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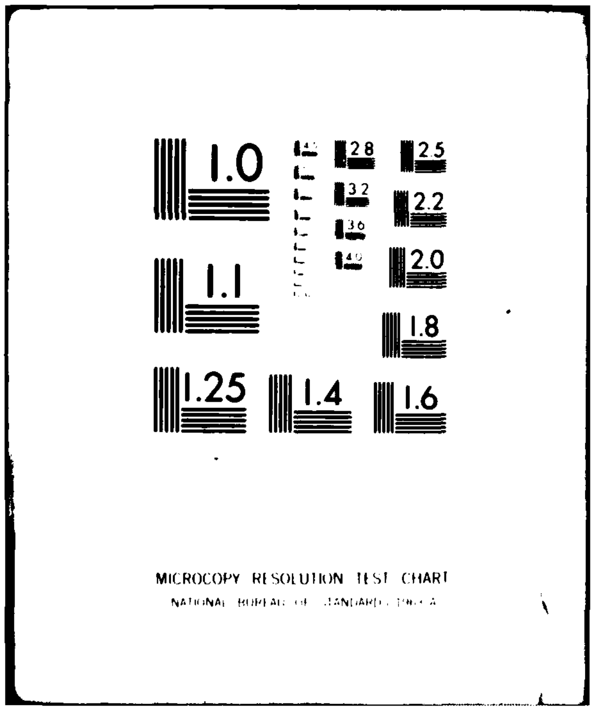
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Abstract

MCCLOY, THOMAS MADISON. Measures of Time-Sharing Skill and Gender as Predictors of Flight Simulator Performance. (Under the direction of RICHARD G. PEARSON).

A two-part experiment was conducted to assess the hypothesized utility of various time-sharing measures as indicators of performance in a general aviation flight trainer. Equal numbers of males (28) and females (28) participated as subjects. Part one involved single and dual performance on a single-axis, compensatory tracker and a digit-cancellation, reaction time task. There were no significant gender differences on time-sharing measures. Part two indicated significantly better male performance on all simulator variables. Separate multiple regression equations were calculated for males and females, as well as overall equations including gender as a variable. Besides gender in the overall equations, measures of time-sharing skill were the best predictors of simulator performance in all three types of equations. The regression equations based on gender differed in constituent predictor variables as well as weightings on similar variables. The results demonstrate the utility of time-sharing measures as predictors of complex-task performance. Additionally, they suggest the appropriateness of employing gender based predictor equations when establishing training or selection criteria for male and female complex-task operators.

MEASURES OF TIME-SHARING SKILL AND GENDER AS PREDICTORS OF FLIGHT SIMULATOR PERFORMANCE

by

THOMAS MADISON MCCLOY

A thesis submitted to the Graduate Faculty of
North Carolina State University at Raleigh
in partial fulfillment of the
requirements for the Degree of
Doctor of Philosophy

DEPARTMENT OF PSYCHOLOGY

RALEIGH

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APPROVED BY:

Chairman of Advisory Committee

Biography

Thomas Madison McCloy was born in Tampa, Florida in July, 1946. With his father in the Air Force, his elementary and secondary education involved a number of different schools in various locations culminating with high school graduation in Anchorage, Alaska in 1964.

The author received a Bachelor of Science degree in engineering management from the United States Air Force Academy, Colorado Springs, Colorado in 1968.

From 1968 to 1974 the author was involved in numerous flying related activities as a pilot and instructor pilot in the U. S. Air Force.

The author entered Colorado State University in the Fall of 1974 and received a Master of Science degree in experimental psychology in 1975.

From December 1975 to May 1977 the author was an instructor in behavioral sciences at the U. S. Air Force Academy.

In August 1977 the author entered the psychology/ergonomics program at North Carolina State University, Raleigh, North Carolina.

The author is married to the former Pamela Sue Bates.

Acknowledgments

Many people contributed to the completion of this research and dissertation; the author is sincerely grateful to all of them. The insight, guidance, and support of the members of the graduate committee, Dr. Richard Pearson, Dr. Howard Miller, Dr. Katherine Klein, and Dr. Michael Goodman were instrumental in the planning and evaluation of this study.

A special word of thanks is extended to Dr. Goodman for the additional effort, inconvenience, and expense involved in advising in an off-campus capacity. The author is particularly grateful for the assistance of Dr. Jock Schwank and Dr. Jefferson Koonce throughout all phases of this endeavor. He deeply appreciates the time and effort supplied by Frank Derry and Ken Fortenberry in the design and maintenance of the experimental equipment. Additionally, the author would like to thank those cadets who participated in the study and made the research possible.

Finally, the author would like to express his deepest appreciation to his wife Pamela, and son, Jeffrey, for their patience, support, and understanding throughout the past two years.

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Introduction

The increasing costs of operating complex man-machine systems has underscored the need for more efficient and effective means of selecting and training operators. From a systems standpoint, this means assessing the system demands -- machine, environment, inputs/outputs, and goals -- on the operator and evaluating his/her capabilities and limitations to meet these demands (Meister, 1971). Those concerned with selection and training frequently find the focal point of system demands to be the operator/task interface. Here they seek to define the conditions imposed on the operator by the task and concomitantly the operator characteristics required to maximize task performance.

The Fleishman (1962) concept of "abilities" as fairly enduring traits influenced by genetics and, to some extent, learning suggests a possible avenue for evaluating individual's capabilities and limitations. This approach suggests "that the skills involved in complex activities, such as flying an airplane, can be described in terms of more basic abilities" (Fleishman, 1978, p. 1009). Passey and McLaurin (1966) review numerous studies which employ psychomotor tests to tap perceptual-motor abilities in an attempt to predict pilot success. The results have been, in general, only moderately successful. One explanation offered by Fleishman and Hempel (1956) is that with continued practice on a task, the particular combination of abilities contributing to performance changes. Consequently, abilities important early in learning may not be as important at a later stage. From a predictive standpoint they may be valuable for predicting early stage performance, but contribute very little to later stage performance prediction.

The growing complexity of modern man-machine systems has typically resulted in increased attentional demands being placed on the operator. Frequently, he or she is required to simultaneously process and respond to information emanating from multiple tasks or multi-faceted tasks. In these situations research has shown the operator can become overloaded with information precipitating performance deterioration (Fitts, 1961, Rolfe, 1971).

Attention and performance theories vary in the theoretical mechanisms they propose to explain performance limitations. A large portion of the research on complex task performance was accomplished in the 1950's and 1960's at which time the predominate theoretical influence was the "single channel hypothesis" (Broadbent, 1958; Craik, 1948; Welford, 1952). In this view, the brain is likened to a single communication channel of limited capacity. As a result performance on two or more concurrent tasks is only possible through "rapid alternation of attention (i.e., by time-sharing on the access to a general purpose central channel) between the requirements of the different tasks" (Allport, Antonis, and Reynolds, 1972, p. 225). If one of the tasks requires the entire limited capacity channel, then performance on additional tasks will be precluded. Although a large body of literature is supportive of the "single channel hypothesis", the locus of the proposed bottleneck cannot be agreed upon (Broadbent, 1971; Deutsch and Deutsch, 1963; Moray, 1969; Neisser, 1967; Norman, 1968; Swets and Kristofferson, 1970; Welford, 1968, 1976).

If it can be said, at the risk of overgeneralizing, that a general task characteristic of complex-tasks is high attentional demands, then it would seem reasonable that an important ability requirement of successful operators would be the ability to effectively and efficiently allocate their attention between the multiple demands placed on them, i.e., to "time-share."

Research Related to Time-Sharing Ability

Although surprisingly little research has been conducted to directly determine the existence of time-sharing ability, considerable research related to this topic lends credence to the validity of such a concept.

Whole-task/part-task performance. Adams (1961) has suggested that whole-task training is frequently necessary to allow the individual to develop skills in "time-sharing" the component tasks. Fleishman (1965) used a three-dimensional pursuit tracking apparatus to investigate the relationship between part-task and whole-task performance. Each dimension had its own display and control. Subjects first performed each of the single dimensions separately. They then performed all possible dual combinations (3) of the single dimensions.

Finally they were tested on all three dimensions (whole-task) at once. Results from this study indicated the best predictors of dual or whole-task performance were other dual-tasks. Furthermore, the particular components involved in a dual-task were less important than the fact that simultaneous practice on the components had occurred. These results and those of similar studies (Bilodeau, 1957; Chambers, 1958 a, b; Freedle, Zavala, Fleishman, 1968; Jennings and Chiles, 1977) suggest that component-task performance is frequently a poor predictor of whole-task performance, and furthermore that whole-task performance may require different skills, e.g. time-sharing, that are not adequately measured in the part-task conditions.

Timing in skill. Conrad (1955b) extended an earlier concept of timing in skill (Bartlett, 1947), defining it as that characteristic of skilled performance that tends toward creating the most favorable temporal conditions for response. In a series of studies, Conrad (1954, 1955a, 1956) studied the ability of subjects to adjust the pacing of a multiple-dial monitoring task. Through adjustment subjects could decrease signal variability and concomitantly improve average response accuracy. Conrad found wide individual differences across subjects in their ability to achieve good timing, in fact some subjects actually performed worse in the self-paced than the externally paced conditions. Jennings and Chiles (1977) have suggested Conrad's findings, are "compatible with the notion that there may be an identifiable ability that is relevant to performance in situations involving time-sharing" (p. 537).

<u>Complex operational tasks</u>. Several studies address the appropriateness of using "time-sharing" tasks as part of performance evaluation when the operational tasks to which they are to generalize are complex, exacting time-sharing demands (Passey and McLaurin, 1966; Chiles, 1967a, 1967b; Chiles, Iampietro, and Higgens, 1972; Chiles and Jennings, 1970). Parker and Fleishman (1960) used a battery of 20 printed tests and 29 apparatus tests to investigate the relationships between ability variables and progress in learning a complex perceptual motor skill. They concluded, in agreement with the aforementioned studies, that reference batteries should contain measures to assess time-sharing ability whenever the criterion task is characterized by time-sharing requirements.

<u>Reserve capacity</u>. The concept of "reserve capacity" or "residual attention" is associated with the literature on secondary tasks. (For reviews of this literature see Welford, 1968; Poulton, 1970; Rolfe, 1971; Kerr, 1973; Sluchak, 1977; Brown, 1978; and McCloy, 1978). Reserve capacity is relevant to the present discussion of time-sharing ability because it addresses the differential capabilities of individuals to perform on complex or multiple tasks.

Brown (1964) presented a conceptual model of the methodology involved in assessing residual attention utilizing the dual task approach. This approach involves the utilization of a secondary task to provide additional demands on the individual. The demands of the primary task in terms of capacity costs can be evaluated through performance measurement on the secondary task. The capability to perform the secondary task without a concomitant drop in primary task performance is thought to be a measure of reserve capacity thereby indicating the primary task's demands on the operator. There are several important assumptions regarding the dual-task methodology: first, the capacity is regarded as a central limited resource or mechanism for which both tasks compete; second, the allocation of attention is under the voluntary control of the subject allowing for compliance with experimental instructions regarding differential task importance; and third, performance on the primary task must remain constant so that secondary task performance will be an indication of spare capacity and <u>not</u> capacity diverted from the primary task.

Although Brown suggests, and his model intuitively implies, that residual attention is task specific, Damos (1978) suggests there may not be large differences (for a particular individual) across routine perceptual-motor tasks. Citing evidence indicating the importance of residual attention in flying (Berringer, Williges, and Roscoe, 1970; Kraus, 1973; Roscoe, 1974; Roscoe and Kraus, 1973; VanderKolk and Roscoe, 1973), Damos attempted to ascertain the predictive validity of residual attention as an indicator of pilot performance. The primary task was a one-dimensional compensatory tracking task and the secondary task was a choice reaction time task with three levels (1, 2, and 3 bits of information) of difficulty. A multiple correlation between mean response time (on the secondary task) at the three levels of stimulus information and performance on a 30-hour flight check was statistically reliable. Based on these results, Damos has suggested reserve capacity forms the upper limit of time-sharing ability.

Learning under time-sharing conditions. A number of studies have investigated learning under time-sharing conditions (Bahrick, Noble, and Fitts, 1954; Bahrick and Shelley, 1958; Baker, Wylie, and Gagne, 1951; Briggs and Wiener, 1966; Garvey, 1960; Herman, 1965; Noble and Trumbo, 1967) by employing secondary task techniques to evaluate differences in secondary task performance resulting from various levels of primary task practice. The results were most frequently interpreted as evidence of automation of the skills required to perform the primary task thereby reducing the need for central control. The development of automaticity and the concomitant reduction in required attentional demands (LaBerge, 1973, 1975; Norman and Bobrow, 1975; Schneider and Shriffin, 1977) certainly offers some explanation of improved time-sharing performance. It fails, however, "to account for the development of time-sharing skills that may be unique to the multiple task situation, such as the parallel processing of information, rapid switching between tasks, or the use of efficient response strategies" (Damos and Wickens, 1977, p.2).

Attentional flexibility. According to Keele, Neil and de Lemos (1978) "flexibility refers to the rapidity with which set or attention can be switched from one signal requiring attention to another" (p. 1). Two studies, Gopher and Kahneman (1971) and Kahneman, Ben-Ishai, and

Lotan (1973) utilized a dichotic listening task and found measures of attention flexibility which correlated significantly with: (a) student pilot flight school success and (b) accident ratings of Israeli bus drivers. Keele, et al. (1978) utilized four different tasks and concluded that "flexibility appears to reflect the proficiency with which one can switch set, whether switching is predictable or not, and not just the proficiency of dealing with unexpected signals" (p. 8). It appears as though this concept of attentional flexibility closely resembles what others have suggested might be characterized as time-sharing ability.

Factor analysis. The existence of time-sharing ability has been proposed from research evaluating complex task performance utilizing the technique of factor analysis. Fleishman (1960a, 1967) and his associates (Fleishman and Hempel, 1954a, 1955) investigated the relationship between certain ability factors and performance at different stages of learning complex skills. The results of these studies and others (Bilodeau and Bilodeau, 1961; Fitts, 1964; Fleishman, 1966, 1967, 1972; Fleishman and Hempel, 1956) suggest the following hypotheses to account for the observed ability/learning relationships: first, performance at the latter stages of a task actually involves different abilities than does early stage learning; second, spatial-visual abilities are most important in early-stage psychomotor learning, while kinesthetic ability is an important factor in late-stage learning and performance; and third, an important individual difference exists with respect to the ability to integrate abilities or actions, i.e., to time-share.

A recent study by Jennings and Chiles (1977) investigated time-sharing ability as a factor in complex task performance. Since it is one of only a few studies designed to directly evaluate time-sharing ability utilizing factor analysis it is worth reviewing in some detail. The authors defined the hypothesized time-sharing ability as a "reliable source of variance that contributes to performance of complex tasks but is independent of simple-task performance of the constituent tasks" (p. 538). The Civil Aeromedical Institute (CAMI) Multiple Task Performance Battery (MTPB) was utilized for this research. The MTPB was designed to test and measure a variety of skills judged to be important to aircrew performance (Chiles, Alluisi, and Adams, 1968). It involved six tasks: a) monitoring warning lights; b) meter monitoring; c) mental arithmetic; d) pattern recognition; e) group problem solving; and f) two-dimensional compensatory tracking. The tasks were combined to form two separate complex tasks -- Task A involving lights monitoring, arithmetic, and problem solving; Task B composed of meter monitoring, pattern identification and tracking. All subjects practiced and were then tested on the six individual tasks and the two complex tasks. Factor analysis of the data supported the hypothesis of a time-sharing ability associated with complex performance. Three orthogonal factors associated with the two monitoring tasks were identified -- light monitoring loaded under the simple condition on one factor; meter monitoring loaded under the simple condition on another factor; and performance on both meters and lights loaded on a third factor under the complex condition. Since the specific performance requirements of the tasks were the same for the simple and complex conditions the results suggest that the tasks are unrelated when performing in the simple condition but related when under the complex situation. The authors suggested that this relationship involves a higher order process (time-sharing) which reflects individuals' ability to shift attention quickly and efficiently between these monitoring tasks and the other component tasks in the complex situation.

