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PROPOSAL FOR

PUBLISHABLE RESEARCH PAPER

to fulfill degree requirements for

Masters of Science in Public Health

University of Colorado Health Science Center

ASSESSMENT OF TWO DEPTH PERCEPTION TESTS

TO PREDICT

UNDERGRADUATE PILOT TRAINING COMPLETION

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22 May 1991

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ABSTRACT

Ophthalmologists at the USAF School of Aerospace Medicine suspect one of the two depth perception tests used to screen candidates for Undergraduate Pilot Training (UPT) inadequately evaluates depth perception abilities required to operate high performance jet aircraft. They hypothesize that candidates passing only the Verhoeff test for near stereopsis have higher attrition rates from UPT than candidates passing the VTA, a test of distant stereopsis. A historical prospective study will be used to test this hypothesis. A cohort of students attending USAF UPT during Fiscal Year 1990 will be compared. UPT attrition rates will be compared among type of depth perception test passed. Multiple logistic regression methods will be used to study attrition rate increases. Confounding variables evaluated include: commissioning source, previous flying experience, training base assigned, degree of phoria and gender of student. If this hypothesis is validated, the USAF may amend its pre-selection depth perception criterion for medical qualification of UPT candidates, thus resulting in significant financial savings to the US Air Force.

EXECUTIVE SUMMARY

Objective: To determine if the VTA, a depth perception test measuring distant stereoacuity, better predicts successful completion of Undergraduate Pilot Training than the Verhoeff test of near stereoacuity.

Design: Historical prospective (cohort)

Setting: U.S. Air Force Undergraduate Pilot Training (UPT) bases

Subjects: USAF pilot candidates entering UPT during FY 90

Interventions: None

Measurements:

1) Outcome variable: UPT outcome (graduate vs. attrit)
2) Independent variable: type of depth perception test passed at medical screening (VTA vs. Verhoeff)
3) Covariates: degrees of phoria, commissioning source, sex, near point of accommodation, UPT base assigned, previous flying experience

Methods:

1) Univariate analyses will be used to determine confounding, potential effect modification, and interactions of independent variables;
2) Multiple stepwise logistic regression will be used for modelling the probability of attrition

Significance: Pre-selection medical screening tests predictive of UPT outcome may change medical qualification criteria for UPT resulting in lower attrition rates and significant financial savings to the United States Air Force.

SPECIFIC OBJECTIVES

Level One Hypothesis:

This study will test for a possible association between type of depth perception test passed by USAF pilot candidates at pre-selection medical screening and outcome of UPT.

Level Two Hypothesis:

Pilot candidates passing the Depth Perception Apparatus - Verhoeff (DPA-V) test for near stereoacuity have higher attrition rates from UPT than pilot candidates passing the Vision Testing Apparatus (VTA) test for distant stereoacuity.

Several level three hypotheses could not be tested and are subjects for future research. They include:

1. Pilot candidates passing the DPA-V test for depth perception have higher attrition rates from UPT than candidates passing the VTA test because the DPA-V tests near stereoacuity which is not used in flying where the VTA tests distant stereoacuity which is used in some phases of flight training.
2. Among pilot candidates who successfully complete UPT, those passing the VTA test for distant stereoacuity are assigned to fighter/bomber type of aircraft in higher proportions than those who failed the VTA but passed the DPA-V test for near stereopsis because instructor recommendations for fighter/bomber aircraft are weighted on performance in phases of UPT requiring the use of distant stereopsis.

BACKGROUND

The cost of Undergraduate Pilot Training (UPT) in the United States Air Force (USAF) is approximately $250,000 per pilot. Attrition from UPT significantly increases the cost per pilot trained and cost the USAF $37 million in 1988[1]. Pre-selection screening of UPT candidates, including extensive medical/visual testing, is used to decrease attrition from UPT. Despite this screening, during FY 90, total attrition for any reasons was 423 students from 1800 UPT entrants (23.5%)[2]. This compares similarly to previous years' attrition rates.

