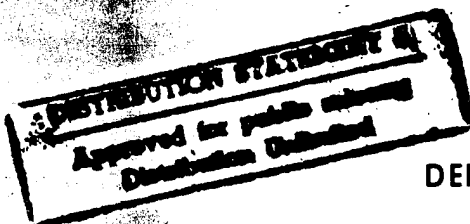


*INCORPORATING PERFORMANCE
HETEROSCEDASTICITY IN THE EVALUATION
OF JOB PERFORMANCE*

THESIS

Max R. Massey, B.A.
Captain, USAF

AFIT/GTM/LAR/95S-9



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DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GTM/LAR/95S-9

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IN THE EVALUATION OF JOB PERFORMANCE*

THESIS

Presented to the Faculty of the Graduate School of Logistics
and Acquisition Management of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Logistics Management

Max R. Massey, B.A.
Captain, USAF

September 1995

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Max R. Massey

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Abstract

This study investigated the relation of agreeableness and experience with performance heteroscedasticity in small groups. Personality assessments were administered to 55 US Air Force personnel. The participants were placed in three groups based on the personality dimension of agreeableness. Group 1 consisted of eleven sub-groups of randomly paired individuals ranked high on agreeableness. Group 2 consisted of eleven sub-groups of randomly paired individuals ranked low on agreeableness. Members of group 3 worked individually. Each dyadic group and individual participant completed 5 load-planning scenarios over a five-day period. The data obtained over the 5 days were used to assess the variability in the subjects' performance. Results showed that the personality dimension of agreeableness and experience are associated with reduced performance heteroscedasticity in small groups. Results also showed that group performance is less variable than individual performance and the performance of groups higher on the dimension of agreeableness is less variable than groups lower on agreeableness.

INCORPORATING PERFORMANCE HETEROSCEDASTICITY IN THE EVALUATION OF JOB PERFORMANCE

I. Introduction

General Issue

In any sector of commerce, the efficient use of resources is one of management's primary concerns. The most important resources available to managers are human resources. Effectively evaluating and predicting the performance of human resources helps decision makers promote, assign, and train personnel.

Selecting individuals for critical tasks on the basis of hunches or guesswork can jeopardize important organizational outcomes. Standard selection procedures focus on mean job performance. Unfortunately, they fail to recognize the importance of performance variability on organizational outcomes (Yetton and Johnston, 1992:18-19). Cascio and Ramos (1986), also argued that individual performance variability should be considered in selection procedures, especially when variations in performance are large or when it is absolutely essential that tasks are completed satisfactorily. Excessive variability in performance can cause severe problems for astronauts, pilots, surgeons, athletes, military personnel in wartime, or others who must perform without error when they are called on. Thus, high performance variability is associated with increased risk and uncertainty about the outcomes of critical tasks.

If everyone being considered for assignment to a critical task has approximately the same mean level of job performance (productivity), then standard selection procedures that ignore differences in variability will not identify the best candidate (Cascio and Ramos, 1986:20). Yetton and Johnston (1992), suggest that differences in performance

variance, or heteroscedasticity, may provide more important information about performance outcomes than mean scores do. They propose giving variability in performance and performance level information equal weight in assessing performance.

According to Yetton and Johnston, "Most research in organisation behaviour focuses on mean-level outcomes and neglects variance effects, or treats them as methodological problems to be eliminated" (Yetton and Johnston, 1992:17). The view that these variances should be treated as problems to be eliminated, overlooks the importance of performance variability as a source of information about present or future job performance in critical air force tasks, especially when too much variability could lead to loss of life or equipment.

Specific Problem

Most military organizations select individuals for critical tasks based on experience, level of past performance, ability, and job knowledge. These selection criteria ignore the importance of performance variability in selecting the "best" individuals for critical tasks, even though filling critical positions with individuals or teams whose performance varies greatly may lead to disastrous results. By learning more about performance heteroscedasticity and variables that may predict variability in job performance, military organizations may become better at assuring critical performance requirements are met.

Performance variability is especially critical in performance of small groups because most important/critical work depends on teams rather than individuals. Some of the most critical work areas for small groups are found in the military. Members of a military team working in a hazardous or dangerous situation depend upon others to perform dependably and predictably. Some examples include personnel working on the flight deck of an aircraft carrier or explosive ordnance disposal personnel. In small

groups, the amount of variance in performance can mean the difference between success and failure. Thus, reducing the variation in performance may be just as important as working to improve the level of performance.

While substantial effort has been devoted to identifying variables that effect mean job performance, there has been very little research to test potential predictors of performance variability. The best information comes from research to improve prediction of mean job performance. Several variables have been found to affect individual and group job performance. They include job knowledge, experience, ability, interpersonal skills, and training (Barrick and Mount, 1993:111; Gordon et al., 1986:518; McDaniel et al., 1988:327; Schmidt et al., 1988:47; Waldman and Aviolo, 1986:33-34). Experience is one of the most important predictors of job performance (McDaniel et al., 1988:329). Schmidt et al. and McDaniel et al. give reason to believe that performance level and variability may be affected by the same variables.

Recent work suggests the personality dimension of agreeableness maybe useful as a predictor of performance variability in small groups (Borman et al., 1991: 863; Tett et al., 1991:703; Van Scotter, 1994:1). Agreeableness should reduce performance variability by increasing cooperation and effectiveness, improving communication, and encouraging better interpersonal performance in small groups.

As a first effort to understand the potential for managers to reduce the chances of costly or disastrous errors, this study will investigate relationship of agreeableness and experience with performance heteroscedasticity in small groups.

Investigative Questions

1. Are differences in agreeableness associated with the performance variability of small groups?

2. Are differences in experience associated with performance variability in small group tasks?

II. Literature Review

Yetton and Johnston (1992) argued that performance heteroscedasticity is an important aspect of performance. They suggested that integrating variance into models of performance would add value to organizational research. They maintained that performance heteroscedasticity is relevant in both individual and group performance (Yetton et al., 1992:21).

Performance Variables

Identifying variables related to successful job performance is important when selecting individuals or groups for accomplishing critical tasks. Schmidt, Hunter, and Outerbridge (1986) found cognitive ability was associated with the size of the gains in job knowledge that occurs after an incumbent begins a new job. Job knowledge, in turn, affected performance significantly. Figure 2-1 shows the effects of ability and job knowledge on work sample performance (Hunter, 1983:126). Schmidt et al. extended this model by showing that work experience had a direct causal effect on degree of job knowledge, which positively affected work performance (Schmidt et al., 1986:432-433, 439).

Waldman and Aviolo's meta-analyses of age differences in job performance showed that age accounts for only a small percentage of the variance in performance (1986:37). A later study examined the usefulness of age as a moderating variable in the experience-job performance relationship (Aviolo et al., 1990:407-408). Age had little effect on job performance, but experience was more strongly related to performance. They reported that correlations between age and performance dropped substantially when experience was controlled. Conversely, relationships between experience and