Dual task approach. Several studies utilized a dual-task paradigm and obtained results suggesting the existence of a time-sharing skill or ability. North and Gopher (1976) employed a one-dimensional compensatory tracking task and a digit-processing, reaction-time task. These tasks were performed individually and in combination. Several dimensions of individual differences were observed, one of which was the general ability to cope with divided-attention, time-sharing requirements.

Gopher and North (1977) evaluated the effects of manipulating the conditions of training under time-sharing conditions. The task was the same as in North and Gopher (1976). The authors found tracking performance continued to improve during repeated single-task presentation, while digit-processing improved only in the time-sharing conditions. They suggested that the major source of improvement on the tracking task could be considered as specific to the skill of tracking, whereas digit-processing improvement appeared to be a result of an improved ability to time-share and interweave performance in the dual-task condition.

Although the previous studies mentioned in this section found evidence suggesting a time-sharing skill, they were not specifically designed to do so. One study (Damos, 1977), however, was designed to investigate the contribution of time-sharing skill to performance in a dual-task situation. The single tasks were a digit classification task, a short-term memory task, and two one-dimensional tracking tasks. For the dual-task condition, the short-term memory and classification tasks were combined and the two one-dimensional tracking tasks were performed together. To identify time-sharing skills, a measurement technique was employed that partitioned improvement in multiple-task. performance into a component due to improved single-task skills and a component due to improved time-sharing skills. To accomplish this, performance on component tasks was initially stabilized and then periodically checked during dual-task trials. It was argued that to the extent that single-task performance was stable across these trials, improvements in dual-task performance may be attributed to the development of time-sharing skills. A significant trials by secondary task load interaction would be a statistical indication of this occurrence. The results of the Damos experiment support an hypothesis of the development of time-sharing skill in the dual-task combinations. Dual-task performance improvement was large in comparison to single-task performance. It should be noted, however, that single-task performance did not remain stabilized as was assumed prior to the experiment.

Female Psychomotor Performance

Although women are more and more frequently assuming the role of operators in traditional male occupations, e.g., commercial airline and military pilots, there is surprisingly little human factors data on female motor skill performance (Williges, Williges, and Savage, 1978). Hudgens and Billingsley (1978) recently reviewed 859 studies published in Human Factors and Ergonomics during the time frame of 1965 through 1976 and found only 25% of the studies even included females. Additionally, of those studies which included both males and females (19%) only one third performed analyses evaluating sex differences as a factor in performance. However, the fact that nearly three quarters of the research where the sex variable was evaluated reported significant gender differences led Hudgens and Billingsley to suggest that more human factors researchers examine this variable.

A brief review of several studies that included and analyzed gender as a performance variable might be instructive for ascertaining its potential usefulness.

Research investigating gender differences in simple motor behavior has found: 1) pre-adult males exhibit superior performance in gross motor activities (Garai and Scheinfeld, 1968); 2) pre-adult and adult females perform better than males in tasks involving fine manual dexterity (Broverman, Klaiber, Kobayashi, and Vogel, 1968); 3) males in the college age group exceed female counterparts in response speed on a discrimination reaction time task (Noble, Baker, and Jones, 1964), and in pursuit tracking (Noble, 1970). Singer (1975) after reviewing a large number of studies which suggested an overall male superiority in most gross motor activities, concluded that the results did not necessarily infer gender differences in motor abilities or learning rates. Instead he suggested performance differences may have been due to "previous learning and transfer possibilities, structural differences, motivational differences, and most obviously, sociocultural factors" (p. 353).

Hagan (1975) utilized a driving simulator to evaluate various aspects of driving performance as demonstrated by male and female licensed drivers. His findings indicated a significant sex difference in the execution phase of the driving task. He suggested these results may have implications for a variety of areas such as driver education courses and road system design.

Savage, Williges, and Williges (1978b) found gender was a reliable predictor of time-to-exit on a two-dimensional pursuit tracking task under adaptive training conditions. These same authors (1978a) used six tests to derive performance measures that could be used to construct regression equations for time-to-exit on a two-axis pursuit tracker. They found equations based on gender were the most reliable and yielded the largest multiple R^2.

The results of the aforementioned studies exemplify the importance of considering gender as a variable in motor skill performance.

This is particularly true if operators are both male and female, but selection and training criteria have been established primarily on a male data base.

Complex Skill Acquisition Rate

Training programs for most complex jobs are usually limited in terms of the time available for the trainee to master the necessary requirements to graduate from the program. The author, after spending four years as an instructor in a flight training program, can substantiate the fact that individuals vary widely in the rate at which they attain flying proficiency. Considering individual differences in capability and time constraints on training, it would appear that learning rate may represent a viable predictor variable for complex tasks. Not surprisingly, Fleishman (1953b) and Passey and McLaurin (1966) both recommend the use of measures of learning rate in the selection battery for complex tasks, e.g., flying training.

In a recent study employing three different types of training models -- fixed difficulty, adaptive, and learner-centered -- Williges and Williges (1977) employed a two-dimensional pursuit tracking task to investigate gender differences in learning rate. Using time-to-exit scores they reported a highly reliable gender difference favoring males. However, transfer task performance indicated no reliable differences in tracking error. This was true even when transfer tracking difficulty was increased above what had been maximum for the training. The authors suggest that this may indicate initial gender differences in the rate of learning (at least on this particular task) although with training these differences should disappear.

The present topic of acquisition rate suggests some interesting questions in light of the previous discussion of time-sharing and gender. First, is rate of acquisition of time-sharing skills a reliable predictor of future complex task performance? If so, are there gender differences? At the present time the author is unaware of any literature addressing this issue.

The Present Study

With the increasing costs of operating modern complex man-machine systems, selection and training processes have received renewed emphasis. To the degree that the cababilities of the individual can be matched to the requirements of the system, dollar savings can be realized through more efficient and effective training, lower attrition rates, etc.

Although specific operator ability requirements would be predicated on particular task combinations, it has been suggested that almost all complex tasks share one operator requirement in common -- the skill at time-sharing. Time-sharing has been described as a higher order process which reflects "differences in the ability of subjects to shift attention quickly and efficiently" between the demands of the component tasks (Jennings and Chiles, 1977, p. 545). If time-sharing skills are really the manifestation of some general underlying time-sharing ability then it seems feasible that measures of time-sharing skill in one situation should facilitate prediction of performance in another time-sharing situation. The preceding review suggests some support for this hypothesis.

The purpose of the present study was to pursue the line of investigation which suggests that measures of time-sharing skill may be useful as selection devices for predicting performance on other complex tasks. Additionally, the study was specifically designed with equal numbers of males (28) and females (28) so that the relationship of gender to time-sharing performance might be examined. Very few studies of complex task performance have included gender as a variable.

The experiment was conducted in two parts. During part one, subjects performed two tasks -- a single-axis, compensatory tracking task and a choice-reaction, digit-cancellation task -- singly and in combination (with equal emphasis on each task). It was hypothesized there would be no significant relationship between tracking and digit-canceling when performed singly, and single-task scores would correlate only modestly with dual-task performance (North and Gopher, 1976). Performance differences associated with gender were uncertain.

Part two of the experiment involved approximately 40 minutes of instruction and practice and 10 minutes of testing in a GAT-1 flight trainer. Two performance measures -- heading and vertical velocity -- were recorded during the performance of three different maneuvers:

(a) a constant rate, constant heading climb; (b) straight and level flight; and (c) a constant rate, constant heading descent. It was expected that dual-task measures would be more useful than single-task measures for predicting simulator performance (Damos, 1977; Gopher and North, 1977). Although significant gender differences in simulator performance were not anticipated, it was expected that multiple regression equations based on sex would yield different predictor variables as well as different weightings (Savage, Williges and Williges, 1978a). Single and dual-task acquisition-rate and variability scores were also examined as predictor variables.

Method

Subjects

Fifty-six Air Force Academy cadets, 28 male and 28 female, participated in the experiment. They were volunteers from the freshmen, sophomore, and junior classes. None of the participants had previous private pilot or simulator experience. All subjects had at least 20-20 correctable vision.

Apparatus

Part one of the experiment was conducted in a closed environmental chamber. Subjects were seated in a chair with armrests in front of a table upon which two psychomotor devices were located. A Hewlett Packard 1205A oscilloscope provided the display for a single-axis compensatory tracking task. The tracking task involved keeping a miniature aircraft superimposed over an horizon bar that moved only in the vertical axis. The control stick for the tracker was mounted on the chair right armrest. Forward and aft movements of the stick resulted in corresponding up and down displacements of the horizon line. A random noise generator was used to produce the tracking forcing function. A Lafayette Instruments clock was used to record time within a "window" which corresponded to approximately ± 1 cm deviation from zero displacement between the horizon bar and the miniature aircraft. A 12.7 x 10.16 cm box containing a digit-cancellation, reaction-time task was located adjacent to the left side of the oscilloscope so that both tasks were in the same horizontal viewing plane. The task was a four by three matrix of keys on which the digits 0-9 appeared in a random order. The last row contained one digit and two blanks. BRS (Behavior Research Systems) counters recorded total responses and number of errors.

Subject's viewing distance varied from approximately 50.8 cm to 71.12 cm. They were instructed to position the chair close enough to the apparatus so that they could support their left elbow on the chair armrest while responding to the reaction-time task.

Throughout part one, BRS logic system provided the timing for the trials and inter-trial intervals. Figure 1 is a schematic representation of the experimental equipment utilized in part one.

Part two consisted of approximately 50 minutes of training and testing in the GAT-1 aircraft simulator.[1] During the testing, analog heading and vertical velocity signals were recorded on a Gould Brush 260 six channel strip recorder.

Procedure

Single-task conditions. Each participant performed the digit-canceling and tracking tasks separately. The order of this performance was counterbalanced across all subjects. For the digit task subjects were briefed to work as quickly as possible without sacrificing accuracy (Appendix A). The task was self-paced, with a new digit being generated immediately following the correct response to the displayed digit. Making an incorrect response or failure to make a response in 5 seconds after a digit presentation resulted in an aural

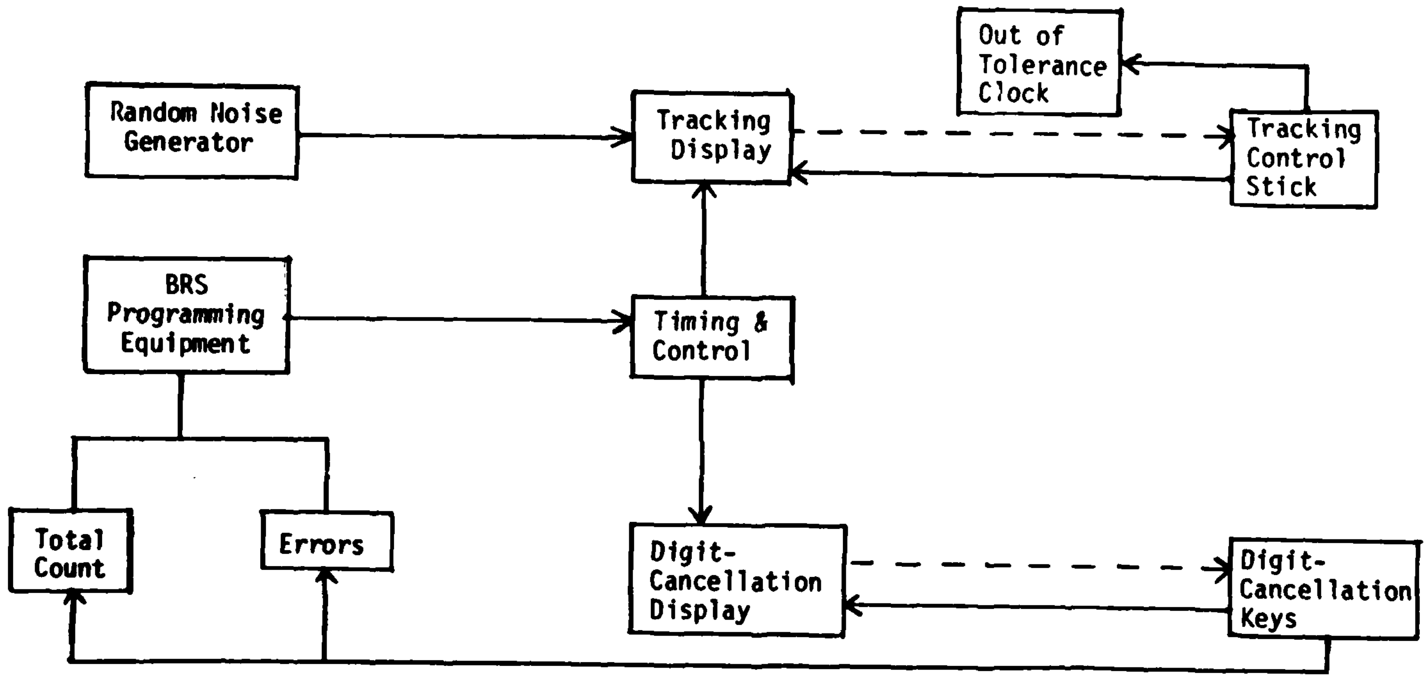

Figure 1. Schematic representation of single and dual-task experimental apparatus.

signal to the subject. The task was performed for periods of one minute duration with 20 second rest pauses between trials. Both correct responses and errors were recorded for each trial period. Exit criterion for this task was two successive trials where total responses differed by 5% or less. All subjects were required to perform a minimum of three trials.[2]

Tracking trials were also one minute in duration with an intertrial interval of 20 seconds (Appendix A). A time on target score was utilized for the exit criterion on this task. A window was established which closely corresponded to a ± 1 cm deviation from zero displacement between the horizon line and the miniature aircraft. A clock recorded the amount of time the subject stayed within the window during each one minute trial. All subjects performed a minimum of three trials and terminated this task when time on target scores for two successive trials differed by 5% or less.[3]

Dual-task conditions. Once subjects reached exit criterion for both tasks performed individually, they then performed the tasks simultaneously. They were instructed to emphasize both tasks equally (Appendix A). Trials were one minute long with 20 second breaks between trials. Five dual-task trials were performed followed by one trial each of the single-tasks after which five more dual-task trials were concluded. The single-task check trials were included to ascertain if single-task performance levels had remained stabilized.[4] The order of the single-task trials was counterbalanced for all subjects.

To facilitate the management of effort between the two tasks during dual conditions, the experimenter procided feedback relative to standard criterion. A base score of 60 correct responses was used for digit canceling and 50 seconds for tracking. After each dual-task trial, proportions were created utilizing the subject's scores on each task and the aforementioned standards. If the difference between the two proportions was greater than 10%, the subject was instructed to allocate a little more effort on the task which produced the smaller proportion. Using only those trials where proportion differences were equal to or less than 10%, the single trial where combined proportions were greatest was identified. The scores associated with this trial were then used for dual-task performance analysis.

Phase-two GAT. During the first 35 minutes in the GAT the subjects received instructions explaining the instruments and controls utilized in flying the simulator, and practiced basic instrument maneuvers (Appendix B). At the end of the instruction and practice period, the subjects were tested on three maneuvers: 1) a constant heading, constant rate climb of 2,000 feet; 2) straight and level flight for 2 minutes; and 3) a constant heading, constant rate descent of 2,000 feet. Analog signals for heading and vertical velocity (rate) were recorded on a strip chart for performance evaluation.[5] Prior to recording performance on any of the maneuvers, the simulator was established in the appropriate flight conditions by the experimenter. The subject then assumed control of the GAT and was instructed to continue executing the appropriate maneuver.

Results

Part One

All analyses, unless otherwise noted, were performed using various statistical routines found in the Statistical Analysis System (Barr et al, 1976). The raw data are listed in Appendix C along with the definitions of the variables.

Single-task conditions. On each digit-cancellation trial both the total number of responses and errors were recorded. These scores were converted to reflect the total response interval (RI) and the correct response interval (CRI). RI was computed by dividing the total number of responses into 60 seconds, which was the trial length for all trials. CRI was computed by dividing the trial length by the number of correct responses. These two distinct measures for the digit-cancellation task were used because they are thought to reflect speed versus accuracy tradeoffs.

To investigate gender differences on the single-task measures, t-tests were performed; three tests yielded significant results. Females minimum performance level on digit-canceling was superior to males for both RI and CRI, with males making fewer responses (higher RI), $t\,(54) = 1.99$, $p < .05$, and more errors (higher CRI), $t\,(54) = 2.24$, $p < .03$. This disparity did not continue through training as RI and CRI for maximum and check trial performance indicated nonsignificant gender differences. Table 1 reflects gender differences in RI and CRI in the single-task conditions.