The USAF is currently upgrading the pre-selection screening processes for pilot candidates. A system is being designed to support Specialized Undergraduate Pilot Training (SUPT). This process will pre-assign pilot candidates to one of two types of aircraft, fighter/bomber or tanker/transport based on results of screening tests[3]. The pilot selection and classification system (PSACS) will continue to include vigorous medical screening with extensive visual testing. Any visual test found to have predictive value for attrition from UPT or aircraft of assignment after successful completion of UPT could be incorporated into the PSACS since it could potentially reduce financial and personnel costs associated with UPT/SUPT to the Air Force.

Depth perception testing of military pilot candidates has been used since WWI[4]. The U S Air Force currently uses two "depth perception" tests in screening pilot candidates, the VTA-ND (Bausch and Lomb Ortho-Rater) stereoacuity test and the Verhoeff (DPA-V) test for stereoacuity[5]. A third test, administered by the USAF School of Aerospace Medicine (USAFSAM), the Howard-Dolman Apparatus for depth perception, is permitted but is very rarely used. Its results are not as reproducible as the other tests and are prone to error through the use of monocular cues[6].

To successfully pass the depth perception portion of visual screening, the UPT candidate must pass one of the two tests[5]. By USAF policy, the VTA, which measures distant (> 6 meters) stereoacuity, is administered first. Candidates passing the VTA pass the screening criterion for depth perception without further testing. Those who fail the VTA (approximately 15%) then take the DPA-V, which measures steroacuity at near (1 meter). Passing the DPA-V at this stage qualifies the candidate for pilot training with respect to the depth perception portion of pre-selection medical screening. Failing the DPA-V results in medical disqualification for UPT. Practically, either the VTA or the DPA-V are administered first and the first test passed is recorded on the "Report of Medical Examination, SF 88".(Appendix 1) Those UPT selectees graduating from the USAF Academy and entering UPT since July 1990 are the single group to universally have the VTA administered initially with the DPA-V administered only to those failing the VTA (personal communication, R Hernandez and M Green).

Ophthalmologists at USAFSAM suspect that UPT candidates passing the DPA-V but failing the VTA have a condition known as microtropia. The reduced stereoacuity associated with microtropia is thought to cause poorer performance in UPT and higher attrition rates. (personal communication, Col (Dr.) Robert Green) UPT graduates with the most favorable final evaluations are generally assigned to fighter/bomber aircraft while other graduates tend to receive assignments to tankers and transports.

Microtropia is described in the medical literature by several authors using a variety of terms and definitions. Jampolsky in 1957[7] used the term "fixation disparity" to describe a very small strabismus (ocular misalignment). Parks coined the term "monofixation phoria" in 1961[8] to describe the absence of bifoveal fusion in well adapted small angle esotropias. Helveston and von Noorden (1967) used a very narrow clinical definition for the entity they called "microtropia"[9], an ultra small angle strabismus with specific sensory adaptations using eccentric parafoveal fixation for both monocular and binocular fixation, thus masking the underlying tropia. Lang accepted a broader definition of "microtropia" or "microstrabismus" in 1968 to include all sensorially compensated small angle esotropias and divided the entity into primary and secondary forms[10]. Epstein and Tredici were the first to describe microtropia in flying personnel, and specifically tested USAF pilots referred to USAFSAM with all three of the currently accepted depth perception tests for military aviators[11]. They found that higher degrees of stereoacuity and less amblyopia (a unilateral or bilateral reduction in corrected central visual acuity without a visible organic lesion commensurate with this loss[12]) than previously described in this condition. Dr. Tredici is still on the USAFSAM Ophthalmology Division faculty and is considered the premier expert in military aviation ophthalmology.

Microtropia is a deviation of the eyes from parallel visual axes that is too small to detect by an examiner on conventional examination [12]. This entity lies midway in a spectrum between orthophoria and visual tropias. Orthophoria is the rare entity of perfect alignment of the eyes' visual axes at all times with fixation in the central fovea, the small area of the retina with the best visual acuity. The most common finding (98-99%) is a heterophoria, the tendency of eyes to move out of alignment when binocular fixation is interrupted or in conditions of fatigue, stress, or visual strain. Up to six degrees of lateral phoria and one degree of vertical phoria are acceptable for USAF pilots[5]. A tropia is a manifest or overt phoria that is continuously present. No degree of tropia is permitted for USAF pilots[5]. Microtropia is continuously present but not observable to the unaided examiner because of the small degree of ocular misalignment. Microtropes tend to have parafoveal fixation with anomalous retinal correspondence (images on slightly offset corresponding retinal locations) that is well adapted and results in only a slightly reduced stereoacuity. Often microtropia is a result of anisometropia (different visual acuities in each eye).