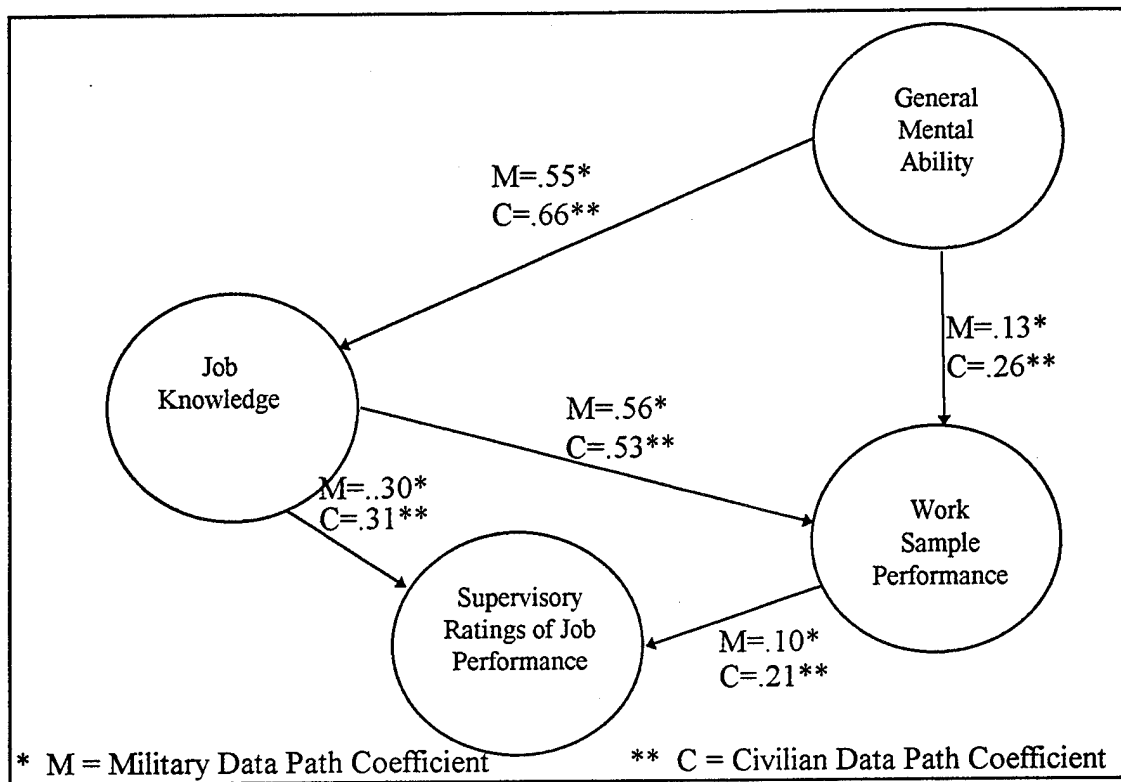


Figure 2-1. Hunter's (1983) Causal Model

performance changed very little when age was controlled. They also found experience was more beneficial in highly complex jobs than less complex jobs. Their study indicated that the "experience learning curve" did not increase as sharply on high complexity jobs as on low complexity jobs and that it leveled out faster for low complexity jobs (Aviolo et al., 1990:410, 414, 416).

Hunter, Schmidt, and Judiesch (1990) studied the correlation of job complexity and job performance. Results supported the theories that high-complexity jobs have a larger performance variability than low-complexity jobs, and that performance variance uniformly increases as the level of complexity increases. Their findings suggest that

sizable rewards could be realized if selection techniques for high-complexity jobs incorporated performance variability into selection procedures (Hunter et al., 1990:38-39).

McDaniel, Hunter, and Schmidt (1988) also reported a positive relationship between job experience and job performance. Their results supported Aviolo et al.'s (1990) finding that experience was more beneficial in highly complex jobs than less complex jobs. McDaniel et al. (1988) suggested that job experience has a greater effect on job knowledge than it has on job performance and job knowledge is a better predictor of job performance in low-complexity jobs than in high-complexity jobs (McDaniel et al., 1988:330). These two studies indicate that job performance is influenced by experience, job knowledge, and job complexity

Predicting Performance

Characteristics of performance criterion measures have also been examined. Maximum performance is usually measured by work sample tests, which encourage workers to do the best they can for a short period, while typical performance is measured in terms of job productivity over time. Sackett, Fogli, and Zedeck (1988) suggested selection procedures usually intend to predict average performance over time, but often inadvertently use measures of peak performance as criteria. Motivational factors played a larger role in typical performance than maximum performance. Several variables were found to moderate the relationship between predictors of typical and maximum performance (Sackett et al., 1988:483, 486). They found cognitive ability impacted maximum performance more than typical performance.

Interpersonal Skills. Interpersonal skills may play an important part in the variability of performance for groups and individuals. Research shows that personality measures are useful for predicting performance in some job settings. Barrick and Mount (1993) and Tett, Jackson, and Rothstein (1991) conducted meta-analyses to investigate

the usefulness of personality measures as predictors of job performance. Both teams of researchers used the "Big Five" personality factors: Extraversion (e.g., sociable, talkative, and assertive), Agreeableness (e.g., good-natured, cooperative, and assertive), Conscientiousness (e.g., responsible, dependable, persistent, and achievement oriented), Emotional Stability (e.g., tense, insecure, and nervous), and Openness to Experience (e.g., imaginative, artistically sensitive, and intellectual) (Barrick and Mount, 1991:1-26; Barrick and Mount, 1993:111; Tett et al., 1991:703). Tett et al. reported a mean correlation of $r = .22$ between agreeableness and performance over 4 studies (total $N = 280$). Van Scotter (1994) reported agreeableness correlated with individual performance ($r = .14$, $p < .01$) for Air Force mechanics ($N = 430$). Monson et al. (1982) argued the importance of personality factors in performance was a function of the amount of discretion (job autonomy) workers had in performing their jobs.

Job Autonomy. Barrick and Mount (1993) found that the importance of Conscientiousness, Extraversion, and Agreeableness was related to performance difficulty, depending on the level of autonomy in the job. These three personality dimensions were better and more reliable predictors of performance in high autonomy jobs (Barrick and Mount, 1993:114), in which much of an employee's performance is discretionary. Higher scores on agreeableness predict better performance for individuals in jobs where cooperation and interaction with others is necessary and employees have some latitude in how they perform. Barrick and Mount found less variability in the job performance of managers in low-autonomy jobs than in high-autonomy jobs. Results indicated that as autonomy increased, variability in performance also increased. The major finding of this study was that the degree of autonomy on the job moderates the validity of these three personality dimensions as predictors of performance (Barrick and Mount, 1993:116-117). Thus when cooperation is required, workers high in agreeableness are expected to be more effective when they have more discretion in how to carry out their jobs.

Personality Dimensions. Helmreich, Sawin, and Carsud incorporated personality dimensions in a study of performance variability. Helmreich et al. suggested that personality dimensions would be most likely to affect performance on tasks requiring interpersonal skills. However, they found two circumstances reduced the predictive power of personality dimensions on job performance. On one hand, high initial performance variance can be attributed to lack of ability and experience in specific job tasks. On the other hand, they suggested there may be a "honeymoon" effect when a worker begins a new job. During this period participants are likely to work harder than they would typically so their performance might be less variable than normal. As the newness of the job fades the "honeymoon" effect is expected to decrease and personality dimensions should become more important predictors of performance. The study concludes that although personality dimensions showed virtually no correlation with performance during the "honeymoon" period, significant correlations were found after the novelty faded (Helmreich et al., 1986:185-187). Thus, their results suggest that personality dimensions may be useful in predicting the average performance of personnel in group tasks.

Summary

Previous studies indicate personality, ability, and experience influence performance variability. They suggest personality has less influence on performance variability in low-autonomy situations than in high-autonomy situations. Experience and ability affect performance in either case.

Performance variability provides important information about performance. It is a clear measure of actual performance. Yetton and Johnston (1992) have argued that performance variability should be given equal weight with mean performance level in assessment of performance. High performance variability translates to unpredictable job

performance and a higher element of risk in critical tasks. Performance variability, whether high or low, is an important element of performance that should be used more often by organizational decision makers.

There are other potentially important moderating variables of performance variability that should be studied: task complexity, the learning effect, and personality dimensions. Task complexity and experience affect both group and individual performance, but, personality dimensions only effect group performance. Yetton and Johnston (1992) focused on individual performance. They examined the effects of goals, task complexity, trials, and task order on performance heteroscedasticity (Yetton and Johnston, 1992:5-8). The fundamental objective of their research, and of the present study, is to include performance variability in the analysis of performance to reduce variance and improve overall performance. As stated by Yetton and Johnston, "...when variance is treated as a substantive performance outcome, within cell variance differences as well as across cell (sub group) variance differences are of interest as potential performance effects," (1992:14-15).