Table 1 Gender differences in response interval (RI) and correct response interval (CRI) for minimum, maximum, and check trials.

		RI	CRI
Minimum	Males	1.11	1.16
	Females	1.06	1.10
Maximum	Males	.97	.98
	Females	.94	.95
Check	Males	.90	.92
	Females	.89	.91

The other significant t-test involved a rate variable, that being the trial on which the maximum number of correct digits were canceled (or the minimum CRI occurred). An F test for equality of variances, $\underline{F}'$ (27,27) = 3.01, $\underline{p} < .006$, indicated a t-test for unequal variances was appropriate. The t-test resulted in significant differences, $\underline{t}$ (43.2) = 2.46, $\underline{p} < .02$, with minimum CRI occurring later for males.

It was hypothesized that there would be no significant relationship between tracking and digit-canceling when performed singly. This was the case with females, but not for males. Table 2 represents correlations, for males, between tracking and digit-canceling using both maximum and check trial scores. Associated significance levels are also provided. Comparable correlations for females were all nonsignificant with $\underline{p} > .4$ in every case.

Table 2 Correlations, for males, between single tracking and digit-canceling using maximum and check trial scores. Significance levels are included in parentheses.

	MIN RI	MIN CRI	CHECK RI	CHECK CRI
Max Track	-.350	-.385	-.348	-.336
	(.068)	(.043)	(.070)	(.081)
Check Track	-.385	-.397	-.303	-.277
	(.043)	(.036)	(.118)	(.154)

Note. MIN RI = maximum total digit-canceling response score latency

MIN CRI = maximum correct digit-canceling response score latency

Previous research has suggested that single-task scores would correlate only modestly with dual-task performance. For females, this relationship appeared to be true. Maximum single tracking scores were significantly related to maximum dual CRI, $r = .416$, $p < .03$, and maximum dual tracking, $r = .485$, $p < .009$. However no other female single-task scores were signigicantly related to dual-task performance. Single-task scores for males, on the other hand, were highly related to dual-task performance. As can be seen in Table 3, only the relationships between digit-canceling check scores and dual digit-canceling performance were non-significant.

Dual-task conditions. Besides the actual dual-task tracking and digit-canceling scores, several measures of dual-task performance were

Table 3 Correlations, for males, between single and dual-task performance. Significance levels are included in parentheses.

		DUAL		
		MIN RI	MIN CRI	MAX TRACK
	Max Track	-.461	-.470	.467
		(.013)	(.012)	(.012)
	Check Track	-.536	-.535	.545
		(.003)	(.003)	(.003)
	Min RI	.486	.446	-.688
SINGLE		(.009)	(.017)	(.0001)
	Min CRI	.499	.481	-.658
		(.007)	(.009)	(.0001)
	Check RI	.253	.241	-.531
		(.194)	(.216)	(.004)
	Check CRI	.176	.203	-.433
		(.369)	(.299)	(.021)

evaluated. Proportion scores were calculated by dividing dual-task scores by single-task scores. Separate proportions were calculated using maximum single and check trial scores respectively. There were no significant gender differences on any of the dual-task performance measures (See Appendix F for a list of dual-task performance variables).

Part Two

Simulator Performance. Subjects' heading and vertical velocity [illegible] for the three different maneuvers provided the basis for simulator performance analyses. Both heading and vertical velocity scores represented deviations from desired values.[6] Consequently, lower scores are indicative of better performance. Table 4 depicts the 2 by 3 matrix that represents each subject's scores.

Table 4. Matrix representing subject's simulator scores.

	Climb	Straight and Level	Descent
Heading	S-CLIMBH	S-SANDLH	S-DESH
VVI	S-CLIMBV	S-SANDLV	S-DESV

Note. VVI = vertical velocity

Prior to statistical analyses, cell scores were standardized to a mean = 0 and a standard deviation = 1 (The variables representing the standardized cell values are depicted in Table 4). Standardized heading and vertical velocity scores were then added to provide overall scores for each of the three maneuvers. Additionally, heading and vertical velocity scores were combined across all three maneuvers to arrive at scores indicating general heading and vertical velocity performance. Finally, an overall total performance score was calculated by adding scores from each of the six cells. The overall total score, the three different maneuver scores, and the scores representing general heading and vertical velocity control were evaluated as indicators of simulator performance. Table 5 portrays the very interesting, but certainly

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[illegible] for [illegible]der [illegible] on th[illegible] simulator perform[illegible] scores.

[illegible]	[illegible]	[illegible]	t-TESTS
STANTOT	Female	1.443	$t = (54) = 3.09$, $p < .003$
	Male	-1.443	
STANHEAD	Female	.692	$t = (54) = 2.08$, $p < .04$
	Male	-.692	
STANVVI	Female	.750	$t = (54) = 3.53$, $p < .001$
	Male	-.750	
STANCLIM	Female	.529	$t = (54) = 2.33$, $p < .02$
	Male	-.529	
STANSL	Female	.436	$t = (54) = 2.264$, $p < .02$
	Male	-.436	
STANDES	Female	.478	$t = (54) = 2.196$, $p < .03$
	Male	-.478	

Note. STANTOT = S-CLIMBH+S-CLIMBV+S-SANDLH+S-SANDLV+S-DESH+S-DESV

STANHEAD = S-CLIMBH+S-SANDLH+S-DESH

STANVVI = S-CLIMBV+S-SANDLV+S-DESV

STANCLIM = S-CLIMBH+S-CLIMB-V

STANSL = S-SANDLH+S-SANDLV

STANDES = S-DESH+S-DESV

unexpected, results of simulator performance evaluated for gender differences. As can be clearly seen, males exhibited better performance (lower scores) on all six simulator variables.

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A [illegible] finding concerns the interrelationships of the six simulator performance variables. Correlation matrices were computed to assess these relationships for both females (Table 6) and males (Table 7). Perusal of these matrices indicates not only significant, but very similar male and female patterns of performance. Table 6 shows that, for females, only two of the [illegible] correlations are not significant (i.e., the relationship of straight [illegible] level performance to that of: (a) climbs and (b) descents).

Table 6 Intercorrelations of the six simulator performance variables for females. Significance levels are included in parentheses.

	S[illegible]OT	ST[illegible]	ST[illegible]AVI	STA[illegible]	STANSL	STANDES
[illegible]OT	-					
[illegible]	.895 (.0001)	-				
[illegible]VI	.810 (.0001)	.464 (.0130)	-			
[illegible]CLIM	.690 (.0001)	.562 (.0019)	.631 (.0003)	-		
[illegible]ANSL	.534 (.0011)	.508 (.0059)	.492 ([illegible]8)	-.032 (.8702)	-	
[illegible]ANDES	.846 (.0001)	.827 (.0001)	.594 (.0009)	.438 (.0196)	.344 (.0734)	-

The results for males (Table 7) indicate only three nonsignificant interrelationships. Two of the relationships (i.e., those between straight and level and: (a) climbs and (b) descents) were identical to the females. The third nonsignificant intercorrelation involved straight [illegible] and overall vertical velocity [illegible].

[illegible] 7 [illegible] correlation of the six simulator performance variables for males. [illegible] levels are included in parentheses.

	ST[illegible]OT	ST[illegible]AD	ST[illegible]VI	STANCLIM	STANSL	STANDES
[illegible]IOT	-					
[illegible]EAD	.936 (.0001)	-				
[illegible]VI	-.716 (.0001)	.424 (.005)	-			
[illegible]CLIM	.790 (.0001)	.727 (.0001)	.591 (.0003)	-		
[illegible]SL	.657 (.0001)	.724 (.0001)	.254 (.153)	.216 (.2272)	-	
[illegible]NDES	.819 (.0001)	.687 (.0001)	.745 (.0001)	.487 (.0037)	.356 (.0633)	-

Predicting simulator performance. Since it was hypothesized that multiple regression equations based on gender would yield different predictor variables as well as different weightings on similar variables, separate regression equations were calculated for males and females. Due to the large number of variables (see Appendix F) considered for inclusion in the predictor equations, a stepwise multiple regression technique was employed whereby only those variables whose partial F - statistics were significant at a minimum of p = .05 were allowed entry into the models.

Tables 8-13 present the multiple regression equations for the six simulator performance variables. For each performance variable, an overall equation including gender as a variable was calculated as well as separate equations for males and females. For each equation, associated $\underline{R}^2$, $\underline{F}$, and $\underline{p}$ values are included. Examination of Tables 8-13 provides several important findings: (a) As can be seen in Table 8, over 30% of overall simulator performance (STANTOT) variance can be explained using only two variables--GENDER and PRODCTMX (a time-sharing measure). (b) In general, female based regression equations afford better predictability of female simulator performance (i.e., higher $\underline{R}^2$ values), than do corresponding male based equations for predicting male simulator performance (female $\underline{R}^2$ values are equal to or greater than male's in five of the six equations). (c) Corresponding female and male equations differ in terms of constituent variables as well as weightings on similar variables. (d) There was no consistent relationship between the variables in gender based equations, and the variables appearing in the corresponding overall performance equations.

Table 8 Overall, male, and female multiple regression equations for simulator variable STANTOT (ST).

OVERALL ST	= 4.05 + 3.32 GENDER + (-16.63) PRODCTMX + 0.53 OKTRIALS
MALE	NONE
FEMALE ST	= 12.77 + (-15.58) PRODCTMX
OVERALL $\underline{R}^2$	= .313, $\underline{F}$ (2,53) = 7.89, $\underline{p} \angle .0002$
MALE	N/A
FEMALE $\underline{R}^2$	= .135, $\underline{F}$ (2,25) + 4.07, $\underline{p} \angle .05$

__Note__. PRODCTMX = Dual digit-canceling total response score/max single digit-canceling total response score.

To test for possible violations of the multiple regression assumption of linearity of relationships, a direct examination of residuals was conducted. Visual inspection of a scatterplot of residuals versus actual scores yielded no apparent abnormalties. Additionally, a correlational analysis between all independent variables and residuals indicated no significant relationships.

As a means to further investigate the relationships between the predictor variables (Appendix F) and the simulator performance variables, a canonical correlation analysis was performed. This analysis seeks to maximize the amount of variance accounted for in a linear combination of criterion variables by a linear combination of predictor variables. The results of this analysis proved to be of minimal useage in clarifying the predictor-criterion relationships for the present study.

Table 9 Overall, male, and femalt multiple regression equations for simulator variable STANHEAD (SH).

OVERALL	SH = 4.15 + (-8.58) PRODCTMX + 1.39 GENDER
MALE	NONE
FEMALE	SH = -12.26 + .020 MAXSDCT
OVERALL	$\underline{R}^2$ = .150, $\underline{F}$ (2,53) = 4.66, $\underline{p} \angle .01$
MALE	N/A
FEMALE	$\underline{R}^2$ = .210, $\underline{F}$ (1,26) = 7.05, $\underline{p} \angle .01$

Note. PRODCTMX = Dual digit-canceling total response score/max single digit-canceling total response score.

MAXSDCT = Max single digit-canceling total response score.

Table 10 Overall, male, and female multiple regression equations for simulator variable STANVVI (SV).

OVERALL SV = 2.47 + 1.89 GENDER + (-33.23) MAXPRODC + 0.28 OKTRIALS + 0.54 MAXCDCTO + (-8.37) PRODCCMX

MALE SV = 4.52 + (-7.24) PRODCCMX

FEMALE SV = 7.78 + 0.55 OKTRIALS + (-6.22) TSMAXDCT

OVERALL R^2 = .465, F (5,50) = 8.69, p < .0001

MALE R^2 = .192, F (1,26) = 6.18, p < .02

FEMALE R^2 = .308, F (2,25) = 5.57, p < .01

Note. MAXPRODC = Total digit responses for max dual trial /60.

OKTRIALS = Number of dual trials where the difference between tracking and digit-canceling proportions was .10 or less.

MAXDDCTO = Total digit responses for max dual trial.

PRODCCMX = Dual digit-canceling correct response score/max single digit-canceling correct response score.

TSMAXDCT = (Dual digit-canceling total response/single digit-canceling total response score) + (Dual tracking score/max single tracking score).

Table 11 Overall, male, and female multiple regression equations for simulator variable STANSL (SL).

OVERALL	SL	= -1.31 + 0.87 GENDER
MALE	SL	= 1.92 + 1.83 IMAXSDCT + 0.23 TRIALNO + (-1.16) IMAXSDCC + (-39.23) PRODCCMX + 32.54 PRODCTMX + (-0.31) IEXITST
FEMALE	SL	= 0.71 + (-0.11) MIDTRK + 0.12 MINSDCT + (-0.77) IMAXSDCC
OVERALL	$\underline{R}^2$	= .087, $\underline{F}$ (1,26) = 5.12, $\underline{p} < .028$
MALE	$\underline{R}^2$	= .735, $\underline{F}$ (6,21) = 9.68, $\underline{p} < .0001$
FEMALE	$\underline{R}^2$	= .417, $\underline{F}$ (3,24) = 5.73, $\underline{p} < .004$

Note. IMAXSDCT = Trial on which max single digit-canceling total response occurred.

TRIALNO = Trial on which max dual performance occurred.

IMAXSDCC = Trial on which max single digit-canceling correct response occurred.

PRODCCMX = Dual digit-canceling correct response score/max single digit-canceling correct response score.

PRODCTMX = Dual digit-canceling total response score/max single digit-canceling total response score.

IEXITST = Single tracking exit trial.

MIDTRK = Single tracking check trial.

MINSDCT = Minimum single digit-canceling total response score.

Table 12 Overall, male, and female multiple regression equations for simulator variable STANCLIM (SC).

OVERALL	SC	= -3.29 + 1.28 GENDER + 0.28 OKTRIALS
MALE	SC	= NONE
FEMALE	SC	= NONE
OVERALL	$\underline{R}^2$	= .176, $\underline{F}$ (2,53) = 5.65, $\underline{p} < .006$
MALE		N/A
FEMALE		N/A

Note. OKTRIALS = Number of dual trials where the difference between tracking and digit-canceling proportions was .10 or less.

Table 13 Overall, male, and female multiple regression equations for simulator variable STANDES (SD).

OVERALL	SD	= 5.77 + (-9.91) PRODCTMX + 0.96 GENDER
MALE	SD	= 6.44 + (-9.51) PRODCCMX
FEMALE	SD	= 7.05 + (-11.09) PRODCTMX + 0.23 TRIALNO
OVERALL	$\underline{R}^2$	= .316, $\underline{F}$ (2,53) = 8.50, $\underline{p} < .0001$
MALE	$\underline{R}^2$	= .249, $\underline{F}$ (1,26) = 8.62, $\underline{p} < .007$
FEMALE	$\underline{R}^2$	= .379, $\underline{F}$ (2,25) = 7.64, $\underline{p} < .003$

Note. PRODCTMX = Dual digit-canceling total responses score/max single digit-canceling total response score.

TRIALNO = Trial on which max dual performance occurred.

Discussion

Part One

Single tasks. The significant differences, for males and females, noted in minimum RI and CRI may reflect somewhat more exposure on the part of females to keyboard type activities. Several females who performed exceptionally well on digit-canceling commented they had considerable exposure to adding machines and desktop calculators. The essentially equal terminal performance levels, as indicated in Table 1, also support the idea of previous experience as opposed to actual ability differences as an explanation of initial performance differences.

The fact that the trial on which the maximum number of correct digit-canceling responses (minimum CRI) occurred was significantly later for males appears to be closely related to the aforementioned tendency for males to initially make fewer responses (larger RI) and more errors (larger CRI). As their overall responding improved (decrease in RI) so did their accuracy (decrease in CRI), but due to their initial low performance level, it took them significantly longer to reach their maximum performance level.

As evidenced by the increase in check scores over maximum scores (Table 1), single digit-canceling performance did not remain stabilized through the dual-task trials. This finding is in accord with previous research (Damos, 1977) indicating that single digit-canceling continues to improve past initial exit criterion levels. On the other hand, single tracking performance on check trials remained essentially the same as exit levels, which again was in agreement with the Damos (1977) findings.