Depth perception is usually a subconscious, though sometimes conscious, sensation that results from an integration of visual cues in the visual cortex of the brain. Because depth perception involves integration of various cues, some components of depth perception can be learned. The visual cues to depth perception fall into two broad categories, monocular and binocular cues. The USAF tests for "depth perception" in reality only measure a subset of binocular cues, stereoacuity. Thus the VTA and DPA-V are more accurately termed stereoacuity tests.

Aviation requires the frequent use of depth perception. The military aviator is generally exposed to more strenuous physiologic challenges during flight than his/her civilian counterpart. Supersonic speeds, high G-loading, formation flight, in-flight refueling, use of night vision devices, potential hypoxemia, low level operations, and searching for multiple targets at the extremes of visual limits are examples of increased visual demands on the military pilot. The civilian pilot tends to use monocular cues to depth perception during routine flight profiles. Stereopsis is probably required during landing at minima, formation flying, in-flight refueling, and operations in space such as extra vehicular activity, docking, and lunar landing, conditions which are more common in military aviation.[6,13]

Monocular cues to depth perception in aviation include[6,13-15]:

size constancy/relative size, interposition of objects, motion parallax, geometric perspective, texture gradient, aerial perspective, height in the plane, shadows, brightness / color contrasts, apparent fore-shortening, movement perspective, and kinetic effect.

Size constancy, the known size of a familiar object relative to the size of the image on the retina, and motion parallax, the apparent greater movement of a near object than a distant object, are the two strongest monocular cues to depth perception in aviation[14]. A pilot can operate using only monocular cues through training and experience, but these cues are subject to illusions. Wiley Post is a well known example of a monocular pilot and the Federal Aviation Administration will allow pilots who have lost an eye to fly after a period of learning to consciously utilize monocular cues[16]. The FAA will not permit monocular non-pilots to obtain a medical certificate.

Binocular cues to depth perception include convergence, accommodation and stereopsis. Convergence is the inward deviation of the eyes when looking at very near (< 1 meter) objects in an attempt to maintain binocular central foveal fixation. Accommodation describes the increasing thickness of the lens of the eye by tightening the ciliary muscles to maintain the sharpest retinal focus on a near object. Accommodation and convergence occur simultaneously, deteriorate with increasing age, and are not useful as depth perception cues at distances greater than one meter. Therefore, they are not useful to the pilot during flight. A Russian study states that convergence is useful in landing at distances up to 30-50 meters in 75% of pilots, but they did not eliminate stereoscopic cues[17].

Stereopsis, as described by Tredici, "is the visual apnreciation of three dimensions during binocular vision, occurring during fusional signals from slightly disparate retinal points, which cause different retinal images in each eye but do not cause diplopia" (double vision)[14]. Ogle described two components to stereopsis in 1967, an obligatory quantitative component and a more vague qualitative or facultative component[18]. The former represents what is now called stereopsis, while the latter probably represents accommodation and convergence components. Stereoacuity is the measure of steropsis expressed in arc seconds of resolution. Stereopsis is a cue to relative, rather than absolute, distances[13] and therefore is useful in judging distances between unfamiliar objects or in situations lacking monocular cues, such as night time refueling or formation flight in hazy weather. The civilian pilot may use stereopsis when judging wing tip clearance distance when parking next to another plane.

The maximum distance at which stereopsis is useful as a visual cue in distance[6,13,14] is dependent on the interpupillary distance, arc seconds of stereoacuity in an individual and the distance between two objects being compared. Useful limits of stereopsis are said to range from 30 meters[13], to 200 meters[14,19], to 1 mile[6] while theoretic limits of stereopsis range from 1300 m[14] to 7420 m (4 miles)[6] based on 2 arc sec of stereoacuity. Distinguishing between the theoretic and practical limits of stereoacuity is nearly impossible because of the numerous monocular cues always available to the binocular observer. A general rule is that as objects are nearer to an observer, stereoscopic visual cues increase.