Yetton and Johnston suggested that integrating variance into models of performance would show the advantage of group problem solving compared with individual efforts. On standard tasks, Yetton and Johnston found group variance is significantly lower than individual variance. They suggest the same results are likely to occur on critical tasks (Yetton and Johnston, 1992:21), but this proposition has not been tested.

An extreme case of high task complexity - professional decision making - illustrates the argument and shows how selection and training make 'difficult' goals easy where high performance coupled with low variance is required. Consider professions such as law, medicine, and audit. A professional decision as defined by law is that another professional faced by the same factors would have acted in a similar

manner. The essence of the definition is that performance variance is low.
(Yetton and Johnston, 1992:19)

Yetton and Johnston conclude that variance should be included in performance theory and suggested separating group and individual performances into variance and level components as a way to begin understanding performance variance (Yetton and Johnston, 1992:22).

To investigate these issues, the present study will examine the effects of the personality dimension of agreeableness on the performance variability of small groups and also determine the effect of experience on the relationship between agreeableness and variability in small groups.

III. Methodology

This chapter describes the methods used to investigate the effects of agreeableness and experience on performance variability in small groups. Quasi-experimental field research methods provided a realistic task environment.

Subjects

Subjects for the study were (n=82) military aerial port workers assigned to Dover AFB, Delaware. All the volunteers completed the first phase of the study; 55 completed all phases of the research.

The subjects were initially asked to complete a questionnaire designed to collect demographic data and assess the personality dimension of agreeableness which was used to determine group assignments.

Instruments

Pre-Experiment Questionnaire. The pre-experiment questionnaire (see Appendix A) developed by the author consisted of questions concerning demographic information and the Interpersonal Adjectives Scales-Revised (IASR-B5) personality inventory (Wiggins et al., 1988). The response variables of primary interest in the pre-experiment questionnaire were the amount of Air Force and work center experience and the score on the personality dimensions of agreeableness.

To protect respondents' privacy, demographic data was limited to age, gender, race, total Air Force experience, work center experience, education level, and rank. Participants recorded their responses on a computer-scored answer sheet. The second part of the questionnaire consisted of the IASR-B5 personality inventory (Wiggins et al., 1988). The IASR-B5 was designed to measure the "Big Five" personality dimensions (Wiggins et al., 1988:517).

The IASR-B5 questionnaire consists of a series of 124 adjectives. The subjects were asked to indicate how accurately each adjective described them as a person. All responses required a selection from a six-point Likert scale anchored by "1 = Extremely Inaccurate" at one end and "6 = Extremely Accurate" at the other. This questionnaire was scored using procedures provided with the instrument. Raw scores on agreeableness were the measure of interest for this part of the research. Wiggins reports internal consistency (Chronbach's Alpha) for IASR-B5 scales that range from 0.813 to 0.906 (Wiggins et al., 1988:524). The alpha calculated for the present sample, 0.823 indicates adequate internal consistency.

Field Experiment. The field experiment consisted of a series of 5 aircraft load-planning tasks completed over a five-day period. The data obtained over the 5 days were used to assess the variability in the subjects' performance.

Their task was to plan the cargo load for a US Air Force C-141 cargo aircraft. The subjects had no prior experience with the task. The scenarios were the same except that each had a different destination. Thus, the basic task was the same, although the details changed from day to day. Each day the participants were given a consolidated, randomly ordered list of cargo pallets. The pallet list contained information on pallet location (alpha-numeric designator for physical location within a storage facility), pallet identification (alpha-numeric designator used to identify specific cargo pallets), pallet destination (location pallet is to be shipped), pallet priority (relative shipping rank of cargo importance), pallet age (time cargo has been waiting for shipment), total pallet weight (aggregate weight of all cargo on the pallet), and pallet hazard class (numerical designation of hazardous cargo). The participants were instructed to plan a load for each of the different scenarios based on destination, priority, age, aircraft restriction, and hazard restriction. They were also instructed to list the pallets on the answer sheet by decreasing

weight (heaviest-first, lightest-last). A typical scenario, an example of the consolidated pallet list, and answer sheet may be found at Appendices B, C, and D, respectively.

Procedure

The pre-experiment questionnaire was administered to all subjects 2-3 weeks before the experiment was conducted. The subjects were divided into groups based on their scores on the personality dimension of agreeableness. The 22 participants who scored highest on the personality dimension of agreeableness and the 22 participants who scored lowest on agreeableness were assigned to either high- or low-agreeableness groups. The 11 subjects whose scores placed them in the mid-range of the scores on agreeableness participated as individuals.

Group 1 consisted of eleven sub-groups of randomly paired individuals ranked high on agreeableness. Group 2 consisted of eleven sub-groups of randomly paired individuals ranked low on agreeableness. Members of group 3 worked individually, so their performance was not affected by their level of agreeableness. Once divided into groups, each individual or pair of participants completed the series of 5 aircraft load-planning scenarios.

Group 1 and Group 2 were instructed to complete the scenarios as a team and agree on all responses before recording them. Group 3 was instructed to complete the scenarios individually. All participants were instructed to work without any outside help. The participants were given verbal instructions to record completion time, destination, pallet identification, pallet location, pallet hazard classification, pallet weight, and total cargo weight on answer sheets provided by the author. This procedure was expected to encourage them to interact with each other frequently.

Independent Variables. The main factor of interest was the agreeableness level used to assign subjects to the experimental groups. The subjects' Air Force, and work

center experience were used as covariates to partial out the effects of experience on the response variables.

Dependent Variables. The response variables were completion time (T), weight utilization (WT), safety errors (SA), administrative errors (AD), cargo priority (PR), and cargo age (SET). These variables were scored by the author after all exercises were complete based on the guidance provided in the load-planning scenarios. Subjects did not receive any feedback about their performance during the experimental sessions.

Completion Time. The raw score for completion time (T) was the total time (in minutes) for completion of the load plan for each trial.

Weight Utilization. The raw score for weight utilization (WT) was calculated by subtracting the total weight (in pounds) utilized from the total weight available for each trial. Thus, weight utilization was a measure of the errors or the unused weight for each trial. Table 3-1 shows the total weight available for each trial.

Table 3-1. Total Cargo Weight (WT) Available

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
122,616 lb.	89,870 lb.	100,892 lb.	130,419 lb.	131,424 lb.

Safety Errors. The raw score for safety errors (SA) was the total safety errors in each trial. Safety errors were associated with hazard classifications that were assigned to the cargo. Cargo was assigned one of four different hazard classifications: (blank) - no hazard, 1 - hazard class 1, 2 - hazard class 2, and 3 - hazard class 3.

The participants were given the following rules governing each hazard classification. Cargo with no hazard classification could be freely utilized. Cargo with a

hazard classification of 1 could not be utilized in conjunction with cargo with a hazard classification of 2 or 3. Cargo with a hazard classification of 2 and 3 could be utilized together, but not in adjacent positions (must be separated by at least one position) and not in conjunction with hazard classification 1 cargo. Violation of any safety rule was deemed a safety error. These rules are similar to those employed by Air Force load planners everyday.

Administrative Errors. The raw score for administrative errors (AD) was the total administrative errors in each trial. Administrative errors were associated with administrative tasks that were required for each trial. The participants were instructed to complete the answer sheet in its entirety following all rules established for each trial. Any violation of the rules or other error on the answer sheet (excluding safety errors) was deemed an administrative error.

