that they can see the moon, and that there is no fog at the ground level. Anxious to extract the wounded Soldier, the crew lines up with the long axis of the valley and begins a slow descent into the fog, expecting to break out before reaching ground level. As they enter the fog forward visibility is reduced to zero.

These 17 questions followed each of the ten scenarios:

1. Compared to other pilots you know, how well would you be able to handle this situation if you were the pilot in command?

    a. Much better than most
    b. Better than most
    c. About the same
    d. A little worse than most
    e. Much worse than most

2. How strongly do you agree or disagree with the following statement: If I were the pilot in command in this situation, the outcome would be determined by my personal skills, knowledge, and abilities.

    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree

[Questions 3 – 13 used a drop-down menu with the digits 1 to 10 listed as alternatives. The following scale was used for questions 3-13:
1 – Almost none

2
3
4
5
6
7
8
9
10 – Almost all]

3. On the scale of 1 to 10, how much of the outcome in this situation would be under your personal control?

4. On the scale of 1 to 10, how much of the outcome in this situation would be determined by Luck?

5. On the scale of 1 to 10, how much of the outcome in this situation would be determined by others (enemy, ground troops, other aircraft crews)?

6. On the scale of 1 to 10, how much of the outcome in this situation would be determined by your personal knowledge and skills?

7. On the scale of 1 to 10, how much of the outcome in this situation would be determined by your attitudes?

8. On the scale of 1 to 10, how much of the outcome in this situation would be determined by your determination?

9. On the scale of 1 to 10, how much of the outcome in this situation would be determined by your professionalism?

10. On the scale of 1 to 10, how much of the outcome in this situation would be determined by your airmanship?

11. On the scale of 1 to 10, how much of the outcome in this situation would be determined by your crew management skills?

12. On the scale of 1 to 10, how much of the outcome in this situation would be determined by your crewmembers' performance?

13. On the scale of 1 to 10, how much of the outcome in this situation would be determined by changes in weather?

[Questions 14 - 15 used a drop-down menu with the digits 1 to 10 listed as alternatives. The following scale was used for 14-15:
1 – Very little risk
2
3
4
5
6
7
8
9
10 – Very high risk]

14. On the scale of 1 to 10, if you were placed in this situation tomorrow (as PC), how risky do you think it would be?

15. If a typical Aviator from your unit were placed in this situation tomorrow (as PC), how risky do you think it would be?

[Questions 16 – 17 used a drop-down menu with the digits 1 to 10 listed as alternatives. The following scale was used for 16-17:
1 – Very unlikely
2
3
4
5
6
7
8
9
10 – Highly likely]

16. How likely is it that you would be able to complete this mission successfully and without an incident/accident?

17. How likely is it that the typical Aviator from your unit would be able to complete this mission successfully and without an incident/accident?

Appendix E.
Army Locus of Control a priori Scale

<u>Internality Scale Items</u>

Item Number	Item Text
LC41	If I take the right actions, I can avoid accidents.
LC65	If I have an accident, It's because I was not careful enough.
LC70	If I have a close call, it just means I have to work harder next time.
LC67	Safety is due to effort, not Luck
LC37	If I take care of myself, I can avoid accidents
LC46	It is my ability and determination that will determine whether I am in an accident.
LC11	Most accidents that result in injuries are largely preventable
LC33	I am in control of my life
LC50	I believe I have control over my own destiny
LC63	You are responsible for the things that happen to you in your life
LC81	There are no problems that cannot be overcome with enough effort
LC38	The main thing that affects my safety is what I myself do
LC1	If Aviators follow all the rules and regulations, they can avoid many aviation accidents.
LC6	Most accidents and incidents can be avoided if Aviators use proper procedures.
LC19	There is a direct connection between how careful Aviators are and the number of accidents they have