The value of stereopsis in military aviation is undetermined. Tredici initially considered it "essential to the completion of flight training"[11], but later states, "This is not to imply that stereopsis is an absolute must in flying an aircraft because numerous individuals who lack stereopsis still make good aviators"[14]. Karlsenberg et al state "[For] demanding aerospace activities, a high degree of stereoacuity is probably necessary for maximum performance"[6] and advocates stereoscopic threshold testing for naval aviators. Roman et al[20] found no increased landing error in military pilots with artificially restricted fields of vision simulating monocular conditions while Lewis and Krier[21] showed landing performance did not decrease in military pilots with alternate eyes patched during landing. Both of these studies utilized trained pilots landing at their home bases in ideal daytime conditions, a situation with plentiful monocular cues to depth perception. Cibis[22] (1952), of USAFSAM, lists several authors who demonstrate binocular depth perception does not correlate with flying ability. He concluded that binocular testing was not appropriate for testing pilot candidates for high speed aircraft and that flying ability could be improved by training pilots to better utilize monocular cues. Sheehy and Wilkinson[23] found that military helicopter pilots had decreased performances on stereoscopic depth perception tests after using night vision goggles. Clapp[24] argues strongly for stereoscopic imagery in training scenarios of simulated inflight refueling, formation flight and low level flight. I conclude that stereoscopic depth perception, while not required for most flight conditions, may compliment and enhance flying abilities in these situations. Stereopsis is most utilized during unfamiliar flight conditions, marginal weather conditions, and in proximity to other aircraft or the ground. These are all conditions the military fighter/bomber pilot routinely encounters.

Few studies comparing results of visual testing with performance in military flight training are available. Bohnker et al[25] showed a significant ($p=0.029$) increase in the likelihood of naval student aviators with waivers for uncorrected visual acuity less than 20/20 to complete flight training when compared to student aviators not requiring visual waivers. Carretta[26] showed spatial ability, as measured by performance on a visual Mental Rotation test given prior to UPT, was not related to pass/fail measures from UPT, but was positively correlated with recommendations for post UPT assignments to fighter type aircraft. Kruk et al[27] studied flight performance in advanced simulators for pilot training and found that for student pilots, landing performance strongly correlated with ability to track targets appearing to move in depth. Experienced instructor pilots performed much better than students making flying experience an important confounder. Buzelli et al[28] and Lyons[29] call for research into dynamic visual testing as a predictor for pilot performance.

This is the first study relating two screening tests measuring different aspects of stereoscopic depth perception (near and distant) to performance in UPT. If a relationship is found between predicting UPT outcome and one of the two tests, pre-selection medical screening criteria may be amended for USAF UPT applicants. Amending selection criteria would potentially result in lower UPT attrition rates. Also, a more useful visual screening criterion could be developed for pilot classification in the SUPT program which will soon be instituted. The net savings to the USAF for 1% decrease in attrition from UPT is estimated to be approximately $1 million.

METHODS

SUBJECTS

Subjects to be studied will include all USAF pilot candidates entering UPT during the period Nov 89 - Nov 90. Pilot candidates selected to attend Euro-NATO Joint Jet Pilot Training (ENJJPT) at Sheppard Air Force Base will be included in my preliminary analysis but may later be excluded because their selection to this program is based on previously demonstrated flying abilities. Student pilots from allied nations will be excluded because of: 1) inadequate control on administration medical screening tests, 2) differential flying experience from USAF candidates, and 3) special efforts to retain these students in UPT beyond the point where a USAF student would be involuntarily attrited. Otherwise, candidates from all commissioning sources are included in these analyses.

The subjects are of both sexes (11% female) and range in age from 21 to 26 years on entry to UPT. They have: at least a bachelors degree; have undergone a standardized medical examination administered at many sites; met uniform criteria; and have all volunteered for pilot training. Prior to entering UPT, each has a minimum of 14 hours of flight instruction in a single engine aircraft or has a pilot's license. Most candidates from the USAF Academy have also been trained for solo flight in a glider and have 22 hours of flight instruction in single engine aircraft.