Cargo Priority. The cargo priority (PR) rating was calculated by subtracting the aggregate weighted cargo priority from the aggregate weighted cargo priority available for each trial. This calculation resulted in the total unused weighted cargo priority for each trial. Table 3-2 shows the weighted rating scale for each priority class. Table 3-3 shows the total priority cargo rating available for each trial.

Table 3-2. Cargo Priority (PR) Class Rating Scale

Priority	AMC/MICAP	999	1	2
Weight	4	3	2	1
Notes: AMC/MICAP = Air Mobility Command cargo (highest priority) 999 = high priority cargo 1 = normal priority cargo 2 = low priority cargo				

Table 3-3. Total Cargo Priority (PR) Rating Available

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
30	36	34	37	37

Cargo Age. The cargo age (SET) was the total time (in hours) the cargo had been waiting for movement. The raw score for cargo age was calculated by subtracting the aggregate cargo age utilized from the aggregate cargo age available for each trial. This calculation resulted in the aggregate age of the unused cargo for each trial. Table 3-4 shows the aggregate cargo age available for each trial.

Table 3-4. Total Cargo Age (SET) Available

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
704	749	1332	748	586

Statistical Analyses

Performance effectiveness and performance efficiency were analyzed for variability in a designed experiment. "A designed experiment is one for which the analyst controls the specification of the treatments and the method of assigning the experimental units to each treatment" (McClave and Benson, 1994:854).

Statistical Procedures. Multivariate Analysis of Covariance (MANCOVA) was chosen as the method of analysis for the data in this study. MANCOVA was selected for three reasons: (1) it takes into account intercorrelations among the variables, (2) it keeps the overall α level (or Type I error rate) under control, and (3) it has a greater sensitivity

for detecting differences in certain situations (Stevens, 1992:182). The analyses were conducted at $\alpha = .10$. The α level of .10 was chosen because there were less than 20 subjects per group (Stevens, 1992:175). The Box test was used to test the homogeneity of covariance matrices. The Box test gives a χ^2 and an F approximation for the test statistic. The F approximation was used here because it is more accurate when there are less than 20 people per group, there are more than 6 groups, and more than 6 dependent variables (Stevens, 1992:260).

Plan of Analysis. Standard procedures were developed to study each of the dependent variables. Analyses included a listing of descriptive statistics by group for each of the five trials, plotting the variances of the dependent variables by group for each of the five trials, testing the correlations between independent and dependent variables, and testing the homogeneity of the covariance matrices. The Box test examined my main question, the homogeneity of covariance matrices.

IV. Results and Analysis

Pre-Experiment Questionnaire

The variables of interest from the pre-experiment questionnaire were the scores for agreeableness, work center experience, and total Air Force experience (averaged over the pair of subjects in groups 1 and 2).

Personality Dimensions. The pre-experiment questionnaire data were analyzed to determine the individual scores on the personality dimension of agreeableness. The summary statistics for agreeableness for each group are shown in Table 4-1.

Table 4-1. Agreeableness Group Summary Statistics

	N (group)	N (individuals)	Mean	S _d
Group 1 (high)	11	22	77.32	6.21
Group 2 (low)	11	22	59.32	4.48
Group 3 (individuals)	11	11	67.27	1.74

Experience. Experience data (in months) was obtained using the pre-experiment questionnaires. Raw scores for Air Force experience and work center experience were averaged for the 2 subjects in each of the 11 high and low agreeableness groups. Table 4-2 shows the summary statistics for Air Force experience and work center experience by group.

Table 4-2. Experience Summary Statistics

	Air Force Experience		Work Center Experience	
	Mean	s _d	Mean	s _d
Group 1	200	139.1	20.9	13.1
Group 2	102.5	83.4	30.3	22.1
Group 3	99.2	78.6	9.5	6.1
Notes: Figures expressed in months of experience. n = 11 pairs of workers for Groups 1 and 2. n = 11 individuals for Group 3.				

Field Experiment

The response variables from the field experiment were the variances of the aggregate group scores for administrative errors (AD), completion time (T), cargo age (SET), cargo priority (PR), cargo weight utilization (WT), and safety errors (SA) over the five trials.

Homogeneity of Variances. Plots of the six dependent variables for each group and trial show the relationships between the variances. The homogeneity of the covariance matrices was tested to investigate the extent to which the groups differed in heteroscedasticity. Figure 4-1 shows the relationship of administrative error (AD) variances by group for each trial. Box test results for administrative errors (AD) indicate that the covariance matrix significantly departs from homoscedasticity at the .10 level (Box M = 61.89, F = 1.55, p = 0.028). The plot shows an aggregate variance of 39.88 for Group 1 (high agreeableness) which is lower than the aggregate variance of 56.53 for Group 2 (low agreeableness).

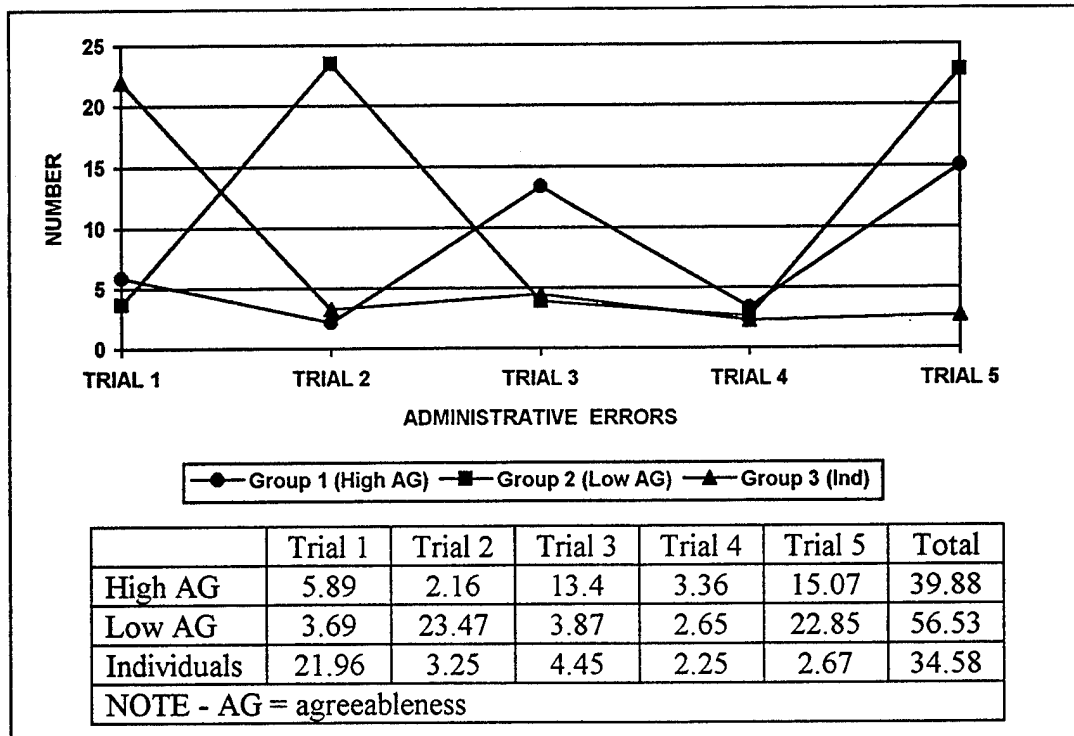


Figure 4-1. Administrative Error (AD) Variances

Figure 4-2 shows the relationship of completion time (T) variances by group for each trial. Box test results for completion time (T) indicate this variable significantly departs from homoscedasticity (Box M = 55.63, F = 1.40, p = 0.075). Consistent with the findings in Figure 4-1, Group 1 (high agreeableness) has a lower aggregate variance (196.55) than Group 2 (low agreeableness) (284.21).