Externality Scale Items

Item Number	Item Text
LC52	Whether or not I get into an accident is mostly a matter of Luck.
LC35	Luck plays a big part in determining whether you will be in an accident.
LC61	If something is meant to happen there is nothing you can do to change it.
LC85	In flying, what will be, will be.
LC84	In a tight situation, I trust to fate.
LC87	Sometimes you just have to depend on Luck to get you through.
LC57	Chance has a lot to do with avoiding accidents.
LC60	Bad Luck is what gets many pilots into trouble.
LC58	Being at the wrong place at the wrong time is what causes accidents.
LC56	My success is mainly a matter of chance.
LC39	No matter what I do, I’m likely to have an accident
LC78	A person’s destiny determines what happens to them
LC88	Successful flying is partly a matter of good Luck.
LC49	Much of the time when I am successful, it is because I am Lucky.
LC36	My success in aviation is largely a matter of good fortune.

Appendix F
Army Locus of Control Component Scales and Loadings

Component 1 Luck

Item Number	Weight	Item Text
LC88	.680	Successful flying is partly a matter of good luck
LC87	.667	Sometimes you just have to depend on luck to get you through
LC55	-.655	I do not really believe in luck
LC82	.639	If I had an accident, it would be the result of bad luck
LC57	.616	Chance has a lot to do with avoiding accidents
LC52	.593	Whether or not I get into an accident is mostly a matter of luck
LC35	.586	Luck plays a big part in determining whether you will be in an accident
LC74	.562	I am superstitious
LC49	.560	Much of the time when I am successful, it is because I am lucky
LC62	-.528	The idea that luck determines what happens to you is ridiculous
LC26	.519	I'd rather be lucky than good
LC79	.516	At some point a person must accept the inevitable and face their fate calmly
LC78	.507	A person's destiny determines what happens to them
LC60	.506	Bad luck is what gets many pilots into trouble
LC56	.503	My success is mainly a matter of chance

Component 2 Externality

Item Number	Weight	Item Text
LC86	.617	Most of the time accidents are caused by things beyond the Aviator's control
LC39	.612	No matter what I do, I'm likely to have an accident
LC36	.563	My success in aviation is largely a matter of good fortune
LC52	.530	Whether or not I get into an accident is mostly a matter of luck
LC16	.523	Most injuries are caused by accidental happenings outside people's control
LC5	.518	Avoiding accidents is a matter of luck
LC60	.505	Bad luck is what gets many pilots into trouble
LC20	.501	Most accidents are unavoidable
LC53	.494	Whether or not I get into an accident depends mostly on other people
LC7	.484	Most accidents and injuries cannot be avoided
LC31	.477	No matter what I do, if I am going to have an accident, I will have an accident
LC12	.476	Aviators can do very little to avoid minor incidents while flying their missions

LC54	.471	Whether or not I get into an accident depends mostly on things that I cannot control, like the weather
LC13	.464	Whether people get injured or not is a matter of fate, chance, or luck
LC42	.456	Regarding safety, I can only do what the Army tells me to do

Component 3 Internality

Item Number	Weight	Item Text
LC33	.661	I am in control of my life
LC50	.643	I believe I have control over my own destiny
LC30	.638	If I get in a difficult situation, it is my own behavior that determines if I make it out OK
LC45	.616	If I get what I want, it is because I worked for it
LC37	.609	If I take care of myself, I can avoid accidents
LC71	.566	I feel completely in control, all the time
LC63	.531	You are responsible for the things that happen to you in your life
LC66	.473	If I try hard enough, I can get out of any situation
LC41	.465	If I take the right actions, I can avoid accidents
LC32	.462	Getting regular training and practice is the best way for me to avoid an accident
LC47	.446	I am careful to check everything on the aircraft before I depart on a mission
LC46	.440	It is my ability and determination that will determine whether I am in an accident
LC34	.417	When I make a mistake, I am to blame
LC70	.401	If I have a close call, it just means I have to work harder next time
LC67	.400	Safety is due to effort, not luck