The relationship between tracking and digit-canceling when performed singly was different for males and females. Previous research (North and Gopher, 1976) using similar measures found no significant relationship between the two tasks when performed individually. In the present study, female performance evidenced this nonsignificant relationship. Males, however, as shown in Table 2, indicate mostly significant positive relationships between both maximum and check trial tracking and maximum digit-canceling measures (minimum RI and CRI). These significant findings are not noted when the two tracking measures are correlated with check trial RI and CRI values. The results suggest, for males, the relationship of single-task tracking and digit-canceling changes as a result of additional exposure to the tasks past the exit criterion levels. As most of the observable performance differences were in digit-canceling, as opposed to tracking scores, it is conceivable that these results reflect the continued improvement in male digit-canceling performance. Since check trial digit-canceling scores are higher in terms of actual responses (lower RI and CRI) it may be reasonable to suggest that they constitute a better measure of "highest" performance than do maximum single trial scores. If this is true it may be argued that, for males, the two tasks are related while learning is still taking place, but are unrelated once asymptotic levels are attained. This terminal relationship is in agreement with previous research findings as well as the results for females in the present study.

It was anticipated, based on past research findings, that single-task scores would correlate only modestly with dual-task performance. Results for females support this hypothesis, with only maximum single-task tracking scores being significantly related to any dual-task performance measures (CRI and tracking respectively). Single-task scores for males, on the other hand, were highly related to dual-task performance (Table 3) with only check RI and CRI values and dual RI and CRI scores showing non-significant correlations with each other. These results suggest that, for females, only one single-task measure, tracking, is a good indicator of dual-task performance. Males, on the other hand, exhibit a number of single-task measures that are indicative of dual-task scores.

Part Two

Simulator performance. The finding of significantly better male performance on all six simulator performance variables was not anticipated either by previous research or by performance in part one of this experiment. Since previous flying experience was controlled for it is unlikely that this could have influenced the results.

Although it is only speculation, there are several lines of reasoning that might explain the differential performance. Williges, et al.

(1978) in reviewing a previous study (Williges and Williges, 1977), concluded that on a two-dimensional pursuit tracking task, females initially needed more training time to reach similar task proficiency levels as males. They also suggest that many of the gender differences noted in motor skills may simply reflect more experience by males with similar motor control tasks. Since flying, like driving, involves both compensatory and pursuit tracking it is conceivable that the differences in simulator performance merely reflect the requirement for additional training on the part of the females.

Another possible explanation is related to the concept of spatial abilities. A recent review (Casey, 1978) indicates research generally finds males superior to females in spatial ability performance. If part of the problem involved in interpreting the attitude indicator involves conceptualization of the aircraft relative to the horizon, this might explain some of the performance differences. If, on the other hand, attitude interpretation is more a stimulus-response (input-output) relationship then this concept will be of little interpretive value.

Perhaps a study being conducted at the same time as the present research may provide some insight into the problem. Becker, Williges, Williges, and Koonce (1979) investigated the ability of several measures of cognitive and psychomotor performance to predict performance on a desktop flight simulator. Their study is of particular interest because half of the subject sample were Air Force Academy cadets. Since the population at the Academy is considerably more homogeneous in terms of cognitive and athletic skills, the author feels somewhat more comfortable in generalizing from it to the present research. Several findings from that research are of particular relevance to the present discussion. The authors found males to be significantly better than females on two measures of spatial ability (spatial orientation and spatial scanning, respectively). However, they also noted that there was no significant difference in desktop simulator performance for Academy males, VPI (Virginia Polytechnic Institute and State University) males, and VPI females but all three of these groups were significantly better than Academy females. Since AFA and VPI females performed similarly on the spatial abilities tests, but differentially on the simulator, it appears that spatial abilities (as measured in this study) are not related to desktop simulator performance. Additionally, since performance requirements for the desktop simulator were similar to those for the GAT-1 in the present study, it is unlikely that spatial abilities (had they been measured) would have accounted for male-female performance differences in the GAT-1.

The results of Becker, et al. and the present study suggest a curious tendency for Academy females to perform in an unpredictably poorer manner on flying related tasks. Although it would take additional research to substantiate the fact, it is the opinion of the author that a major factor in the poorer performance may have been a simple case of the Academy females trying "too hard" to prove themselves equal to the males in terms of flying capabilities. This resulted in a typical Yerkes-Dodson overarousal-poor performance relationship. For one thing, there appeared to be more of a tendency for females to exacerbate their heading deviations by not waiting long enough after making proper control inputs to let the input take effect. In these situations, they would make a correction, quickly check to see if their input was rectifying the situation, and then, because a change had not yet taken place, make a correction in the opposite direction thereby aggravating the situation. This pattern of responding is, of course, different from the common reversal errors where a subject misinterprets the attitude indicator and turns in the inappropriate direction. The two patterns of responding are relatively easily discriminated from one another. The author substantiated his observations by questioning a number of subjects who performed in the indicated manner. Although this pattern of responding is certainly related to attitude misinterpretation problems, the fact that it is somewhat characterized by "over-responding" suggest possible implications of more than optimal arousal. Unfortunately, no arousal measures were taken in the present study.

One other observation on the part of the author, suggesting that females may have been trying too hard, came from conversations with cadets and listening to their repartee.

In spite of the fact that all of the aforementioned explanations for performance differences are purely speculative, the need for more research to investigate the issue is clearly indicated.

Although the males performed significantly better than the females on all six simulator scores, an examination, by gender, of the inter-correlations of the simulator variables (Tables 6 & 7) suggest the pattern of responding was very similar for both males and females. The first relationship of interest is that between heading and vertical velocity. Since these were the two performance variables it is conceivable that different strategies may have been employed, perhaps maximizing one score at the expense of the other. In general, this does not appear to be the case, as both males and females exhibit significant and similar correlations between heading and vertical velocity performance. This suggests there was more of a tendency for subjects to either do well on both, or poorly on both, as opposed to emphasizing one over the other.

The relationship of the three separate maneuvers to each other is also of interest. Although the performance measures for all three maneuvers involved deviations from desired headings and vertical velocities, there were several basic differences between the maneuvers that might help explain performance differences. The GAT is designed to closely simulate light aircraft handling characteristics. Consequently, it generally requires some right rudder in a climb to offset the effects of rigging and asymmetrical loading of the propeller, and left rudder in a descent to compensate for rigging. Straight and level flight, on the other hand, does not normally require the use of rudder. Since the use of the rudder necessitates the checking of another instrument (the turn and slip indicator) as well as the operation of another control, it may be that climbs and descents are more related and perhaps more difficult than straight and level. The pattern of correlations for both males and females suggest the likelihood of this interpretation. Both males and females exhibit significant correlations between climb and descent performance, and nonsignificant correlations between straight and level and either climbs or descents.

Additionally, the relationship between the measure of overall performance, STANTOT, and climb and descent performances tended to be stronger than that indicated between STANTOT and straight and level. This finding was the same for both males and females.

Of all the intercorrelations between simulator variables (Tables 6 & 7) there was only one in which males and females did not correspond with respect to significance or nonsignificance. This was the relationship of the overall vertical velocity performance to that of straight and level. For females this relationship was significant for males it was nonsignificant. In view of the numerous other similar relationships between male and female simulator performance, the importance of this one example of noncorrespondence appears minimal.

Simulator prediction. It was hypothesized that dual-task, or time-sharing, measures of performance would be more useful than single-task measures for predicting simulator performance. Examination of the "overall" (including gender as a variable) multiple regression equations (Tables 8-13) for the six simulator variables provides strong support for this hypothesis. Besides gender, the only other variables appearing in any of the six equations are all time-sharing measures. The reason for gender's appearance in all of the equations is a direct result of the significantly better male performance on all six simulator variables. The positive (sign) relationship between gender and the simulator scores is merely an artifact of the dummy coding procedures whereby females were given a higher number than males.[7] It should be remembered, of course, that a numberically higher simulator score corresponds to poorer performance as it is indicative of greater deviation from desired values.

One of the most important findings of the present study was that, besides gender, the most frequently occurring variable in the "overall" predictor equations was a time-sharing proportion score, PRODCTMX (which represents the ratio of the total digits canceled on the maximum dual performance trial divided by the total responses on the maximum single-task trial). This ratio of dual to single-task performance is thought to be a measure of time-sharing efficiency (North & Gopher, 1976). Within this framework, single-task maximum performance is conceptualized as an operational definition of an individual's capacity. The proportion score then indicates the percentage of this capacity maintained in the dual situation. The magnitude of the weightings associated with this variable are indicative of its importance in the regression equations. Additionally, the negative sign is appropriate since it indicates the higher the efficiency score, the better (lower) the simulator score. This is important because it indicates that in predicting simulator performance the relationship between dual and single-task performance is more important than the magnitude of single or dual-task performance scores.

Although it was not anticipated that there would be overall gender differences in simulator performance, it was hypothesized that regression equations based on gender would involve different variables as well as different weightings for similar variables. The separate male and female equations for the six simulator variables (Tables 8-13) are in agreement with this hypothesis. A perusal of the variables involved in these gender-based equations provides some interesting results. For males, all of the variables are either dual-task performance scores or single-task rate of acquisition scores. Female results indicated that several single-task variables were significant for predicting overall heading and straight and level performance. Additionally, several dual-task measures and a single-task rate of acquisition variable were important in two of the predictor equations.

In general, considering overall, male, and female regression equations, time-sharing measures provided the best estimates of simulator performance. This is true despite the lack of a consistent relationship between the variables in gender-based equations, and those appearing in corresponding overall performance equations (which resulted from performance variability both within and between male and female groupings).

An unexpected finding was that using gender-based regression equations, female simulator performance was more accurately predicted than male performance. This differential predictive capability was due to the male-female differences in simulator performance variability (with females exhibiting much more variability, and therefore, better predictability).

Conclusions

The present research was designed to investigate the efficacy of various measures of time-sharing skill derived from scores on two psychomotor tasks to predict performance in a general aviation flight trainer. Of special interest was the issue of possible gender differences in these skills.

It is evident from the results of this study(and from other research) that time-sharing measures provide better performance predictability than do single-task measures. It is of special interest that the best single predictor, besides gender, was a time-sharing proportion score which conceptually is thought to reflect dual-task capacity efficiency.

In agreement with previous research (Savage, et al, 1978 (b)), regression equations based on gender were found to be comprised of different predictor variables and different weightings on similar variables.

The finding of general male superiority in simulator performance was speculated to have resulted, at least in part, from the tendency of females to "try too hard" resulting in overarousal and subsequently poorer performance. Even though overall performance differed for males and females in the simulator, the relationships between the six simulator variables tended to be both significant and similar.

There are several implications of this research for those involved in the selection and training of individuals for complex-skill perform ance: (a) time-sharing measures, particularly proportion scores, can be useful indicators of prospective performance; (b) if both males and females are involved in the proposed activity, then it is likely that different regression equations will result in better performance predictability; (c) if the training involves both males and females it may be necessary to insure that a "nonproductive" sense of competitiveness does not adversely affect performance. The difference between optimum arousal and over-arousal in many cases may be quite small and difficult to recognize.

Suggestions for Future Research

The need to investigate further the overall gender differences in simulator performance is apparent. Perhaps the appropriate experimental paradigm is an information processing approach (Marteniuk, 1976) which would examine differences in perceptual, decision, and effector capabilities. At the same time, it might prove beneficial to investigate the appropriateness of the concept of time-sharing ability in a multi-processor (Hawkins, Church, and de Lemos, 1978; Hawkins, Rodriguez, and Reicher, 1978; McLeod, 1977; Navon and Gopher, 1979) versus a single-channel model of attention and information processing.

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FOOTNOTES

[1]The GAT-1 was constructed to simulate performance characteristics of a single-engine, propeller driven aircraft (e.g., a Cessna-172). The instruments and controls correspond to those typically installed in that type of an aircraft (see Appendix B).

[2]A pilot study indicated that subjects' performance became reasonably stabilized after three to six minutes on the task. This corresponded to approximately 180 to 360 responses.

[3]In a pilot study, subjects' demonstrated minimal performance improvement after three to six minutes of tracking (three to six trials).

[4]Since single-task exit scores formed the indices for several time-sharing measures, it was important to check that these scores were accurate measures of an individual's maximum performance capability.

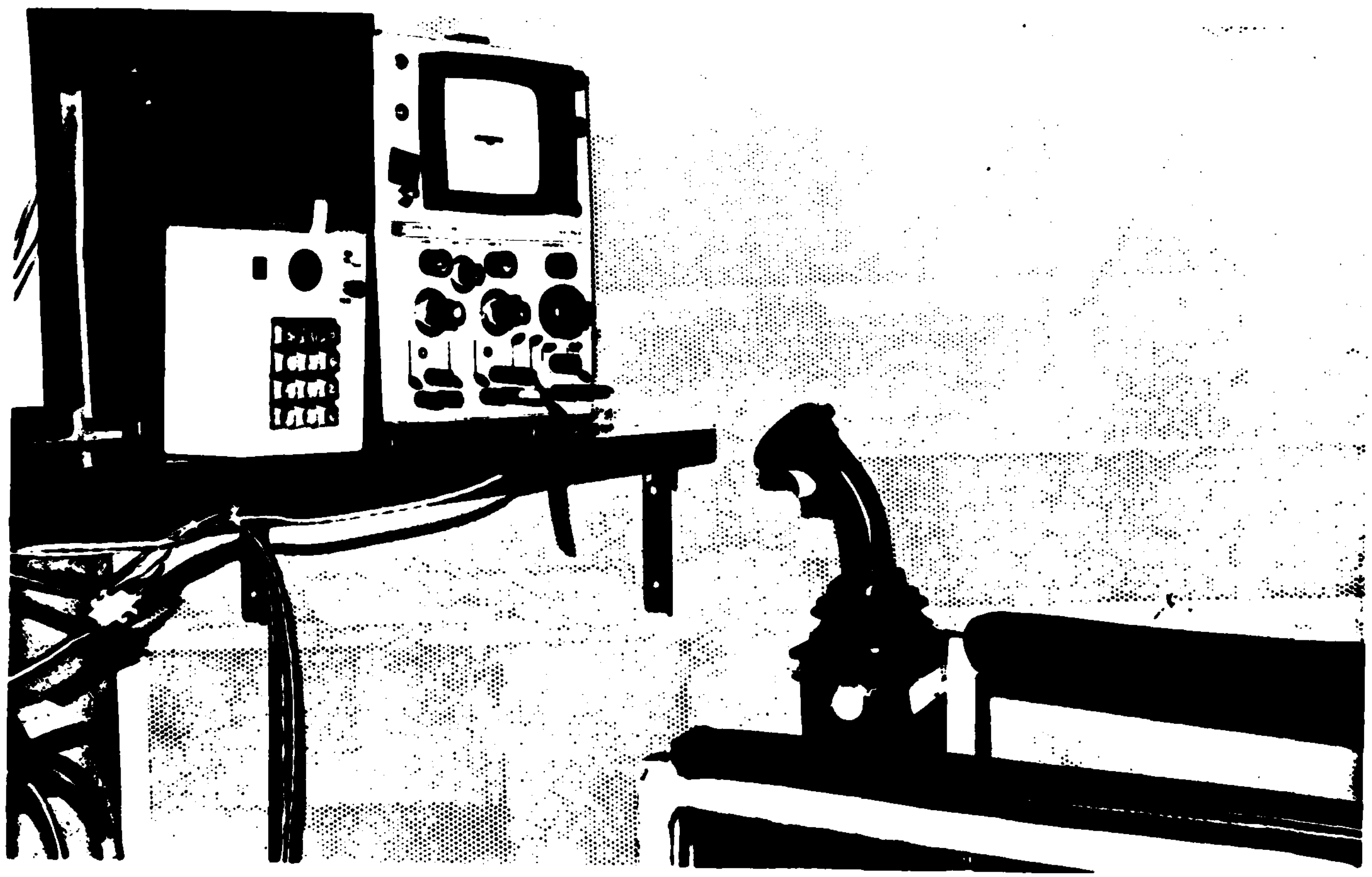
[5]An analog computer was not available at the time of this study.

[6]Except for straight and level vertical velocity scores (which represented "total" absolute deviation), heading and vertical velocity scores on all three maneuvers were obtained by calculating "average" absolute deviations from desired values.