SAMPLING

A one hundred percent sample of all candidates from this period will be used. Headquarters, Air Training Command (HQ ATC) maintains an electronic data base of all UPT entrants, with results of UPT (pass vs. attrit by specific reason for attrition). HQ ATC also maintains medical records including a Standard Form 88 on each candidate for the duration of their attendance at UPT and until the end of the fiscal year for those attriting. The SF 88 (Appendix 1) includes SSAN, type of depth perception tests taken and the results, and results of all other visual tests.

A preliminary sequential sample, by alphabetized last name, of two hundred USAF Academy cadets qualified for pilot training yielded proportions of 85.5% passing the VTA stereoscopic test and 14.5% passing the DPA-V. Sample size calculations using one and two-sided Z tests for independent proportions are shown in Appendix 2. Approximately 1500 subjects are available for the study and the baseline pass rate from UPT for all students is 77%. This gives an 80% power to detect a difference in UPT attrition of 8% using a one-sided test and an attrition difference of 9% using a two-sided test. Because my level two hypothesis predicts the VTA is positively correlated with successful completion of UPT, a one sided test is appropriate.

INSTRUMENTATION

The dependent variable, UPT outcome, is coded on HQ ATC data tapes as a "transaction code". "N22" indicates graduation from UPT. "E5X" indicates attrition with the X indicating the reason for attrition. Possible reasons include deficiencies in flying skills, academics, military training and medical status as well as manifestations of apprehension, self initiated elimination and other causes. I would not expect attrition due to defective distant stereopsis to fall exclusively in any single category, although it would tend to be catagorized as flying deficiency, medical status, manifestations of apprehension, or self-initiated elimination.

The USAF is concerned with attrition from *any* cause rather than a *specific* cause since attrition for every reason is equally costly. Therefore, stratifying by reason for attrition serves no practical purpose and would markedly reduce the power of the study. Such a stratification could generate new hypotheses about reasons for attrition but these would be difficult to test given current data limitations.

The independent variable of primary interest, type of stereoscopic depth perception test passed at pre-UPT selection medical screening (VTA vs DPA-V), is recorded on the SF 88. Both tests are administered at a USAF Flight Surgeon's Office by

Aerospace Medicine technicians trained to perform the tests according to the standards set in AFR 160-17[30].

The VTA test for stereopsis is one of several tests in the standard Armed Forces Visual Testing Apparatus (Ortho-Rater by Bausch and Loomb). The test is administered through a set of lenses that place the visual target at 6.1m (20 feet) and thus measures distant stereopsis. The VTA uses a series of horizontal rows of circles, five circles in each row, three rows to a block, each measuring a unique degree of stereoacuity (80 to 15 arc sec). One of the five circles in each appears closer than the others. The examinee is shown a lucite block with a row of four circles, one obviously nearer than the others, even to the monocular observer, as a demonstration. The examinee is then asked to name the closer circle in each of the three rows of each block. Each block (labelled A, B, C, D, E, and F) requires progressively finer degrees of stereoacuity to answer correctly. A single wrong answer constitutes a failure. To pass the test, the examinee must answer correctly on all rows through block D (25 arc seconds). If the examinee answers block E (20 arc seconds) or block F (15 arc sec) correctly, the results are recorded to the smallest degree of stereoacuity passed on the SF 88. Erroneous passing of this test can result from the technician allowing multiple guesses for wrong responses until the correct response is achieved or by falsification of the results. Both types of errors are very unlikely.

The DPA-V test is administered using a small (2" x 4" x 8") hand-held back-lit box with three movable black bars of unequal width (to override the monocular cue of size constancy). One of the three bars is either nearer or more distant than the other two depending on their positioning by the examiner. Four presentations of near or distant are possible and by inverting the box, a total of eight presentations are possible. The test is given at a distance of 1 meter and the examinee is not permitted to move his head during the test (to override the monocular cue of motion parallax). To pass the test, the examinee must answer all eight presentations correctly. If a single answer is incorrect, 16 additional presentations are given with a perfect score required to pass. Successful completion requires 16.38 arc sec of stereoacuity at near. Improper administration of this test will result in candidates with deficient near stereopsis passing the test. If the technician does not hold the Verhoeff testing apparatus perpendicular to the examinee's line of sight or if the examinee moves his/her head and/or alternately closes each eye, additional monocular cues to depth perception are possible. Thus, true stereopsis would not be tested in isolation from other cues. I suspect passing the Verhoeff as a result of these types of errors account for less than ten percent of the total passing this test.