Component 4 – Accident Causality

Item Number	Weight	Item Text
LC8	.623	Most accidents are due to Aviators' carelessness
LC65	.582	If I have an accident, It's because I was not careful enough
LC4	.581	Accidents and injuries occur because Aviators do not take enough interest in safety
LC14	.574	Aviators' accidents and injuries result from the mistakes they make
LC64	.568	If I have an accident, it's because I didn't try hard enough
LC11	.543	Most accidents that result in injuries are largely preventable
LC68	.468	Accidents could be eliminated, if pilots made more of an effort
LC19	.453	There is a direct connection between how careful Aviators are and the number of accidents they have

LC46	.431	It is my ability and determination that will determine whether I am in an accident
LC15	.428	Most accidents can be blamed on poor command oversight
LC6	.399	Most accidents and incidents can be avoided if Aviators use proper procedures
LC10	.377	Aviators should be punished if they have an accident or incident while "horsing around"
LC1	.373	If Aviators follow all the rules and regulations, they can avoid many aviation accidents
LC17	.368	People can avoid getting injured if they are careful and aware of potential dangers
LC41	.350	If I take the right actions, I can avoid accidents

Component 5 - Destiny

Item Number	Weight	Item Text
LC83	.732	I'll die when it's my time to go, but not before
LC89	.685	You don't go until your number is up
LC80	.604	I feel that there is some higher power looking out for me
LC78	.463	A person's destiny determines what happens to them
LC61	.458	If something is meant to happen there is nothing you can do to change it
LC85	.453	In flying, what will be, will be
LC84	.376	In a tight situation, I trust to fate
LC79	.371	At some point a person must accept the inevitable and face their fate calmly
LC25	.368	If you keep your wits about you, success is always possible

Component 6 - Resignation

Item Number	Weight	Item Text
LC21	.550	No matter how hard Aviators try to prevent them, there will always be accidents
LC66	-.455	If I try hard enough, I can get out of any situation
LC22	.439	There are so many dangers in this world that you never know how or when you might be in an accident
LC81	-.430	There are no problems that cannot be overcome with enough effort
LC10	.403	Aviators should be punished if they have an accident or incident while "horsing around

LC3	.365	Aviators should be reprimanded if they periodically neglect to use safety devices (for example, seat belts, checklists, etc) that are required by Army Regulations
LC27	.327	Sometimes you get the bear, sometimes the bear gets you
LC9	.327	Most Aviators will be involved in accidents or incidents which result in aircraft damage or personal injury
LC28	.305	Stuff just happens

Appendix G
Army Safety Attitudes Component Scales and Loadings

Component 1 Impulsivity (15 Items, Alpha = .8687, N = 205)

Item Number	Weight	Item Text
SA25	.53	I follow the motto, "Nothing ventured, nothing gained"
SA29	.56	I like making turns steeper than 60 degrees, just to see if I can do it
SA30	.61	I like to see how close I can cut things
SA31	.53	I might dip into my fuel reserve to avoid a fuel stop and save time
SA40	.52	I would duck below minimums to get home
SA46	.63	If I hear other pilots discussing a maneuver that can be done on my aircraft, I'll try it out
SA47	.52	If I want to fly somewhere, I want to do it now
SA5	.51	Even when I know that my chances are limited I try my luck
SA50	.55	I'm basically an impatient pilot
SA67	.50	When I'm in a tough spot, I figure if I make it, I make it, and if I don't, I don't
SA71	.71	Cutting a few corners on safety to get the job done is OK
SA72	.67	My first duty is to get the mission accomplished, even if I have to bend the rules a bit
SA73	.53	Being too worried about safety is the mark of a poor pilot
SA76	.64	To get the job done, you have to bend the rules occasionally
SA80	.54	Showing off a little in the aircraft is just part of being a great pilot

Component 2 Anxiety (10 items, Alpha = .8270, N = 207)