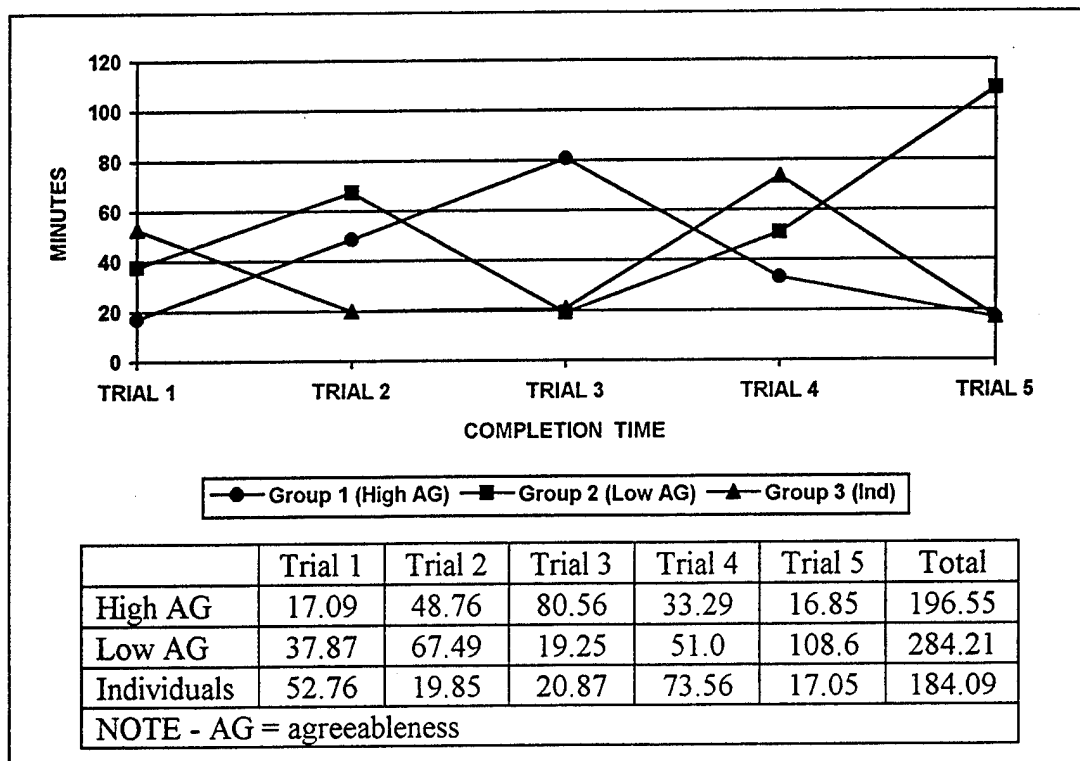


Figure 4-2. Completion Time (T) Variances

Figure 4-3 shows the relationship of cargo age (SET) variances by group for each trial. Box test results for cargo age indicate this variable significantly departs from homoscedasticity (Box M = 57.53, F = 1.44, p = 0.057). Again, Group 1 (high agreeableness) has a lower aggregate variance (66039) than Group 2 (low agreeableness) (82756).

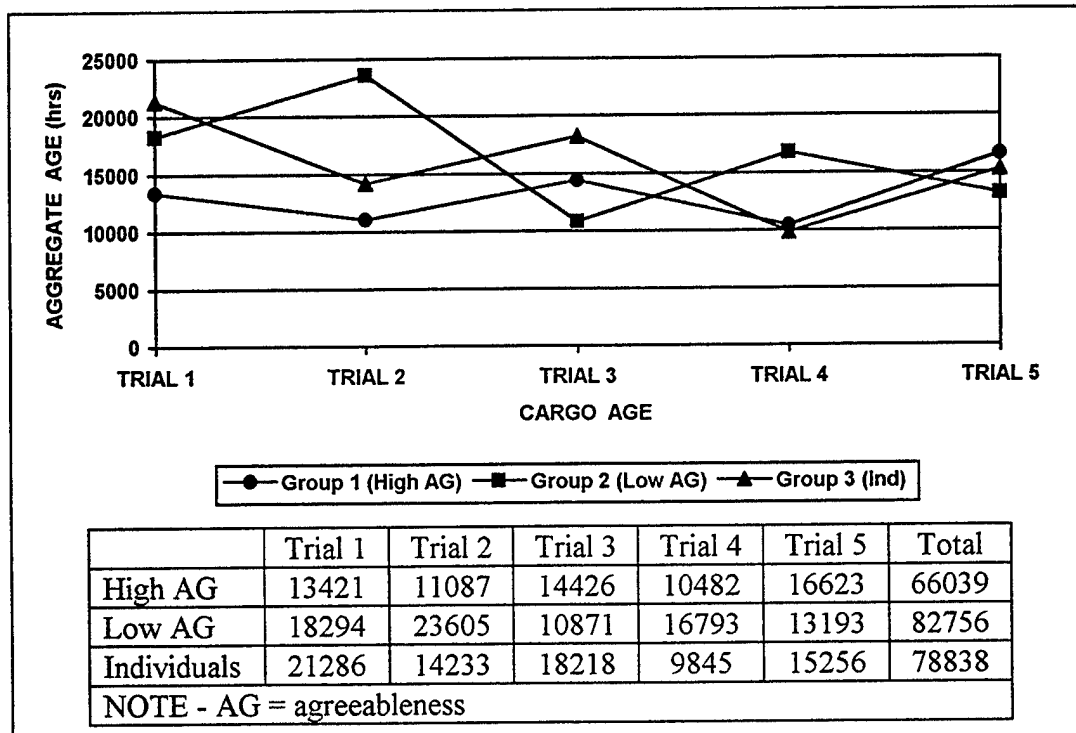


Figure 4-3. Cargo Age (SET) Variances

Figure 4-4 shows the relationship of cargo priority (PR) variances by group for each trial. Box test results for cargo priority (PR) indicate this variable significantly departs from homoscedasticity (Box M = 82.47, F = 2.07, p = 0.001). Again, Group 1 (high agreeableness) has a lower aggregate variance (124.88) than Group 2 (low agreeableness) (135.08). Thus, 4 of the 5 dependent variables tested had heteroscedastic variances and in each case the high agreeableness group had a lower total variance than the low agreeableness group. Therefore, the hypothesis that the variances for weight are homogenous must be rejected. Missing data made it impossible to test the variances in safety error (SA) scores. The results for cargo weight (WT) show no significance. The plots of the cargo weight variances and safety error variances may be found at Appendix E.