[7]Dummy coding (assigning numeric values to classification variables) allows classification variables to be evaluated as numeric variables in the step-wise regression analysis.

Appendix A

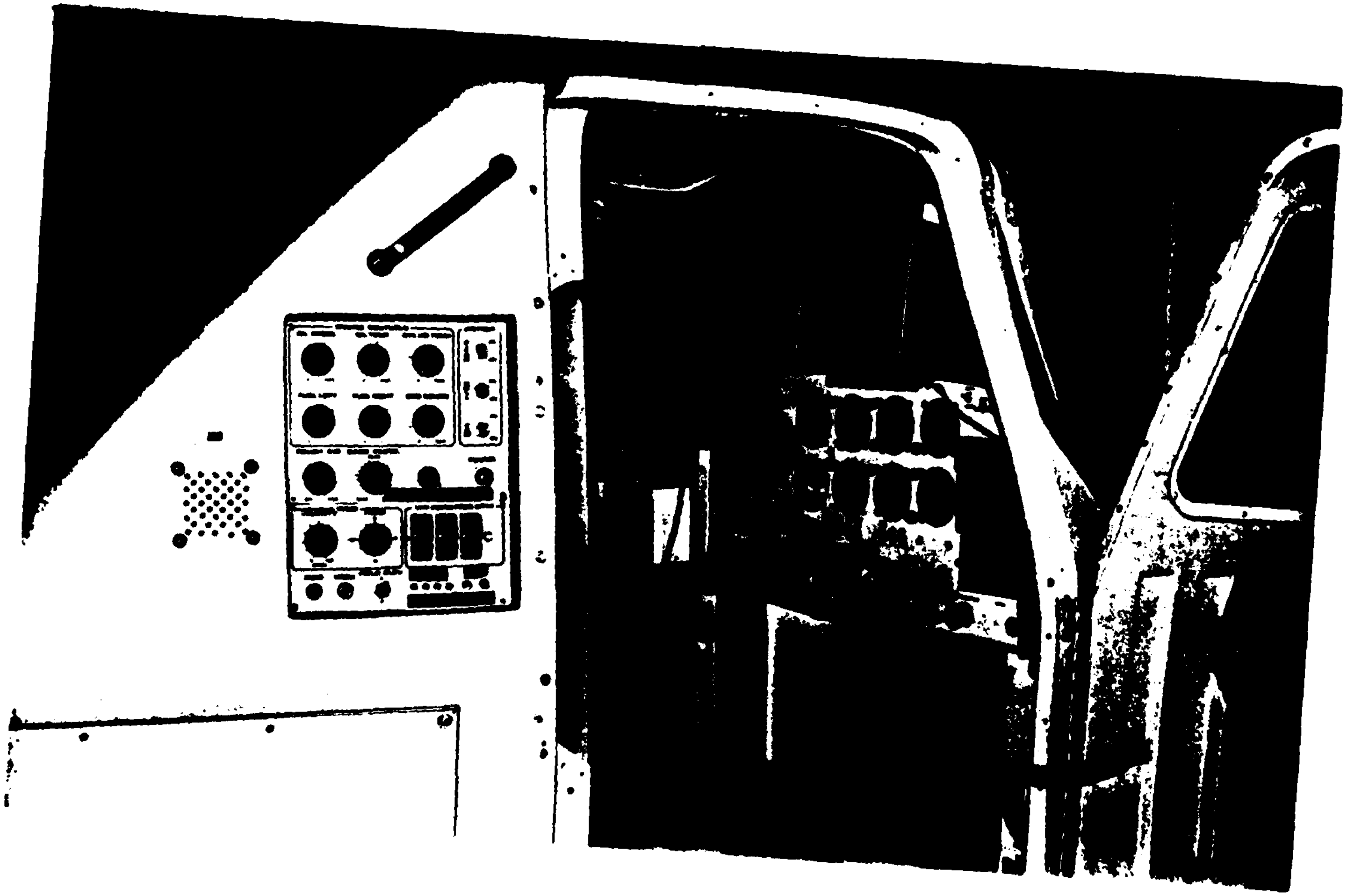
Single and Dual-Task Apparatus



Single and dual-task apparatus

Appendix B

General Aviation trainer (GAT-1)



General aviation trainer (GAT-1)

Appendix C

Single and Dual-Task Instructions

Single and Dual Task Instructions

Today you will perform a series of trials involving the individual and simultaneous use of the single-axis, compensatory tracker and the digit-cancellation task. Throughout the session, trials will be one minute in duration with 20 second rest periods between successive trials.

First, let me demonstrate the operation of the tracker. The objective in this task is to keep the miniature aircraft superimposed on the moving horizon line. To accomplish this you pull the control stick towards you if the horizon line is above the miniature aircraft. (Demonstrate) Conversely, if the horizon line is below the miniature aircraft you must push the stick away from you. (Demonstrate) Now you try it. Grasp the stick lightly in your right hand and be careful to avoid making large abrupt movements. (Let Subject Practice) Do you have any questions? If not, you are ready to start the tracking trials. When I close the door to the booth I will place the task in the rest period. At the start of the rest period the horizon line will shrink to a dot and remain stationary in the center of the scope. During the rest period you should relax, but continue to hold the stick lightly and monitor the scope. After 20 seconds the horizon line will expand across the scope and start moving up and down. This is your signal to start tracking. I will now place the tracker in the rest period and you will begin this task. (Subject Performs The Tracking Trials)

Now you will work the digit cancellation task by itself. With your left hand press the key corresponding to the digit appearing in the window. If you press an incorrect key you will hear a tone like this, (Demonstrate) and the digit will remain in the window. If this occurs, ignore the tone and press the appropriate key to cancel the digit. The object of this task is to work as quickly as possible without sacrificing accuracy. No digits will appear in the window during the 20 second rest periods. Are there any questions? If not, I will close the door and put the task in the rest period. When the trial begins, a number will appear in the window and a tone will sound. Remember to work as rapidly and accurately as you can. (Subject Performs The Digit Canceling Trials)

Now you are going to perform both tasks simultaneously. I want you to consider the tasks of equal importance and attempt to balance your effort between them. After the third trial I may utilize the microphone to provide you feedback as to how you are doing balancing your effort. I might say for instance, "you need to concentrate a little more on tracking." This doesn't mean forget digit-canceling, but merely modify your present strategy so as to allocate a little more effort to tracking. You will perform both tasks together for five trials, then one trial of tracking by itself, one trial of digit-canceling by itself, and finally five trials with both tasks together. You don't have to remember the order of the trials as I will inform you over the speaker of the conditions for the upcoming trial. Do you have any questions? If not I will place the tasks in the rest period and close the door. When the trial starts remember to allocate equal importance to both tasks.

Appendix D

Simulator Instructions

Simulator Instructions

Today you are going to be introduced to a few of the basic aspects of instrument flying. I want you to relax and enjoy yourself and today's session should be fun as well as a learning experience. If at any time you do not understand my instructions please interrupt me and I will attempt to clear up the problem. First, I am going to explain the controls, and instruments and talk briefly about how to fly instruments. Then I'll introduce a few basic maneuvers and you'll get a chance to practice them, first with my help and then by yourself. Don't worry about trying to remember everything as I will be reminding you of the important aspects of each maneuver as you attempt them. Now let's get started.

Controls

There are three controls utilized in flying the simulator: 1) the yoke or control wheel; 2) the rudders; and 3) the throttle. The yoke is used for turning, or changing heading, and for climbing and descending. The rudders are used to coordinate turns, right turns generally require a little right rudder, left turns a little left rudder. The amount of rudder needed will be indicated by the ball in the turn and slip indicator. If the ball is centered within the two black lines the aircraft is in coordinated flight and no rudder is required. If it is off to one side, press on the rudder on the side the ball is on to move the ball back to the center. Rudders are also used to counteract the effects of torque and rigging, right rudder is normally required in a climb and left rudder in a descent.

Instruments

Attitude Indicator. This is the primary instrument used in instrument flying. Any time you want to change the attitude of the aircraft, e.g., climb, descend, or turn, you do so by placing the miniature aircraft in a position relative to the artificial horizon that will give you the desired condition. Today I will show you what the proper positions are for the maneuvers you will be doing. Realize that these positions should put you very close to what you want, but they probably won't be "exactly" right. Normally you will have to make minor changes from these positions so that your conditions of flight will be exactly what you desire. You should note that when you make a change on the attitude indicator, e.g., pitch or bank, it is the horizon bar not the miniature aircraft that actually moves.

At the tip of the attitude indicator you will notice a bank pointer and bank indices. The bank indices are in 10 degree increments. For our purposes today you should try not to use more than 10 degrees of bank. Notice that the bank pointer moves in the "opposite" direction of aircraft turn, so be careful not to use it as an indicator of direction of bank.

Heading Indicator. This indicates the magnetic heading of the aircraft. Today you will generally be trying to maintain a heading of West or 270 degrees. If the "W" moves off center, turn towards the "W" to get back on heading.

Airspeed Indicator. The numbers on the inner dial indicate airspeed in miles per hour.

Vertical Velocity Indicator (VVI). This indicates rate of climb or descent. The markings are in 100 feet per minute increments.

Altimeter. This provides pressure altitude. The shorter pointer indicates thousands of feet and the longer pointer hundreds of feet. The divisions between hundred foot markings are 20 feet.

Turn and Slip Indicator. The needle points in the direction of turn and the ball indicates whether the simulator is in coordinated flight.

Crosscheck. To perform any maneuver you must use what is called a crosscheck. This involves establishing the proper picture, i.e., miniature aircraft with respect to the horizon bar, and then checking the other relevant instruments to insure you have what you want. For example, take straight and level flight. At normal cruise airspeed the proper picture is the miniature aircraft superimposed on the artificial horizon. Once you have established this attitude you must then check three other instruments to insure you are exactly straight and level -- the altimeter, vertical velocity indicator, and heading indicator. If you notice that you don't have exactly what you want, go back to the attitude indicator and make the appropriate change on it. You then recheck the other three instruments and continue to make small adjustments as they are necessary. When flying instruments you spend most of your time looking at the attitude indicator, while trying to maintain a particular picture, and then cross checking the other instruments relevant to the maneuver you are trying to accomplish.

Climb (without heading)

The first maneuver you are going to do today is a climb. The yaw switch will be turned off so your heading will not change even if your wings are banked. I want you to concentrate on maintaining your wings level with the proper pitch attitude. Let me demonstrate the proper attitude. (Demonstrate). As you can see the miniature aircraft is about one bar width (width of the horizon bar) above the artificial horizon. With full power this should result in a rate of climb of approximately 500 feet per minute. Changes in pitch are normally very small with a quarter of a bar width displacement resulting in a rate change of approximately 100 feet per minute.

Now you practice the climb. Remember with full power the only way you can maintain 500 feet per minute is by changing your pitch, lowering the nose to increase the rate and raising it to decrease the rate. Additionally, if the wings are not level they will produce less lift and this will affect the proper pitch attitude so be sure to keep the wings level. (Student practices for 2,000 feet with feedback as appropriate).

Straight and Level

Now you will practice staying on altitude and maintaining heading. If the "W" moves off to one side turn towards it to bring it back to the center. Let me demonstrate how to roll into and out of turns.

feedback as appropriate).

Climb (with heading)

This climb will be the same as the first climb with the exception that you will have to maintain your heading as well as the appropriate pitch attitude to maintain a 500 feet per minute rate of climb. You may find it necessary to use right rudder in the climb. If the ball isn't centered push on the rudder to center the ball.

Are there any questions? (Student practices for 2,000 feet with feedback as appropriate).

Descent (with heading)

For this descent you will also have to maintain heading. It might require a little left rudder so check the position of the ball. Remember the proper pitch attitude is with the miniature aircraft tangent to the bottom of the horizon line.

Are there any questions? (Student practices descent for 2,000 feet with feedback as appropriate).

Remember not to use more than 10 degrees of bank. (Demonstrate Turns). There are several important points to remember when executing turns: 1) keep the dot (nose of miniature aircraft) at the proper pitch attitude relative to the artificial horizon when rolling into and out of bank; 2) as the bank indicator approaches 10 degrees you must turn the yoke slightly in the opposite direction of turn (this neutralizes the ailerons and allows the bank angle to remain constant); 3) in order to roll out on a desired heading, e.g., West, you must initiate your roll-out just prior to reaching your desired heading. A good lead point when using 10 degrees of bank is approximately 1 to 2 degrees.

Are there any questions? If not, then maintain a heading of West and your present altitude. (Student practices, with feedback as appropriate, for 2 minutes).

Descent

Just like in the climb the heading indicator (yaw switch) will be off for the first descent. Concentrate on keeping the wings level and maintaining the proper nose low attitude to hold 500 feet per minute rate of descent. The proper picture is the top of the miniature aircraft wings tangent to the bottom of the artificial horizon line.

If there are no questions, let's start the descent. I'll set the throttle and get you situated in the proper attitude and then you can fly it by yourself. (Student practices for 2,000 feet with

Appendix E

Raw Data and Definitions of Variables

Definition of Raw Data Variables

SUBNUM - subject identification number

GENDER - female=0; male=1

CLASS - freshmen (4); sophomore(3); junior (2)

FLY EXP - 0=none

STRK 1-6 - single tracking trials

EXIT TRK - tracking score at exit

SDCTOT 1-6 - single digit-canceling trials, total responses

EXDCTOT - digit-canceling total responses at exit

SDCCOR 1-6 - single digit-canceling trials, correct responses

EXSDCCOR - digit-canceling correct responses at exit

MIDTRK - single tracking check trial

MIDDCTOT - single digit-canceling check trial total responses

MIDDCCOR - single digit-canceling check trial correct responses

DTRK 1-10 - dual tracking trials, time in window score

PROTRK 1-10 - dual tracking score/50

DDCTOT 1-10 - dual digit-canceling trials, total responses

PRODC 1-10 - dual digit-canceling score/60

DDCCOR 1-10 - dual digit-canceling trials, correct responses

CLIMBH - average heading variation in degrees during climb

CLIMBV - average vertical velocity variation/100 during climb

SANDLH - average heading variation during straight and level

SANDLV - difference between climbing deviations and descending deviations during straight and level

DESH - average heading variation during descent

DESV - average vertical velocity variation/100 during descent

Raw Data

SUBNUM	1	2	3	4	5	6	7	8	9
GENDER	1	0	1	1	1	1	1	1	0
CLASS	4	4	2	2	4	4	4	4	4
FLY EXP	0	0	0	0	0	0	0	0	0
STRK 1	52.22	44.70	43.57	49.43	26.60	29.30	24.00	26.90	44.90
STRK 2	55.66	48.00	47.82	44.65	23.72	25.50	32.68	26.74	45.00
STRK 3	51.90	47.56	49.95	52.24	22.22	27.70	34.90	34.90	45.10
STRK 4	52.65	.	.	49.05	22.81	27.60	.	20.50	.
STRK 5	53.58	.	.	49.86	27.64	.	.	25.08	.
STRK 6	.	.	.	.	29.36	.	.	24.65	.
EXIT TRK	53.12	47.78	48.89	49.95	28.50	27.65	33.79	24.87	45.05
SDCTOT 1	51	57	58	46	50	54	55	54	49
SDCTOT 2	58	62	61	59	54	49	60	57	63
SDCTOT 3	60	60	61	56	55	52	59	59	61
SDCTOT 4	.	.	.	57	.	50	.	.	.
SDCTOT 5	.	.	.	60	.	58	.	.	.
SDCTOT 6	.	.	.	51	.	54	.	.	.
EXDCTOT	59.0	61.0	61.0	60.5	54.5	56.0	59.5	58.0	62.0
SDCCOR 1	51	56	57	44	49	54	54	54	45
SDCCOR 2	57	61	61	59	51	46	58	56	61
SDCCOR 3	60	58	59	54	52	49	58	59	60
SDCCOR 4	.	.	.	55	.	48	.	.	.
SDCCOR 5	.	.	.	59	.	56	.	.	.
SDCCOR 6	.	.	.	60	.	51	.	.	.