Item Number	Weight	Item Text
SA20	.34	I feel uncomfortable flying VFR when the visibility is very low
SA21	.58	I feel very vulnerable to accidents
SA32	-.46	I never feel stressed when flying
SA35	.73	I really worry about having to make an emergency landing
SA36	.73	I really worry about mid-air collisions
SA37	.68	I really worry about running out of fuel
SA38	.65	I tend to imagine the unfavorable outcomes of my actions
SA53	.67	In an uncontrolled area with lots of traffic, I worry about the possibility of a mid-air collision

SA68	.57	While flying at night, I worry about not seeing navigation landmarks and getting lost
SA7	.60	I always worry about an accident when I'm flying

Component 3 Self-Confidence (10 items, Alpha = .7325, N = 208)

Item Number	Weight	Item Text
SA14	.53	I deal with stress very well
SA18	.51	I feel comfortable flying at night
SA24	.48	I fly enough to maintain my proficiency
SA26	.72	I have a thorough knowledge of my aircraft
SA27	.68	I know aviation procedures very well
SA28	.38	I know how to get help from ATC if I get into trouble
SA55	-.46	In my work I only set small goals so that I can achieve them without difficulty
SA56	-.40	It is riskier to fly at night than during the day
SA59	-.35	Sometimes I feel like the aircraft has a mind of its own
SA60	-.42	Sometimes I feel that I have very little control over what happens to the aircraft

Component 4 Safety Orientation (11 items, Alpha = .7578, N = 208)

Item Number	Weight	Item Text
SA10	.54	I am a very cautious pilot
SA13	.54	I am very skillful on controls
SA17	.37	I express my opinion even if most people have opposite views
SA42	.54	I’m quite cautions when I make plans and when I act on them
SA48	.49	If the weather is marginal, I don't mind waiting at the airport until it clears up
SA54	.33	In flying it's better to be safe than sorry
SA58	.51	My decisions are always made carefully and accurately
SA6	.44	I always feel I have complete control over the aircraft
SA65	.36	Usually, your first response is the best response
SA8	.58	I am a very capable pilot
SA9	.66	I am a very careful pilot

Component 5 Denial (12 items, Alpha = .6560, N = 206)

Item Number	Weight	Item Text
SA1	.48	A successful flight is solely due to good planning and good execution
SA12	.52	I am so careful that I will never have an accident
SA2	.35	Aviation weather forecasts are usually accurate
SA22	.44	I figure nothing can happen to me in an aircraft that I cannot handle
SA23	.33	I find it easy to understand the weather information I get before flights
SA4	.49	Careful route planning and attention to navigation determines whether or not I will get lost
SA51	.30	In a congested area, I figure that if I keep the correct altitude and heading I'll get through safely
SA57	.41	It is very unlikely that an Aviator of my ability would have an accident
SA63	.46	The thoroughness of my preflight mostly determines the likelihood of my having mechanical trouble with the aircraft
SA66	.45	When I fly a well-maintained aircraft, I feel sure that nothing will really go wrong with it
SA78	.41	When things start to go bad, it is best to simply stick to your original plan
SA81	.44	The pilot should not question what he is told by the pilot in command

Component 6 Weather Anxiety (7 items, Alpha = .6968, N = 205)

Item Number	Weight	Item Text
SA11	-.62	I am capable of instrument flight
SA33	.43	I often feel stressed when flying in or near weather
SA61	.40	Speed is more important than accuracy during an emergency
SA69	.35	You should decide quickly and then make adjustments later
SA74	.66	I prefer not to file and fly on instruments
SA75	.69	Whenever possible, I avoid instrument flight
SA82	.46	The crew in the back of the aircraft should not bother the pilots with suggestions or comments

Appendix H
Accident Status and the Army LOC Scale

Table H1
Analysis of Recent Accident Status for Army-HES and A Priori Army-LOC Scales

Scales	*df*	*F*	η_p^2	p	Power
Army-HES	1, 181	13.32	.07	.00	.95
Internality	1, 186	7.23	.04	.01	.76
Externality	1, 186	.30	.00	.58	.09

Note. Levine Test for Homogeneity of variance was non-significant for all these comparisons.