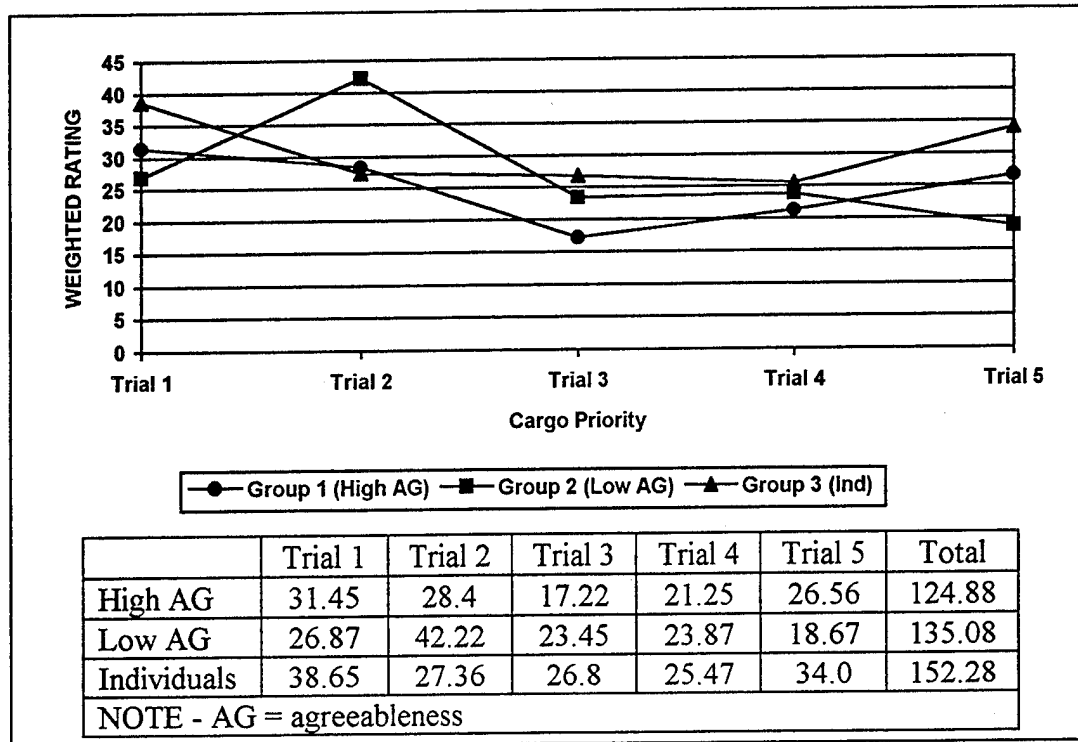


Figure 4-4. Cargo Priority (PR) Variances

As shown in Figures 4-1 through 4-4, the aggregate variances for the high agreeableness group (Group 1) were consistently lower than the variance for the low agreeableness group (Group 2). In addition, the aggregate variances for the high agreeableness group (Group 1) were lower than aggregate variances for all groups on two of the four dependent variables tested. This provides considerable support for the hypothesis that performance heteroscedasticity in small groups is affected by agreeableness.

Multivariate Analyses of Covariance. A multivariate analysis of covariance tested the differences in means between the groups using a repeated measures design.

Combined Groups. The results from the MANCOVA for all groups combined show significance at the 0.10 level for within-subjects effects of cargo weight

(WT) ($F = 204.92$, $p = 0.00$, $df = 4$), cargo priority (PR) ($F = 70.85$, $p = 0.00$, $df = 4$), and cargo age (SET) ($F = 629.18$, $p = 0.00$, $df = 4$) over the five trials. Analyses did not find any between-subjects effects. In other words, the sub-groups varied over trials within their respective groups, but not between the three groups. Thus, tests of the mean differences indicated the groups did not differ in their level of performance. MANCOVA results for the combined sample may be found at Appendix F.

Table 4-3 shows the squared partial correlations between the dependent variables and experience obtained in the MANCOVA analyses. Significant correlations were found between work center experience and the dependent variables of cargo weight (WT), cargo priority (PR), and cargo age (SET). The correlation between total Air Force experience and completion time (T) was also significant. This echoes Schmidt et al.'s (1988) results showing experience is highly correlated with performance, and supports the notion that individual performance and group performance may share at least some of the same antecedents.

Table 4-3. Squared Partial Correlations (all groups)

Partial R^2 for Experience in MANCOVA						
	WT	AD	PR	SA	T	SET
Work Center Experience	.99	.37	.85	.30	.02	.99
Total Air Force Experience	.01	.63	.15	.70	.98	.01
Notes: WT = Cargo weight, AD = Administrative Errors, PR = Cargo Priority, SA = Safety Errors, T = Completion Time, SET = Cargo Age						

Group 1 and Group 2. To ensure that including individual performance (Group 3) with team performance did not confound the tests, the MANCOVA were re-accomplished for the two person data alone. The results from the MANCOVA for Group

1 and Group 2 were significant in tests of within-subjects effects for cargo weight (WT) ($F = 149.47, p = 0.00, df = 4$), agreeableness by cargo weight (COOP by WT) ($F = 2.24, p = 0.072, df = 4$), cargo priority (PR) ($F = 75.66, p = 0.00, df = 4$), and cargo age (SET) ($F = 489.14, p = 0.00, df = 4$). The analysis found no significance in tests of between-subjects effects. This indicates that the sub-groups varied over trials but not between high and low groups. The MANCOVA results for these two groups may be found at Appendix G.

Table 4-4 shows the squared partial correlations between the dependent variables and experience for the combined Groups 1 and 2 obtained in the MANCOVA analyses. Significant correlations were found between work center experience and cargo weight (WT), completion time (T), and cargo age (SET). A significant correlation was found between total Air Force experience and safety (SA).

Table 4-4. Group 1 and Group 2 Squared Partial Correlations (combined)

Partial R^2 for Experience in MANCOVA						
	WT	AD	PR	SA	T	SET
Work Center Experience	.90	.32	.57	.25	.95	.92
Total Air Force Experience	.10	.68	.43	.75	.05	.08
Notes: WT = Cargo weight, AD = Administrative Errors, PR = Cargo Priority, SA = Safety Errors, T = Completion Time, SET = Cargo Age						

V. Conclusions and Recommendations

Overview

This research investigated the potential for performance variance (heteroscedasticity) to be used as a criterion for selecting individuals for critical tasks. More specifically, it examined the relationships between agreeableness, experience, and performance heteroscedasticity.

Findings

Results showed that group performance, like individual performance, varies significantly between occasions. More formal statistical analysis supports the view that the personality dimension of agreeableness is associated with reduced performance heteroscedasticity in small groups. Four of five Box tests identified significant differences in heteroscedasticity among the 3 groups (Figures 4-1 through 4-4). Evidence also supported the influence of experience on performance variability (Tables 4-3 and 4-4).

Research suggests that personality traits may have limited ability to predict behavior in some situations. Subjects participating in the present study knew they were being evaluated on a task that was at least indirectly related to their duties in the Air Force. The knowledge that they were being evaluated, even if only for research purposes, may have increased the pressure to perform. If increased pressure to perform was perceived, the affect of agreeableness on group performance should have been attenuated. In this case, my results are probably somewhat understated. My results support work showing that personality traits are weakly related to performance when pressures to perform are strong or workers can not exercise discretion (Monson et al., 1982:397). Overall, these results show that group performance is less variable than individual

performance and the performance of groups higher on the dimension of agreeableness is less variable than groups lower on agreeableness.

The results suggest that even when individuals work together on a difficult, relevant task, personality differences and task characteristics and demands all influence behavior. Understanding how this occurs in high-risk situations or situations clearly linked to organizational goals seems especially important for the military. Future research should investigate the influence of varying degrees of task complexity.

My results support Yetton and Johnston's (1992) argument for the importance of incorporating performance heteroscedasticity in performance theory. The results obtained here are also compatible with previous research by Schmidt et al. (1986) which found experience positively effects work performance.

Future Research

The results of this research suggest the need for further research on performance variability. First, further research is needed to determine the effects of personality dimensions on group performance in less structured work environments. Second, future research should address the effects of longer series of tasks on performance where more typical performance may occur. Finally, future research needs to address the influence of task complexity and the learning effect on performance variability.

Appendix A. Pre-Experiment Questionnaire

HQ AMC/DOZ SPONSORED PERFORMANCE RESEARCH STUDY

Rank/Name: _____ Time in Service: _____

Squadron/Duty Section: _____ Time in Section: _____

Work Days and Shift: _____ Time on Station: _____
(example: Sunday - Thursday 2200-0600)

Answer sheet number: _____ AFSC: _____

PROCEDURES FOR PARTICIPANTS

1. Please look over your entire survey package. A computer scoring sheet should be included with the survey. If you do not have a computer scoring sheet, or do not have a #2 pencil please ask the person administering the survey for them.
2. Enter your responses to the survey questions.
3. **The success of this project depends on your honesty and accuracy. Please be as accurate as possible. Your responses will be kept confidential.**
4. Turn the completed forms in to the survey administrator.