SUBNUM	1	2	3	4	5	6	7	8	9
EXSDCCOR	58.5	59.5	60.0	59.5	51.5	53.5	58.0	57.5	60.5
MIDTRK	52.70	47.15	50.20	49.60	24.00	28.30	30.20	31.15	45.62
MIDDCTOT	65	69	70	66	62	62	67	59	67
MIDDCCOR	64	67	70	66	62	60	66	58	64
DTRK 1	42.90	33.50	35.80	44.55	22.10	25.80	24.90	38.20	34.90
PROTRK 1	0.858	0.670	0.716	0.891	0.440	0.520	0.500	0.760	0.698
DDCTOT 1	33	36	36	24	33	34	31	48	28
PROPDC 1	0.550	0.600	0.600	0.400	0.550	0.570	0.520	0.800	0.467
DDCCOR 1	33	35	36	24	31	26	29	46	28
DTRK 2	45.65	35.14	34.85	38.00	27.30	31.90	35.10	27.00	31.80
PROTRK 2	0.913	0.703	0.697	0.760	0.550	0.640	0.700	0.540	0.636
DDCTOT 2	34	41	36	22	26	31	31	50	26
PROPDC 2	0.567	0.683	0.600	0.367	0.430	0.520	0.520	0.830	0.433
DDCCOR 2	34	41	35	22	25	30	31	49	24
DTRK 3	40.90	29.90	37.70	48.20	26.50	24.40	26.40	24.75	36.90
PROTRK 3	0.818	0.598	0.754	0.964	0.530	0.490	0.530	0.482	0.738
DDCTPT 3	35	38	35	19	33	33	30	44	22
PROPDC 3	0.583	0.633	0.583	0.317	0.550	0.550	0.500	0.730	0.367
DDCCDR 3	35	34	35	19	32	33	30	42	22
DTRK 4	32.64	27.61	31.84	41.60	22.10	28.65	23.10	35.80	33.50
PROTRK 4	0.653	0.552	0.637	0.832	0.440	0.570	0.460	0.720	0.670
DDCTOT 4	42	43	53	35	28	36	30	41	33
PROPDC 4	0.700	0.717	0.833	0.583	0.470	0.600	0.500	0.680	0.550

SUBNUM	1	2	3	4	5	6	7	8	9
DDCCOR 4	42	41	53	35	28	35	30	40	32
DTRK 5	36.84	29.75	31.85	38.40	40.80	32.00	26.40	25.80	32.14
PROTRK 5	0.737	0.595	0.637	0.768	0.820	0.640	0.530	0.520	0.643
DDCTOT 5	46	47	49	34	28	37	32	39	34
PROPDC 5	0.767	0.733	0.817	0.567	0.470	0.620	0.530	0.650	0.567
DDCCOR 5	45	44	47	34	28	37	32	39	34
DTRK 6	35.05	31.15	34.14	38.00	22.30	20.65	26.70	26.70	32.50
PROTRK 6	0.701	0.623	0.683	0.760	0.450	0.410	0.530	0.530	0.650
DDCTOT 6	46	50	50	40	40	37	37	51	36
PROPDC 6	0.767	0.833	0.833	0.667	0.670	0.620	0.620	0.850	0.600
DDCCOR 6	46	49	49	40	37	35	37	51	34
DTRK 7	32.90	30.85	35.00	37.55	35.60	21.40	29.00	21.50	36.25
PROTRK 7	0.658	0.617	0.700	0.751	0.710	0.430	0.580	0.430	0.725
DDCTOT 7	48	45	50	37	37	33	42	47	36
PROPDC 7	0.800	0.750	0.833	0.617	0.620	0.550	0.700	0.780	0.600
DDCCOR 7	48	45	48	37	36	32	42	47	33
DTRK 8	33.00	32.50	35.85	41.00	25.80	23.80	25.60	28.00	34.90
PROTRK 8	0.660	0.650	0.717	0.820	0.520	0.480	0.510	0.470	0.698
DDCTOT 8	51	44	54	39	32	28	41	38	38
PROPDC 8	0.850	0.733	0.900	0.650	0.530	0.470	0.680	0.630	0.633
DDCCOR 8	51	42	53	39	30	28	40	38	38
DTRK 9	33.90	40.05	43.17	37.00	2142	34.90	25.30	28.00	24.80
PROTRK 9	0.678	0.801	0.863	0.740	0.430	0.700	0.510	0.560	0.496

SUBNUM	1	2	3	4	5	6	7	8	9
DDCTOT 9	41	51	36	44	29	30	32	39	33
PROPDC 9	0.683	0.850	0.600	0.733	0.480	0.500	0.530	0.650	0.550
DDCCOR 9	38	50	36	44	27	29	32	26	32
DTRK 10	35.70	23.70	40.27	41.55	27.30	29.90	32.80	28.55	26.90
PROTRK 10	0.714	0.474	0.805	0.831	0.550	0.600	0.660	0.570	0.538
DDCTOT 10	41	45	41	39	35	36	37	42	35
PROPDC 10	0.683	0.750	0.683	0.650	0.580	0.600	0.620	0.700	0.583
DDCCOR 10	41	39	41	39	32	35	37	42	32
CLIMBH	2.045	6.913	3.661	5.417	6.783	4.524	7.400	3.442	9.103
CLIMBV	0.545	1.109	1.054	0.438	1.987	0.524	0.580	0.615	1.500
SANDLH	2.650	6.410	4.842	8.176	5.000	4.317	6.486	4.037	6.568
SANDLV	4.0	42.5	30.0	41.5	14.5	39.0	27.5	22.0	35.5
DESH	2.357	5.300	6.800	5.960	7.690	4.396	7.091	1.975	8.700
DESV	1.095	1.860	2.000	1.200	1.357	1.250	1.977	1.425	3.150
FEEDBK	0	1	0	0	0	0	0	0	0

SUBNUM	10	11	12	13	14	15	16	17	18
GENDER	0	0	0	1	1	1	0	0	1
CLASS	3	3	2	4	4	4	3	3	4
FLY EXP	0	0	0	0	0	0	0	0	0
STRK 1	43.12	49.75	49.80	43.15	37.28	52.10	46.20	45.05	50.40
STRK 2	35.00	50.35	53.30	45.80	40.25	51.10	50.80	46.62	51.00
STRK 3	44.50	48.40	52.75	47.25	51.60	51.05	49.05	46.50	52.90
STRK 4	48.03	.	.	.	52.50	.	.	.	.
STRK 5	42.85	.	.	.	.	.	.	.	.
STRK 6	48.70	.	.	.	.	.	.	.	.
EXIT TRK	46.78	49.38	53.03	46.53	52.05	51.75	49.57	46.64	51.95
SDCTOT 1	60	66	59	53	49	60	59	52	57
SDCTOT 2	61	72	64	54	53	62	68	57	55
SDCTOT 3	67	74	66	58	56	61	69	59	62
SDCTOT 4	68	.	.	62	59	.	.	.	60
SDCTOT 5	.	.	.	60	61	.	.	.	.
SDCTOT 6	.	.	.	.	.	.	.	.	.
EXDCTOT	67.5	73.0	65.0	61.0	60.0	61.5	68.5	58.0	61.0
SDCCOR 1	58	65	59	49	48	60	58	52	56
SDCCOR 2	60	71	64	53	51	59	65	57	54
SDCCOR 3	67	73	66	56	55	59	64	58	60
SDCCOR 4	67	.	.	61	59	.	.	.	59
SDCCOR 5	.	.	.	60	60	.	.	.	.
SDCCOR 6	.	.	.	.	.	.	.	.	.

SUBNUM	10	11	12	13	14	15	16	17	18
EXSDCCOR	67.0	72.0	65.0	60.5	59.5	59.0	64.5	57.5	59.5
MIDTRK	41.85	47.37	52.00	46.60	46.80	53.60	50.75	47.80	55.10
MIDDCTOT	68	74	66	69	67	68	70	65	66
MIDDCCOR	67	71	62	69	66	66	66	64	65
DTRK 1	34.40	36.40	39.65	27.80	37.40	32.75	38.50	35.80	44.55
PROTRK 1	0.688	0.728	0.793	0.556	0.748	0.655	0.770	0.716	0.891
DDCTOT 1	37	36	36	39	36	29	45	31	32
PROPDC 1	0.617	0.600	0.600	0.650	0.600	0.483	0.750	0.517	0.533
DDCCOR 1	37	36	36	39	36	29	45	31	32
DTRK 2	35.95	38.90	44.25	27.50	43.95	40.70	39.90	40.00	49.75
PROTRK 2	0.719	0.778	0.885	0.550	0.879	0.814	0.798	0.800	0.995
DDCTOT 2	35	33	42	38	33	38	52	35	31
PROPDC 2	0.583	0.550	0.700	0.633	0.550	0.633	0.867	0.583	0.517
DDCCOR 2	35	32	42	38	33	38	52	34	31
DTRK 3	41.60	48.90	40.90	32.75	37.56	36.35	36.50	40.15	53.10
PROTRK 3	0.832	0.978	0.818	0.655	0.751	0.727	0.730	0.803	1.060
DDCTOT 3	31	39	49	38	33	35	42	36	33
PROPDC 3	0.517	0.650	0.817	0.633	0.550	0.583	0.700	0.600	0.550
DDCCOR 3	31	39	49	38	33	35	40	35	33
DTRK 4	40.30	39.10	45.85	34.70	36.00	33.00	34.50	31.20	41.10
PROTRK 4	0.806	0.782	0.917	0.694	0.720	0.660	0.690	0.624	0.822
DDCTOT 4	44	49	51	48	35	42	43	36	44
PROPDC 4	0.733	0.817	0.850	0.800	0.583	0.700	0.717	0.600	0.733

SUBNUM	10	11	12	13	14	15	16	17	18
DDCCOR 4	44	49	51	47	34	39	42	36	44
DTRK 5	28.70	31.70	45.50	31.90	39.50	27.75	35.40	34.45	34.40
PROTRK 5	0.574	0.634	0.910	0.638	0.790	0.555	0.708	0.689	0.688
DDCTOT 5	45	48	50	44	42	43	55	39	43
PROPDC 5	0.750	0.800	0.833	0.733	0.700	0.717	0.917	0.650	0.717
DDCCOR 5	45	48	50	42	41	43	53	39	43
DTRK 6	42.40	38.74	41.75	32.10	24.50	39.05	42.90	39.45	30.00
PROTRK 6	0.848	0.775	0.835	0.642	0.490	0.781	0.858	0.789	0.600
DDCTOT 6	50	55	50	50	35	42	54	39	43
PROPDC 6	0.833	0.917	0.833	0.833	0.583	0.700	0.900	0.650	0.717
DDCCOR 6	50	55	50	49	35	41	51	39	39
DTRK 7	38.55	38.70	40.70	34.50	30.55	38.20	38.90	29.90	37.55
PROTRK 7	0.771	0.774	0.814	0.690	0.611	0.764	0.778	0.598	0.751
DDCTOT 7	50	58	49	40	41	40	53	42	49
PROPDC 7	0.833	0.967	0.817	0.667	0.683	0.667	0.883	0.700	0.817
DDCCOR 7	50	58	49	39	41	40	50	41	49
DTRK 8	36.80	42.15	41.70	35.55	37.22	31.44	35.45	40.00	41.40
PROTRK 8	0.736	0.843	0.834	0.711	0.744	0.629	0.709	0.800	0.828
DDCTOT 8	49	42	51	44	43	41	57	45	51
PROPDC 8	0.817	0.700	0.850	0.733	0.717	0.683	0.950	0.750	0.850
DDCCOR 8	49	42	51	44	41	41	54	45	51
DTRK 9	34.00	34.80	46.40	36.50	37.00	31.90	32.72	34.90	40.40
PROTRK 9	0.680	0.696	0.928	0.730	0.740	0.638	0.654	0.698	0.808

SUBNUM	10	11	12	13	14	15	16	17	18
DDCTOT 9	50	54	54	41	48	41	48	43	49
PROPDC 9	0.833	0.900	0.900	0.683	0.800	0.683	0.800	0.717	0.817
DDCCOR 9	50	54	54	41	48	41	47	43	48
DTRK 10	32.80	39.75	37.30	37.50	32.75	40.35	39.63	35.35	39.20
PROTRK 10	0.656	0.795	0.746	0.750	0.655	0.807	0.793	0.707	0.784
DDCCTOT 10	42	51	53	47	39	45	45	43	49
PROPDC 10	0.700	0.850	0.883	0.783	0.650	0.750	0.750	0.717	0.817
DDCCOR 10	42	51	53	45	39	45	44	43	48
CLIMBH	9.188	5.475	8.964	6.174	5.120	6.540	6.460	8.183	2.870
CLIMBV	0.938	0.850	1.000	0.630	0.540	1.020	0.680	1.150	0.217
SANDLH	7.171	5.730	5.763	6.579	3.446	6.789	6.635	7.257	2.365
SANDLV	55.5	18.0	36.5	64.0	38.5	34.5	33.5	14.5	12.0
DESH	9.565	5.575	7.250	8.396	3.480	7.180	6.900	6.225	0.810
DESV	2.152	1.325	1.768	1.396	0.920	1.160	2.200	3.425	0.690
FEEDBK	0	1	0	0	0	0	1	3	0

SUBNUM	19	20	21	22	23	24	25	26	27
GENDER	0	1	1	0	0	1	1	0	1
CLASS	2	4	4	3	3	4	4	2	4
FLY EXP	0	0	0	0	0	0	0	0	0
STRK 1	43.70	45.50	48.40	40.55	41.33	40.60	43.50	34.55	48.05
STRK 2	37.43	49.33	48.30	40.15	51.50	43.50	50.10	34.05	47.36
STRK 3	41.44	50.30	.	46.50	50.35	40.40	45.15	39.20	50.60
STRK 4	44.17	.	.	51.50	.	42.55	47.20	43.35	48.15
STRK 5	50.45	.	.	45.00	.	46.10	48.10	32.00	.
STRK 6	47.85	.	.	.	.	49.90	.	.	.
EXIT TRK	49.15	49.82	48.35	48.25	50.93	48.00	47.65	38.18	49.38
SDCTOT 1	63	52	66	55	55	50	60	61	59
SDCTOT 2	63	55	75	62	57	55	64	65	64
SDCTOT 3	67	57	66	63	59	58	63	64	62
SDCTOT 4	66	.	75	.	.	62	.	.	66
SDCTOT 5	.	.	.	.	.	.	.	.	.
SDCTOT 6	.	.	.	.	.	.	.	.	.
EXDCTOT	66.5	56.0	70.5	62.5	58.0	60.0	63.5	64.5	64.0
SDCCOR 1	62	49	62	55	51	46	59	60	59
SDCCOR 2	58	52	73	60	52	52	60	65	64
SDCCOR 3	66	56	57	62	58	56	60	63	61
SDCCOR 4	66	.	74	.	.	61	.	.	64
SDCCOR 5	.	.	.	.	.	.	.	.	.
SDCCOR 6	.	.	.	.	.	.	.	.	.