Table H2
Analysis of Career Accident Status and Army-HES and A Priori Army-LOC Scales

Scale	*df*	*F*	η_p^2	p	Power
Army-HES	1, 182	5.90	.03	.02	.68
Internality	1, 187	3.75	.02	.05	.49
Externality	1, 187	1.52	.01	.22	.23

Note. Levine Test for Homogeneity of variance was non-significant for all these comparisons.

Table H3
Analysis of Army-LOC Component Scores for Recent Accident Status Groups

Component	*df*	*F*	η_p^2	p	Power
Luck	1, 189	.03	.00	.86	.05
Externality	1, 187	1.35	.01	.25	.21
Internality	1, 186	4.91	.03	.03	.60
Accident Causality	1, 187	3.93	.02	.05	.51
Fate	1, 187	.21	.00	.65	.07
Resignation	1, 187	10.57	.05	.00	.90

Note: Levine Test for Homogeneity of variance was non-significant for all these comparisons, except Resignation, where the Levene F (1,187) = 4.611, p = .033. Repeating the comparison using a t-test, with equal variances not assumed yielded a t (df = 18.686)= 2.385, p = .028.

Table H4
Analysis of Army-LOC Component Scores for Career Accident Status Groups

Component	*df*	*F*	η_p^2	p	Power
Luck	1, 190	.47	.00	.49	.11
Externality	1, 188	2.53	.01	.11	.35
Internality	1, 187	3.68	.02	.06	.48
Accident Causality	1, 188	.86	.01	.36	.15
Fate	1, 188	1.00	.01	.32	.17
Resignation	1, 188	13.58	.07	.00	.96

Note: Levine Test for Homogeneity of variance was non-significant for all these comparisons.

Table H5
Analysis of Army-SA Component Scores and Army-HES for Recent Accident Status Groups

Component or Scale	*df*	*F*	η_p^2	p	Power
Impulsivity	1, 201	1.43	.01	.23	.22
Anxiety	1, 200	.01	.00	.93	.05
Self-Confidence	1, 200	.03	.00	.87	.05
Safety Orientation	1, 200	.08	.00	.77	.06
Denial	1, 202	.22	.00	.64	.08
Weather Anxiety	1, 201	.31	.00	.58	.09
Army-HES	1, 185	.07	.00	.79	.06

Note. Levine Test for Homogeneity of variance was non-significant for all these comparisons.

Table H6
Analysis of Army-SA Component Scores and Army-HES for Career Accident Status Groups

Component or Scale	*df*	*F*	η_p^2	p	Power
Impulsivity	1, 201	.15	.00	.70	.07
Anxiety	1, 200	1.61	.01	.21	.24
Self-Confidence	1, 200	1.49	.01	.22	.23
Safety Orientation	1, 200	1.09	.01	.30	.18
Denial	1, 202	.15	.00	.70	.07
Weather Anxiety	1, 201	1.03	.01	.31	.17
Army-HES	1, 185	.76	.00	.39	.14

Note. Levine Test for Homogeneity of variance was non-significant for all these comparisons.