PRIVACY ACT STATEMENT

In accordance with AFR 12-35, paragraph 8, the following information is provided as required by the Privacy Act of 1974.

Authority: 10 U.S.C. 8012, Secretary of the Air Force; powers and duties; delegation by; implemented by AFR 30-23, Air Force Personnel Survey Program.

Purpose: To obtain information on the effect of personality on group work performance variance.

Routine Use: To increase understanding of the relationship between personality and group work performance variances. Only members of the research team will be permitted access to the raw data. Elements identifying specific individuals will be stripped from the data as soon as all data is merged.

Participation: Participation in this study is strictly VOLUNTARY. No adverse action will be taken against any member who elects not to participate in this survey.

BACKGROUND INFORMATION

INSTRUCTIONS: Please mark your answers on this booklet and on the answer sheet. Make dark marks that fill the circle completely. Erase any marks you wish to change completely. Make no stray marks. Do not fold this form.

Correct Incorrect
Example: ☒ ☐

Please answer the following questions about your background and job experience. This information will be used to develop a profile of the participants in this study. Your responses will be kept completely confidential.

1. What is your sex? (check one):

- (1) ____: Male
- (2) ____: Female

2. What is your race? (check one):

- (1) ____: Asian
- (2) ____: Black
- (3) ____: Hispanic
- (4) ____: White
- (5) ____: Other

3. What is your age in years? (check one):

- (1) ____: Less than 20
- (2) ____: 20-29
- (3) ____: 30-39
- (4) ____: 40-49
- (5) ____: 50 or more

4. Highest education level completed? (check one):

- (1) ____: Did not complete High School
- (2) ____: High School Diploma or GED
- (3) ____: Some college - no College Degree
- (4) ____: 2-Year College Degree
- (5) ____: Other (please specify: _____)

5. What is your present grade? (check one):

- (1) _____: Airman Basic
- (2) _____: Airman
- (3) _____: Airman First Class
- (4) _____: Senior Airman/Sergeant
- (5) _____: Staff Sergeant
- (6) _____: Technical Sergeant or higher

*****NOTE: Dr. Wiggins authorized use of the IASR-B5 in this study with the stipulation that it not be published.*****

Appendix B. Sample Field Experiment Scenario

LOAD PLANNING EXERCISE

SCENARIO:

You are the senior member(s) of a team deployed to a classified location tasked with carrying out all aerial port functions. Due to a deployment oversight there is no equipment available for load planning (CALM, etc...). You are the most qualified to perform the load planning task. You must prepare a load plan for an inbound C-141. The loadmaster will validate the load plan prior to loading. Due to the location and situation in the area of operations, the C-141 can remain on the ground for only a short period of time. Although a few pallets can be resequenced, there is not enough time to resequence the entire load before the aircraft must depart. Your load plan must be as accurate as possible with the information and expertise you have available.

GENERAL INFORMATION:

Down line clearances are not required.

No passengers will be planned on the aircraft.

The aircraft is configured for 13 pallets.

When planning the load, plan it heavy to light. (PP #1 - heavy, PP #13 - light)

Pallet Position (PP) #1 is the first position behind the cockpit.

PP #13 is the ramp pallet.

Pallets should be planned based on System Entry Time (SET), priority, hazard class, weight, and height.

SET time - age of the cargo

Priority - AMC MICAP/VVIP (highest priority)

999 (next highest priority)

priority 1 (next lowest priority)

priority 2 (lowest priority)

Hazard Class - hazard class 1 cannot be planned or loaded with any other hazardous cargo.

- hazard class 2 and hazard class 3 cargo can be loaded together, but not on adjacent pallets (must be separated by at least one pallet).

Pallet positions (PP) available: 13

Restrictions: PP #1 -- 76" maximum height

PP #2-12 -- 96" maximum height

PP #13 - 76" maximum height, 7500lbs maximum weight

Destination: RAMSTEIN

Appendix C. Sample Cargo Pallet List

Pallet Listing							
ID	Location	Height	Weight	Hazard Class	SET (hours)	Priority	Destination
4RFH	2F7	101	4930		450	1	CHARLESTON
6MKL	1F6	77	4400	HC1	198	1	KUWAIT
RFV6	1B4	58	3000	HC1	100	1	RHEIN MAIN
3WED	1A3	24	2400	HC3	66	1	CHARLESTON
HU8Y	1C2	66	9002	HC1	65	1	RAMSTEIN
3RDF	1A4	39	2000		63	1	CHARLESTON
5RG6	1D6	79	5750		55	999	KUWAIT
EDC5	1D2	75	7600		53	MICAP	RAMSTEIN
4ESA	2F2	99	8200		52	1	CHARLESTON
TF54C	2C5	94	9320		44	1	RHEIN MAIN
2IOK	2B10	88	2700		43	1	CAIRO WEST
32D4	2C10	94	3700	HC2	43	2	CAIRO WEST
RFVC	1B3	53	3700		42	2	RHEIN MAIN
5TG	1F1	82	4176		40	2	KUWAIT
6J7F	1F5	84	4200		36	1	KUWAIT
7H89	1H1	85	8272		34	1	KUWAIT
4VTE	2A7	88	3970		34	1	KELLY
2WS4E	2B7	92	4000		34	MICAP	CAIRO WEST
5T67	1D9	80	4279		32	1	KUWAIT
6TG	1F7	84	3920		29	1	KUWAIT
UY7	2D1	96	7105	HC3	26	1	RHEIN MAIN
3DG7	1B1	48	3700		25	1	CAIRO WEST
RRDS	1B2	49	7900		24	1	RHEIN MAIN
RD4	1B5	58	7000		24	1	RHEIN MAIN
HG54	1C4	68	9800		24	2	RAMSTEIN
FR549	1C8	70	3980		24	2	RAMSTEIN
E4R5	1D4	77	5432	HC2	24	2	RAMSTEIN
7JGF	1H3	86	7191		24	2	KUWAIT
8WS	1H6	87	5270		24	2	MILDENHALL
AQWE	2A1	87	9200		24	2	RAMSTEIN
2GT	2B1	88	3900		24	2	CAIRO WEST

Appendix D. Sample Field Experiment Answer Sheet

NAMES:

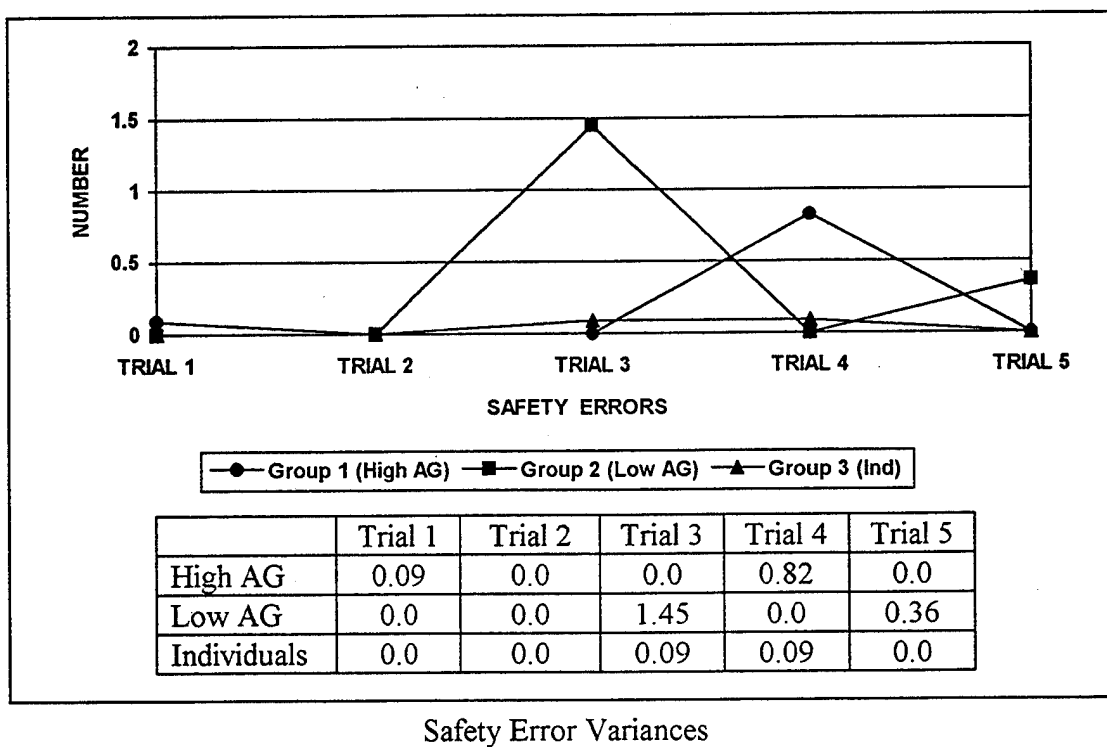
Outbound

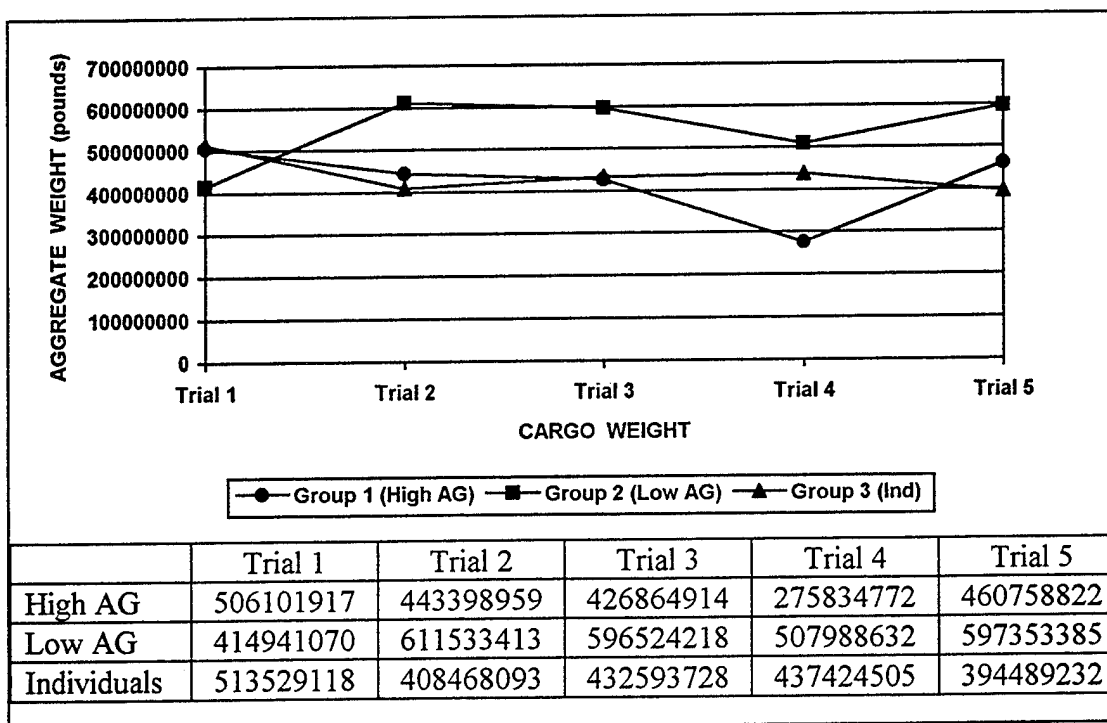
Destination:

DATE:

Pallet Position	Pallet Location	Pallet ID	Hazard Class	Weight
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
Total				

Appendix E. Non-Significant Variance Plots





Cargo Weight Variances

Appendix F. Aggregate MANCOVA Results

Test of Within-Subjects Effects on Mean Performance (Differences due to trial)

Variable	Effect	F	p	df
WT	WT	204.92	0.000	4
	COOP X WT	1.51	0.162	8
AD	AD	0.82	0.515	4
	COOP X AD	1.20	0.308	8
PR	PR	70.85	0.000	4
	COOP X PR	0.80	0.600	8
SA	SA	0.66	0.621	4
	COOP X SA	0.87	0.547	8
T	T	0.30	0.877	4
	COOP X T	0.38	0.931	8
SET	SET	629.18	0.000	4
	COOP X SET	0.86	0.556	8

Test of Between-Subjects Effects on Mean Performance (Differences due to agreeableness)

Variable	Effect	F	p	df
WT	REGRESSION	1.12	0.341	2
	COOP	0.75	0.480	2
AD	REGRESSION	1.84	0.177	2
	COOP	0.10	0.908	2
PR	REGRESSION	0.97	0.392	2
	COOP	0.50	0.614	2
SA	REGRESSION	1.40	0.263	2
	COOP	0.21	0.808	2
T	REGRESSION	0.24	0.791	2
	COOP	0.16	0.851	2
SET	REGRESSION	0.23	0.793	2
	COOP	0.21	0.808	2

Appendix G. Groups 1 and 2 MANCOVA Results

Test of Within-Subjects Effects on Mean Performance
(Differences due to trials)

Variable	Effect	F	p	df
WT	WT	149.47	0.000	4
	COOP X WT	2.24	0.072	4
AD	AD	1.23	0.306	4
	COOP X AD	1.03	0.396	4
PR	PR	75.66	0.00	4
	COOP X PR	0.97	0.426	4
SA	SA	0.41	0.802	4
	COOP X SA	1.19	0.320	4
T	T	0.69	0.598	4
	COOP X T	0.12	0.976	4
SET	SET	489.14	0.000	4
	COOP X SET	1.71	0.157	4

Test of Between-Subjects Effects on Mean Performance
(Differences due to agreeableness)

Variable	Effect	F	p	df
WT	REGRESSION	1.44	0.263	2
	COOP	0.63	0.436	1
AD	REGRESSION	1.56	0.236	2
	COOP	0.02	0.898	1
PR	REGRESSION	1.57	0.234	2
	COOP	1.05	0.318	1
SA	REGRESSION	0.95	0.407	2
	COOP	0.09	0.769	1
T	REGRESSION	0.01	0.989	2
	COOP	0.08	0.778	1
SET	REGRESSION	0.24	0.790	2
	COOP	0.16	0.697	1

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Vita

Captain Max Massey is from Mesquite, Texas. He graduated from Dallas Baptist University in 1988 with a Bachelor of Arts degree in Criminal Justice. After receiving his commission into the United States Air Force through Officers Training School, and completing the Transportation Officers Course, Captain Massey was assigned to the 7100th Air Base Wing, Lindsey Air Station, Germany.

During his tour at Lindsey Air Station, Captain Massey served as a transportation officer in various capacities to include Vehicle Operations OIC, Vehicle Maintenance OIC, Combat Readiness OIC, and Traffic Management Officer.

In December of 1992, Capt Massey took an assignment to the 608th Air Mobility Support Squadron at Andersen Air Force Base, Guam, as an Air Terminal Operations Center (ATOC) Duty Officer and then as the Air Freight OIC. While stationed at Andersen AFB, Guam, Capt Massey served in the Persian Gulf as the Port Operations Officer in Dhahran, Saudi Arabia.

He was selected to attend the Air Force Institute of Technology at Wright-Patterson AFB in May, 1994 and graduated with a Masters degree in Logistics Management in September, 1995. His follow-on assignment was to the Logistics Directorate, Headquarters Air Force Materiel Command.

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REPORT DOCUMENTATION PAGE

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