SUBNUM	19	20	21	22	23	24	25	26	27
EXSDCCOR	66.0	54.0	65.5	61.0	55.0	58.5	60.0	64.0	62.5
MIDTRK	50.43	51.45	49.50	47.90	54.80	52.90	49.50	35.80	51.50
MIDDCTOT	68	62	76	67	62	70	70	64	69
MIDDCCOR	66	60	71	67	61	69	67	62	67
DTRK 1	36.35	26.05	32.60	34.15	34.60	34.35	39.05	31.80	36.90
PROTRK 1	0.727	0.521	0.652	0.683	0.692	0.687	0.781	0.636	0.738
DDCTOT 1	36	37	47	49	38	33	36	40	42
PROPDC 1	0.600	0.617	0.783	0.817	0.633	0.550	0.600	0.667	0.700
DDCCOR 1	34	37	44	48	38	33	36	39	42
DTRK 2	39.40	33.05	31.55	39.75	38.75	35.15	39.73	34.30	42.20
PROTRK 2	0.788	0.661	0.631	0.795	0.775	0.703	0.795	0.686	0.844
DDCTOT 2	36	43	48	49	43	39	42	41	43
PROPDC 2	0.600	0.717	0.800	0.817	0.717	0.650	0.700	0.683	0.717
DDCCOR 2	35	40	47	49	42	39	42	39	43
DTRK 3	38.70	27.75	30.50	27.10	35.50	39.05	34.85	25.85	37.00
PROTRK 3	0.774	0.555	0.610	0.542	0.710	0.781	0.697	0.517	0.740
DDCTOT 3	39	45	51	47	43	37	44	46	48
PROPDC 3	0.650	0.750	0.850	0.783	0.717	0.617	0.733	0.767	0.800
DDCCOR 3	38	45	50	47	41	35	43	46	48
DTRK 4	32.00	33.85	36.60	25.45	34.50	37.10	34.80	32.70	39.80
PROTRK 4	0.640	0.677	0.732	0.509	0.690	0.742	0.696	0.654	0.796
DDCTOT 4	43	43	37	37	44	42	48	38	50
PROPDC 4	0.717	0.717	0.617	0.617	0.733	0.700	0.800	0.633	0.833

SUBNUM	19	20	21	22	23	24	25	26	27
DDCCOR 4	43	41	36	36	44	42	46	38	50
DTRK 5	27.35	32.00	32.30	36.60	29.05	35.00	29.80	35.00	35.10
PROTRK 5	0.547	0.640	0.646	0.732	0.581	0.700	0.596	0.700	0.702
DDCTOT 5	47	44	38	43	43	46	54	49	51
PROPDC 5	0.783	0.733	0.633	0.717	0.717	0.767	0.900	0.817	0.850
DDCCOR 5	47	44	34	42	43	46	53	48	50
DTRK 6	32.60	37.80	35.25	35.60	27.10	35.75	37.70	29.10	34.90
PROTRK 6	0.652	0.756	0.705	0.712	0.542	0.715	0.754	0.582	0.698
DDCTOT 6	43	47	40	41	49	44	45	40	48
PROPDC 6	0.717	0.783	0.667	0.683	0.817	0.733	0.750	0.667	0.800
DDCCOR 6	42	46	39	41	48	44	44	40	48
DTRK 7	38.90	32.50	38.50	45.80	39.85	33.60	33.00	30.10	34.25
PROTRK 7	0.778	0.650	0.770	0.916	0.797	0.672	0.660	0.602	0.685
DDCTOT 7	50	41	43	51	43	47	49	41	52
PROPDC 7	0.833	0.683	0.717	0.850	0.717	0.783	0.817	0.683	0.867
DDCCOR 7	50	39	43	51	42	46	48	40	52
DTRK 8	42.60	29.35	44.70	42.70	39.95	32.90	37.70	29.00	38.30
PROTRK 8	0.852	0.587	0.894	0.854	0.799	0.658	0.750	0.580	0.766
DDCTOT 8	51	51	50	49	42	46	39	47	46
PROPDC 8	0.850	0.850	0.833	0.817	0.700	0.767	0.650	0.783	0.767
DDCCOR 8	51	48	47	46	42	45	37	47	46
DTRK 9	33.40	39.60	35.60	35.35	39.60	32.75	40.40	31.40	34.80
PROTRK 9	0.668	0.792	0.712	0.707	0.792	0.655	0.808	0.628	0.696

SUBNUM	19	20	21	22	23	24	25	26	27
DDCTOT 9	51	52	48	52	41	45	43	38	48
PROPDC 9	0.850	0.867	0.800	0.867	0.683	0.750	0.717	0.633	0.800
DDCCOR 9	51	49	47	51	41	43	42	38	47
DTRK 10	35.25	41.30	32.80	47.00	36.35	39.05	34.70	30.50	34.60
PROTRK 10	0.705	0.826	0.656	0.940	0.727	0.761	0.694	0.610	0.692
DDCTOT 10	48	47	44	49	43	43	44	42	44
PROPDC 10	0.800	0.783	0.733	0.817	0.717	0.717	0.733	0.700	0.733
DDCCOR 10	46	45	44	49	43	42	42	42	43
CLIMBH	8.654	6.917	2.315	3.731	4.800	6.444	5.933	4.259	7.180
CLIMBV	1.261	0.667	0.537	0.615	1.240	0.963	1.500	0.630	0.980
SANDLH	9.044	6.324	2.711	2.053	4.842	7.014	3.026	6.592	6.594
SANDLV	23.000	26.500	29.600	33.000	74.500	25.000	23.500	77.500	16.500
DESH	9.185	7.000	1.955	1.477	7.350	8.435	2.881	5.940	7.600
DESV	2.315	1.095	2.477	1.617	2.850	1.348	1.643	1.420	1.300
FEEDBK	2	2	0	0	1	0	0	1	0

AD-A097 452 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH F/G 5/9
MEASURES OF TIME-SHARING SKILL AND GENDER AS PREDICTORS OF FLIG--ETC(U)
1979 T M MCCLOY
UNCLASSIFIED AFIT-CI-79-273D NL

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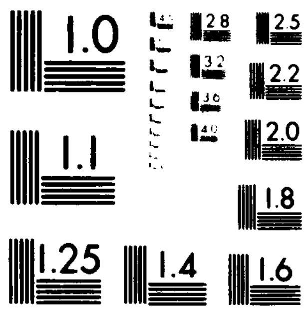

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SUBNUM	28	29	30	31	32	33	34	35	36
GENDER	0	0	0	0	1	1	1	1	0
CLASS	2	3	2	2	4	2	4	2	4
FLY EXP	0	0	0	0	0	0	0	0	0
STRK 1	42.80	38.80	34.80	29.05	37.65	46.23	49.30	22.35	51.50
STRK 2	49.85	33.05	36.75	43.20	44.85	53.75	47.70	35.85	53.50
STRK 3	45.90	30.10	47.10	42.30	45.75	51.60	48.70	42.65	49.95
STRK 4	53.80	34.50	47.90	.	.	55.85	.	42.20	52.00
STRK 5	52.50	35.80	.	.	.	53.50	.	.	.
STRK 6	.	.	.	.	.	.	.	.	.
EXIT TRK	53.15	35.15	47.50	42.75	45.30	54.68	48.20	42.43	50.98
SDCTOT 1	55	50	56	61	56	53	51	51	57
SDCTOT 2	55	59	56	74	57	55	60	53	62
SDCTOT 3	.	61	59	69	62	63	67	55	60
SDCTOT 4	.	.	65	65	64	61	68	61	.
SDCTOT 5	.	.	61	68	.	.	.	59	.
SDCTOT 6	.	.	.	.	.	.	.	.	.
EXDCTOT	55.0	60.0	63.0	66.5	63.0	62.0	67.5	60.0	61.0
SDCCOR 1	53	49	54	61	55	51	51	49	57
SDCCOR 2	52	59	53	73	57	54	58	53	62
SDCCOR 3	.	61	57	67	60	62	65	55	60
SDCCOR 4	.	.	64	63	64	57	66	60	.
SDCCOR 5	.	.	59	68	.	.	.	59	.
SDCCOR 6	.	.	.	.	.	.	.	.	.

SUBNUM	28	29	30	31	32	33	34	35	36
EXSDCCOR	52.5	60.0	61.5	65.5	62.0	59.5	65.5	59.5	60.5
MIDTRK	55.20	35.70	48.40	44.35	47.70	55.90	48.35	46.60	51.00
MIDDCTOT	62	71	71	73	71	70	74	61	58
MIDDCCOR	59	69	71	70	71	69	71	60	57
DTRK 1	39.50	27.80	24.10	30.00	34.20	35.60	34.30	36.15	34.75
PROTRK 1	0.790	0.556	0.482	0.600	0.684	0.712	0.686	0.723	0.695
DDCTOT 1	26	35	36	25	40	34	40	19	43
PROPDC 1	0.433	0.583	0.600	0.417	0.667	0.567	0.667	0.317	0.717
DDCCOR 1	23	33	35	24	40	32	40	18	42
DTRK 2	33.75	28.00	31.20	39.00	33.00	45.20	39.50	36.30	34.10
PROTRK 2	0.675	0.560	0.624	0.780	0.660	0.904	0.790	0.726	0.682
DDCTOT 2	30	42	35	32	43	35	42	25	46
PROPDC 2	0.500	0.700	0.583	0.533	0.717	0.583	0.700	0.417	0.767
DDCCOR 2	29	42	35	32	43	34	42	24	45
DTRK 3	39.70	27.65	34.85	36.60	32.80	41.00	36.40	34.10	34.00
PROTRK 3	0.794	0.553	0.697	0.732	0.656	0.820	0.728	0.682	0.680
DDCTOT 3	27	41	41	32	41	36	47	31	53
PROPDC 3	0.450	0.683	0.683	0.533	0.683	0.600	0.783	0.517	0.883
DDCCOR 3	27	41	41	31	41	34	45	30	53
DTRK 4	33.50	28.75	32.70	31.25	32.50	43.30	34.50	31.15	35.00
PROTRK 4	0.670	0.575	0.654	0.625	0.650	0.866	0.690	0.623	0.700
DDCTOT 4	35	38	46	31	46	45	46	39	41
PROPDC 4	0.583	0.633	0.767	0.517	0.767	0.750	0.767	0.650	0.683

SUBNUM	28	29	30	31	32	33	34	35	36
DDCCOR 4	35	36	46	31	45	42	46	39	41
DTRK 5	35.05	35.50	37.00	43.65	41.40	32.00	37.75	28.15	31.80
PROTRK 5	0.701	0.710	0.740	0.873	0.828	0.640	0.755	0.563	0.636
DDCTOT 5	37	45	31	35	48	49	48	45	34
PROPDC 5	0.617	0.750	0.517	0.583	0.800	0.817	0.800	0.750	0.567
DDCCOR 5	35	44	29	35	48	44	48	43	34
DTRK 6	39.15	30.50	31.90	35.40	30.90	35.15	35.40	38.15	33.55
PROTRK 6	0.783	0.610	0.638	0.708	0.618	0.703	0.708	0.763	0.671
DDCTOT 6	43	55	37	35	52	50	54	50	47
PROPDC 6	0.717	0.917	0.617	0.583	0.867	0.833	0.900	0.833	0.783
DDCCOR 6	41	52	36	35	48	48	53	49	46
DTRK 7	32.00	30.60	35.80	38.85	35.60	34.75	45.45	32.40	30.85
PROTRK 7	0.640	0.612	0.716	0.777	0.712	0.695	0.909	0.648	0.617
DDCTOT 7	35	36	42	43	49	52	49	43	45
PROPDC 7	0.583	0.600	0.533	0.717	0.817	0.867	0.817	0.717	0.750
DDCCOR 7	34	36	31	43	49	50	48	41	45
DTRK 8	39.60	30.00	34.70	27.50	35.60	36.15	30.70	28.35	30.45
PROTRK 8	0.792	0.600	0.694	0.550	0.712	0.723	0.614	0.567	0.609
DDCTOT 8	34	43	48	41	48	55	45	45	34
PROPDC 8	0.567	0.717	0.800	0.683	0.800	0.917	0.750	0.750	0.567
DDCCOR 8	34	42	48	41	48	53	45	44	34
DTRK 9	30.70	32.80	33.90	30.15	38.90	44.60	38.30	38.30	32.60
PROTRK 9	0.614	0.656	0.678	0.603	0.778	0.892	0.766	0.766	0.652

SUBNUM	28	29	30	31	32	33	34	35	36
DDCTOT 9	41	46	48	44	49	56	50	46	42
PROPDC 9	0.683	0.767	0.800	0.733	0.817	0.933	0.833	0.767	0.700
DDCCOR 9	38	43	47	44	48	55	50	45	42
DTRK 10	33.00	27.35	31.25	29.85	39.10	34.25	31.20	29.85	29.40
PROTRK 10	0.660	0.547	0.625	0.597	0.782	0.685	0.624	0.597	0.588
DDCTOT 10	45	46	40	40	53	51	51	40	40
PROPDC 10	0.750	0.767	0.667	0.667	0.883	0.850	0.850	0.667	0.667
DDCCOR 10	44	46	38	39	53	51	51	40	40
CLIMBH	6.900	7.840	3.217	5.568	4.232	1.500	3.324	8.797	7.960
CLIMBV	1.967	0.900	1.065	0.273	1.018	0.148	0.581	1.547	1.500
SANDLH	4.921	3.041	5.105	6.297	5.026	2.135	5.338	6.122	2.474
SANDLV	36.500	51.000	1.500	52.000	18.000	44.500	33.500	20.000	66.000
DESH	5.615	4.708	6.000	8.175	2.667	2.680	5.413	5.456	5.478
DESV	0.981	0.979	2.425	1.775	0.929	1.240	1.152	1.022	1.152
FEEDBK	0	0	0	0	0	0	0	1	0

SUBNUM	37	38	39	40	41	42	43	44	45
GENDER	0	0	0	1	1	0	1	1	0
CLASS	2	2	3	4	4	3	4	2	3
FLY EXP	0	0	0	0	0	0	0	0	0
STRK 1	55.40	48.40	35.05	38.65	34.38	42.40	31.10	38.30	30.45
STRK 2	54.35	46.25	42.30	49.70	42.80	40.20	12.40	35.30	36.40
STRK 3	43.85	46.00	44.65	50.10	43.00	46.80	26.40	46.90	27.05
STRK 4	50.70	49.60	47.80	.	.	49.50	41.50	48.46	26.50
STRK 5	50.50	48.80	47.03	.	.	.	42.60	.	33.50
STRK 6	.	.	.	.	.	.	.	.	32.00
EXIT TRK	50.60	49.20	47.42	49.90	42.90	49.15	42.05	47.75	32.75
SDCTOT 1	58	56	59	61	58	58	64	52	53
SDCTOT 2	60	57	67	60	65	65	63	63	61
SDCTOT 3	66	57	63	66	62	59	66	59	62
SDCTOT 4	64	.	71	68	.	63	.	59	.
SDCTOT 5	.	.	67	.	.	62	.	63	.
SDCTOT 6	.	.	.	.	.	.	.	.	.
EXDCTOT	65.0	57.0	69.0	67.0	63.5	62.5	64.5	61.0	61.5
SDCCOR 1	56	55	57	60	56	57	64	48	52
SDCCOR 2	56	56	66	58	64	63	59	57	61
SDCCOR 3	64	56	62	64	61	58	65	57	60
SDCCOR 4	60	.	70	68	.	62	.	55	.
SDCCOR 5	.	.	64	.	.	61	.	59	.
SDCCOR 6	.	.	.	.	.	.	.	.	.