Table H7

Analysis of Scenario Measures for Recent Accident Status Groups

Item #	Description	df	F	η_p^2	p	Power
Q1	Self-serving bias	1, 230	.66	.00	.42	.13
Q2	Global locus of control - SKA	1, 231	4.93	.02	.03	.60
Q3	Global locus of control	1, 229	.01	.00	.93	.05
Q4	M-LOC – Knowledge and skills	1, 227	.48	.00	.49	.11
Q5	M-LOC – Attitudes	1, 229	.34	.00	.56	.09
Q6	M-LOC – Determination	1, 229	.21	.00	.65	.07
Q7	M-LOC – Professionalism	1, 230	2.81	.01	.10	.39
Q8	M-LOC – Airmanship	1, 229	2.58	.01	.11	.36
Q9	M-LOC – Crew Management Skills	1, 230	2.53	.01	.11	.35
Q10	M-LOC – Crew Performance	1, 229	.11	.00	.74	.06
Q11	M-LOC – Weather	1, 231	.14	.00	.71	.07
Q12	M-LOC – Others	1, 229	.65	.00	.42	.13
Q13	M-LOC – Luck	1, 229	.17	.00	.68	.07
Q14	Personal Risk	1, 231	.17	.00	.68	.07
Q15	Average pilot risk	1, 227	.48	.00	.49	.11
Q16	Personal Likelihood of Success	1, 230	.02	.00	.88	.05
Q17	Average pilot likelihood of success	1, 228	.79	.00	.38	.14
	Army-HES	1, 206	4.47	.02	.04	.56

Note. Levine Test for Homogeneity of variance was non-significant for all these comparisons.

Table H8

Analysis of Scenario Measures for Career Accident Status Groups

Item #	Description	df	F	η_p^2	p	Power
Q1	Self-serving bias	1, 230	3.14	.01	.08	.42
Q2	Global LOC - SKA	1, 231	.29	.00	.59	.08
Q3	Global locus of control	1, 229	2.74	.01	.10	.38
Q4	M-LOC – Knowledge skills	1, 227	1.05	.01	.31	.18
Q5	M-LOC – Attitudes	1, 229	.01	.00	.92	.05
Q6	M-LOC – Determination	1, 229	1.06	.01	.30	.18
Q7	M-LOC – Professionalism	1, 230	10.51	.04	.00	.90
Q8	M-LOC – Airmanship	1, 229	3.24	.01	.07	.43
Q9	M-LOC – Crew Mgt. Skills	1, 230	9.32	.04	.00	.86
Q10	M-LOC – Crewmembers Performance	1, 229	1.57	.01	.21	.24
Q11	M-LOC – Weather	1, 231	2.22	.01	.14	.32
Q12	M-LOC – Others	1, 229	1.81	.01	.18	.27
Q13	M-LOC – Luck	1, 229	3.39	.02	.07	.45
Q14	Personal Risk	1, 231	.02	.00	.90	.05
Q15	Average pilot risk	1, 227	2.17	.01	.14	.31
Q16	Personal Likelihood/success	1, 230	.30	.00	.59	.09
Q17	Avg. pilot likelihood success	1, 228	7.87	.03	.01	.80
	Army-HES	1, 206	.14	.00	.71	.07

Note. Levine Test for Homogeneity of variance was non-significant for all these comparisons.

Appendix I

Army Aviators and the Civilian Aviation Safety LOC Scale

It was discovered during the course of this project that for the past several years Army Aviators taking part in the Aviation Safety Officer (ASO) course conducted by the US Army Combat Readiness Center (CRC) completed the civilian version of the Aviation Safety Locus of Control scale (ASLOC) as part of their training. A review of the ASLOC data from that period identified over 300 Army Aviators for whom data were available. Although not strictly a part of this project, the data are included here since they provide an opportunity to compare the Army Aviators to civil pilots.

As shown in Table I-1, the military pilots did not differ from the civil pilots on the measure of internality. However, the Army Aviators were significantly more external than the civil pilots. This finding is in accord with the results noted by Joseph and Ganesh (2006) in their study using the ASLOC among Indian pilots. They found that the helicopter pilots were more external than the transport and fighter pilots in their sample. Unfortunately, Joseph and Ganesh did not report the results in a form that allowed comparisons of the scores from their sample to be compared to the present sample.

Table I-1
Comparison of Army Aviators and Civilian Pilots on the ASLOC

	Army (N=328)		Civilian[1] (N=477)		
ASLOC Scale	Mean	SD	Mean	SD	t
Internality	38.18	6.01	38.8	4.34	-1.7 (ns)
Externality	21.50	6.51	17.2	3.79	11.81*
Note 1: Data from Hunter (2002a)		* p < .05			