SUBNUM	37	38	39	40	41	42	43	44	45
EXSDCCOR	62.0	56.0	67.0	66.0	62.5	61.5	62.0	57.0	60.5
MIDTRK	48.65	49.50	51.75	49.90	47.30	45.95	37.80	50.70	28.00
MIDDCTOT	72	69	71	64	66	66	73	62	61
MIDDCCOR	70	69	69	61	64	66	70	57	59
DTRK 1	36.15	37.70	34.50	33.40	32.15	29.50	19.50	31.75	30.50
PROTRK 1	0.723	0.754	0.690	0.668	0.643	0.590	0.390	0.635	0.610
DDCTOT 1	35	24	34	40	36	28	43	43	42
PROPDC 1	0.583	0.400	0.567	0.667	0.600	0.467	0.717	0.717	0.700
DDCCOR 1	33	22	32	39	34	27	42	39	41
DTRK 2	43.50	42.00	44.40	27.65	37.00	42.60	24.15	24.65	31.20
PROTRK 2	0.870	0.840	0.888	0.553	0.740	0.852	0.483	0.493	0.624
DDCTOT	36	26	36	42	39	26	37	45	43
PROPDC 2	0.600	0.433	0.600	0.700	0.650	0.433	0.617	0.750	0.717
DDCCOR 2	34	26	36	41	38	26	37	39	43
DTRK 3	41.05	43.20	37.00	37.40	37.20	43.00	26.75	29.30	19.60
PROTRK 3	0.821	0.864	0.740	0.748	0.744	0.860	0.535	0.586	0.392
DDCTOT 3	39	29	29	45	41	32	45	44	49
PROPDC 3	0.650	0.483	0.483	0.750	0.683	0.533	0.750	0.733	0.817
DDCCOR 3	37	29	28	43	41	32	45	41	49
DTRK 4	43.05	38.70	32.90	37.60	34.50	30.60	20.30	32.65	26.10
PROTRK 4	0.861	0.774	0.658	0.752	0.690	0.612	0.406	0.653	0.522
DDCTOT 4	51	31	40	44	50	39	36	37	47
PROPDC 4	0.850	0.517	0.667	0.733	0.833	0.650	0.600	0.617	0.783

SUBNUM	37	38	39	40	41	42	43	44	45
DDCCOR 4	48	31	39	44	50	38	35	34	46
DTRK 5	35.00	37.40	31.20	42.90	42.70	29.34	41.25	31.00	19.15
PROTRK 5	0.700	0.748	0.624	0.858	0.854	0.587	0.825	0.620	0.383
DDCTOT 5	51	34	48	51	43	46	34	42	43
PROPDC 5	0.850	0.567	0.800	0.850	0.717	0.767	0.567	0.700	0.717
DDCCOR 5	49	33	48	51	43	45	34	39	43
DTRK 6	41.20	34.50	36.60	39.30	38.30	41.80	36.60	31.14	19.70
PROTRK 6	0.824	0.690	0.732	0.786	0.766	0.836	0.732	0.623	0.394
DDCTOT 6	51	37	53	50	48	51	38	39	42
PROPDC 6	0.850	0.617	0.883	0.833	0.800	0.850	0.633	0.650	0.700
DDCCOR 6	50	37	52	48	46	51	37	39	41
DTRK 7	49.20	38.60	38.25	31.20	46.00	28.00	41.45	32.15	19.40
PROTRK 7	0.984	0.772	0.765	0.624	0.920	0.560	0.829	0.643	0.388
DDCTOT 7	46	38	51	51	47	48	38	46	34
PROPDC 7	0.767	0.633	0.850	0.850	0.783	0.800	0.633	0.767	0.567
DDCCOR 7	43	37	49	48	46	47	37	40	34
DTRK 8	33.90	36.20	20.60	40.10	40.80	31.70	31.30	36.50	26.30
PROTRK 8	0.678	0.724	0.412	0.802	0.816	0.634	0.626	0.730	0.526
DDCTOT 8	53	39	48	50	45	44	45	42	39
PROPDC 8	0.883	0.650	0.800	0.833	0.750	0.733	0.750	0.700	0.650
DDCCOR 8	50	39	47	48	44	43	45	39	38
DTRK 9	35.10	35.70	39.30	37.80	37.60	31.10	32.10	36.55	27.50
PROTRK 9	0.702	0.714	0.786	0.756	0.752	0.622	0.642	0.731	0.550

SUBNUM	37	38	39	40	41	42	43	44	45
DDCTOT 9	47	41	42	57	50	46	33	44	47
PROPDC 9	0.783	0.683	0.840	0.950	0.833	0.767	0.550	0.733	0.783
DDCCOR 9	46	41	42	57	50	44	32	39	47
DTRK 10	28.90	31.85	38.00	35.40	38.15	33.75	38.00	27.90	17.80
PROTRK 10	0.578	0.637	0.760	0.708	0.763	0.675	0.760	0.558	0.356
DDCTOT 10	51	40	42	59	45	42	43	41	45
PROPDC 10	0.850	0.667	0.700	0.983	0.750	0.700	0.717	0.683	0.750
DDCCOR 10	50	37	42	58	45	41	41	36	45
CLIMBH	3.640	4.917	6.896	5.239	6.958	4.870	4.870	3.780	2.848
CLIMBV	0.700	0.967	0.375	0.174	0.563	0.844	0.500	0.400	0.370
SANDLH	6.263	4.297	6.842	7.250	5.635	4.878	6.041	1.919	7.377
SANDLV	27.000	24.000	2.000	1.303	13.000	3.500	35.500	22.000	82.500
DESH	4.761	5.280	7.425	5.712	4.680	4.040	8.381	4.250	6.260
DESV	1.065	2.040	1.650	1.865	1.120	1.667	1.714	1.775	0.700
FEEDBK	0	0	1	0	0	0	0	0	2

SUBNUM	46	47	48	49	50	51	53	53	54
GENDER	0	1	0	1	0	0	0	0	1
CLASS	4	4	4	4	2	3	3	4	4
FLY EXP	0	0	0	0	0	0	0	0	0
STRK 1	43.08	33.50	32.50	36.13	43.50	45.90	47.22	32.89	26.70
STRK 2	49.01	36.70	42.40	41.05	51.60	44.80	43.50	49.86	49.40
STRK 3	43.00	42.95	44.85	38.85	51.65	43.75	36.90	51.14	52.00
STRK 4	46.50	38.25	.	.	.	50.45	48.65	.	49.70
STRK 5	43.30	44.25	.	.	.	49.70	42.83	.	48.70
STRK 6	50.40	.	.	.	.	.	41.75	.	.
EXIT TRK	46.85	41.25	43.63	39.85	51.62	50.08	42.29	50.50	49.20
SDCTOT 1	65	50	51	52	47	54	61	54	50
SDCTOT 2	68	57	59	59	47	62	59	70	59
SDCTOT 3	70	56	61	60	49	62	65	67	57
SDCTOT 4	.	.	.	.	.	.	62	67	.
SDCTOT 5	.	.	.	.	.	.	.	.	.
SDCTOT 6	.	.	.	.	.	.	.	.	.
EXDCTOT	69.0	56.5	60.0	59.5	48.0	62.0	63.5	67.0	58.0
SDCCOR 1	64	47	49	49	45	53	61	53	49
SDCCOR 2	68	56	57	56	45	62	58	69	59
SDCCOR 3	68	56	61	59	48	62	64	67	57
SDCCOR 4	.	.	.	.	.	.	59	64	.
SDCCOR 5	.	.	.	.	.	.	.	.	.
SDCCOR 6	.	.	.	.	.	.	.	.	.

SUBNUM	46	47	48	49	50	51	52	53	54
EXSDCCOR	68.0	56.0	59.0	57.5	46.5	62.0	61.5	65.5	58.0
MIDTRK	49.80	46.70	45.00	46.10	52.90	49.40	41.87	49.55	47.72
MIDDCTOT	72	55	68	66	62	72	57	74	63
MIDDCCOR	71	55	67	65	59	71	57	72	63
DTRK 1	46.30	33.00	38.30	26.90	37.00	44.40	26.75	44.40	43.00
PROTRK 1	0.926	0.660	0.756	0.538	0.740	0.888	0.535	0.888	0.860
DDCTOT 1	36	39	31	34	32	36	25	34	35
PROPDC 1	0.600	0.650	0.517	0.567	0.533	0.600	0.417	0.567	0.583
DDCCOR 1	35	39	30	33	32	34	25	33	35
DTRK 2	36.37	31.50	35.50	38.80	46.10	39.10	32.60	39.00	41.90
PROTRK 2	0.727	0.630	0.710	0.776	0.922	0.782	0.652	0.780	0.838
DDCTOT 2	27	37	34	43	35	34	33	30	33
PROPDC 2	0.450	0.617	0.567	0.717	0.583	0.567	0.550	0.500	0.550
DDCCOR 2	27	35	34	43	35	34	33	30	33
DTRK 3	38.53	31.30	40.90	30.20	45.40	42.15	27.60	29.64	47.65
PROTRK 3	0.771	0.626	0.818	0.604	0.908	0.843	0.552	0.593	0.953
DDCTOT 3	32	42	40	40	36	43	33	30	37
PROPDC 3	0.533	0.700	0.667	0.667	0.600	0.717	0.550	0.500	0.617
DDCCOR 3	32	42	40	39	36	42	33	30	37
DTRK 4	33.20	31.20	35.10	35.90	33.40	40.70	35.90	33.45	37.25
PROTRK 4	0.664	0.624	0.702	0.718	0.668	0.814	0.718	0.669	0.745
DDCTOT 4	57	41	38	41	41	54	33	36	36
PROPDC 4	0.950	0.683	0.633	0.683	0.683	0.900	0.550	0.600	0.600

SUBNUM	46	47	48	49	50	51	52	53	54
DDCCOR 4	56	41	37	39	41	54	33	36	36
DTRK 5	37.10	26.35	34.70	32.10	31.60	34.30	33.65	33.62	40.00
PROTRK 5	0.742	0.527	0.694	0.642	0.632	0.686	0.673	0.672	0.800
DDCTOT 5	50	43	41	45	43	53	30	41	38
PROPDC 5	0.833	0.717	0.683	0.750	0.717	0.883	0.500	0.683	0.633
DDCCOR 5	49	42	41	43	41	51	30	39	38
DTRK 6	49.83	28.20	36.25	33.70	36.40	32.60	36.30	31.80	41.70
PROTRK 6	0.997	0.564	0.725	0.674	0.728	0.652	0.726	0.636	0.834
DDCTOT 6	50	48	39	45	41	60	36	52	42
PROPDC 6	0.833	0.800	0.650	0.750	0.683	1.000	0.600	0.867	0.700
DDCCOR 6	49	47	39	44	40	59	35	51	42
DTRK 7	35.45	32.50	29.50	23.15	35.50	30.70	35.55	36.70	43.70
PROTRK 7	0.709	0.650	0.590	0.463	0.710	0.614	0.711	0.734	0.874
DDCTOT 7	46	39	41	45	45	52	31	36	46
PROPDC 7	0.767	0.650	0.683	0.750	0.750	0.867	0.517	0.600	0.767
DDCCOR 7	45	39	39	45	43	50	30	36	45
DTRK 8	33.60	35.35	31.25	37.60	33.80	31.20	38.85	39.68	46.40
PROTRK 8	0.672	0.707	0.625	0.752	0.676	0.624	0.777	0.794	0.928
DDCTOT 8	39	38	44	40	45	56	41	35	41
PROPDC 8	0.650	0.633	0.733	0.667	0.733	0.933	0.683	0.583	0.683
DDCCOR 8	38	38	44	40	43	53	41	34	41
DTRK 9	33.85	30.00	41.00	28.70	33.10	39.00	36.80	38.15	33.63
PROTRK 9	0.677	0.600	0.820	0.574	0.662	0.780	0.736	0.763	0.673

SUBNUM	46	47	48	49	50	51	52	53	54
DDCTOT 9	50	36	44	37	48	48	42	53	47
PROPDC 9	0.833	0.600	0.733	0.617	0.800	0.800	0.700	0.883	0.783
DDCCOR 9	48	36	44	36	48	48	42	49	46
DTRK 10	36.45	29.94	38.90	29.85	30.50	39.60	40.50	37.00	34.00
PROTRK 10	0.729	0.599	0.778	0.597	0.610	0.792	0.810	0.740	0.680
DDCTOT 10	54	43	45	38	47	53	42	59	37
PROPDC 10	0.900	0.717	0.750	0.633	0.783	0.883	0.700	0.983	0.617
DDCCOR 10	53	40	45	38	46	52	42	57	37
CLIMBH	9.313	5.540	6.452	7.146	4.591	2.674	8.229	6.714	3.804
CLIMBV	2.063	0.440	1.516	1.313	0.886	0.522	0.938	1.018	1.000
SANDLH	6.986	4.324	3.230	3.816	2.592	6.770	8.200	6.069	5.138
SANDLV	35.0	21.5	4.0	13.0	5.0	42.5	6.0	33.0	10.0
DESH	8.150	5.600	3.900	7.775	2.396	3.520	7.350	7.075	6.103
DESV	1.925	2.600	1.600	3.400	0.833	1.500	3.275	3.325	1.125
FEEDBK	2	0	0	0	0	0	0	0	0

SUBNUM	55	56	SUBNUM	55	56	SUBNUM	55	56
GENDER	1	0	EXSDCCOR	60.0	62.5	DDCCOR 4	29	28
CLASS	4	2	MIDTRK	39.36	53.80	DTRK 5	36.9	30.7
FLY EXP	0	0	MIDDCTOT	65	68	PROTRK 5	0.738	0.614
STRK 1	40.13	43.68	MIDDCCOR	63	57	DDCTOT 5	33	40
STRK 2	47.47	44.78	DTRK 1	29.15	37.58	PROPDC 5	0.550	0.667
STRK 3	40.29	36.47	PROTRK 1	0.583	0.752	DDCCOR 5	33	37
STRK 4	42.48	48.22	DDCTOT 1	33	32	DTRK 6	25.6	30.4
STRK 5	41.50	46.56	PROPDC 1	0.550	0.533	PROTRK 6	0.512	0.608
STRK 6	.	46.95	DDCCOR 1	33	32	DDCTOT 6	38	43
EXIT TRK	41.99	46.76	DTRK 2	27.50	31.54	PROPDC 6	0.633	0.717
SDCTOT 1	58	60	PROTRK 2	0.550	0.631	DDCCOR 6	38	42
SDCTOT 2	61	62	DDCTOT 2	35	28	DTRK 7	34.72	29.64
SDCTOT 3	60	64	PROPDC 2	0.583	0.467	PROTRK 7	0.694	0.593
SDCTOT 4	.	.	DDCCOR 2	35	28	DDCTOT 7	31	46
SDCTOT 5	.	.	DTRK 3	26.70	32.84	PROPDC 7	0.517	0.767
SDCTOT 6	.	.	PROTRK 3	0.534	0.657	DDCCOR 7	31	45
EXDCTOT	60.5	63.0	DDCTOT 3	40	29	DTRK 8	27.00	36.34
SDCCOR 1	57	58	PROPDC 3	0.667	0.483	PROTRK 8	0.540	0.727
SDCCOR 2	61	62	DDCCOR 3	39	27	DDCTOT 8	38	37
SDCCOR 3	59	53	DTRK 4	26.50	37.35	PROPDC 8	0.633	0.617
SDCCOR 4	.	.	PROTRK 4	0.530	0.747	DDCCOR 8	37	34
SDCCOR 5	.	.	DDCTOT 4	29	30	DTRK 9	29.05	38.00
SDCCOR 6	.	.	PROPDC 4	0.483	0.500	PROTRK 9	0.581	0.760

SUBNUM	56	56
DDCTOT 9	41	43
PROPDC 9	0.683	0.717
DDCCOR 9	40	42
DTRK 10	35.1	36.1
PROTRK 10	0.702	0.722
DDCTOT 10	41	47
PROPDC 10	0.683	0.783
DDCCOR 10	41	47
CLIMBH	8.196	8.352
CLIMBV	0.935	0.777
SANDLH	2.432	6.000
SANDLV	20.5	11.0
DESH	5.577	8.650
DESV	1.962	2.350
FEEDBK	0	0

Appendix F

Single and Dual-Task Performance Variables

Single and Dual-Task Performance Variables

MAXST = Max single tracking score

MINST = Minimum single tracking score

DIFFST = MAXST-MINST

IMAXST = Trial on which max single tracking score occurred

IEXITST = Single tracking exit trial

MAXSDCT = Max single digit - canceling total response score

MINSDCT = Minimum single digit - canceling total response score

DIFFSDCT = MAXSDCT-MINSDCT

IMAXSDCT = Trial on which max single digit - canceling total response occurred

IEXTSDCT = Single digit - canceling total exit trial

MAXSDCCO = Max single digit - canceling correct response score

MINSDCCO = Minimum single digit - canceling correct response score

DIFFSDCC = MAXSDCCO-MINSDCCO

IMAXSDCC = Trial on which max single digit - canceling correct response score occurred

MIDTRK = Single tracking check trial score

MIDDCTOT = Single digit - canceling total check trial score

MIDDCCOR = Single digit - canceling correct check trial score

MAXDTRK = Tracking score for max dual trial

MAXPROTK = Tracking score for max dual trial/50

MAXDDCTO = Total digit responses for max dual trial

MAXPRODC = Total digit responses for max dual trial/60

MAXOKSUM = MAXPROTK + MAXPRODC

TRIALNO = Trial on which max dual performance occurred

OKTRIALS = Number of dual trials where the difference between tracking and digit - canceling proportions was .10 or less

PROTRKMX = Dual tracking score / max single tracking score

PRODCTMX = Dual digit - canceling total response score / max single digit - canceling total response score

PRODCCMX = Dual digit - canceling correct response score / single digit - canceling correct response score

TSMAXDCT = PROTRKMX + PRODCTMX

TSMAXDCC = PROTRKMX + PRODCCMX

PROTRKMD = Dual tracking score / single tracking check trial score

PRODCTMD = Dual digit - canceling total response score / single digit - canceling total check trial score

PRODCCMD = Dual digit - canceling correct response score / single digit - canceling correct check trial score

TSMIDDCT = PROTRKMD + PRODCTMD

TSMIDDCC = PROTRKMD + PRODCCMD

DATE

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