In 1988, the USAF directed that the initial depth perception test should be the VTA followed by the DPA-V for those failing the VTA[5]. Passing either test meets the criterion for depth perception standards for flight training. Failure of both eliminates a candidate from consideration for UPT. Prior to the 1988 directive, the tests were not administered in any particular sequence, thus some UPT candidates qualified for the depth perception criterion by taking and passing only the DPA-V. Since the directive, UPT candidates commissioned through the USAF Academy have the depth perception tests administered in the prescribed manner. This cohort began to enter UPT in July 1990. UPT candidates from other commissioning sources may or may not have had both tests administered sequentially because of equipment availability. In most cases, if the VTA was failed but the Verhoeff was passed, the SF 88 (block 65) will indicate this sequence. In some cases, only the results of the DPA-V are noted on the SF 88 and the results of the VTA (if it was administered) are not known. Subjects in this catagory will be addressed separately as discussed in the Analyses section.

Other independent variables of interest include commissioning source (USAF Academy, Reserve Officer Training Corps, or Officer Training School), sex of the candidate, degrees of esophoria (eyes in), degrees of exophoria (eyes out), degrees of hyperphoria (eyes up/down), near point of accommodation (closest point one can focus vision measured in centimeters), and hours of previous flying experience. These are all recorded on the SF 88. Location of UPT base attended (Williams, Vance, Laughlin, Reese, Columbus, or Sheppard AFB) is recorded on the HQ ATC data tapes.

DATA CODING

Data from HQ ATC tapes are in ASCII format and will be converted to a SAS dataset. Variables will be recoded as noted below. Information extracted from the SF 88 will require hand entry into a database/data entry systemand subsequently converted to a SAS dataset for analysis.

Depth perception test passed at screening will require coding as a trichotomous variable (pass VTA / fail VTA, pass DPA-V / pass DPA-V, VTA not noted) because of the DPA-V being administered to some candidates prior to the VTA. Candidates in this last category will be addressed separately in the analysis phase.

The outcome from UPT will be recoded as polychotomous numeric variable (pass / fail-flying / fail-academic / fail-military / fail-medical / fail-MOA / fail-SIE / fail-other) for historical tracking purposes. However, during the analysis phase, UPT outcome will be collapsed to a dichotomous variable (pass / fail). The base attended will be coded as a nominal variable with six levels, each representing one UPT base. Gender of the student is dichotomous while degrees of phorias and hours of flying experience are recorded as continuous variables.

ANALYSES

Simple descriptive distributions of the independent variables stratified by the outcome variable will be presented in tabular form and displayed as rates or means and standard errors. SAS Proc Freq and Proc Univariate will be used for these determinations.

Preliminary to multivariate analysis, ini ial investigations will utilize measures of association for comparing the dependent variable (UPT outcome) with each of the independent variables and comparing the independent variable of interest (stereoacuity test) with the other confounding or adjustment variables. These univariate analyses will help identify variables that could significantly influence the risk ratios. The univariate analyses will categorize possible confounding and effect modifiers.

During the analysis, candidates passing the DPA-V with an unknown VTA result will be eliminated from the sample in one analysis and included as a third catagory in a separate analysis. My preliminary survey revealed 85.5% of UPT candidates passed the VTA when administered first, but there is no study published describing the percentage of people passing the DPA-V who would also pass the VTA.

The final analyses will consist of stepwise multiple logistic regression methods for assessing stereoscopic depth perception test passed as an early predictor of UPT outcome while adjusting for any of the other independent variables remaining after the preliminary analysis. P-values for statistical tests with confidence intervals will be reported at a 0.05% level of significance. The power of all analyses presented in the study is 0.80 based on sample size available. Estimates of power for this study are based on binomial proportions which generate the most conservative estimates. Using multivariate regression will increase the power to detect a smaller difference in attrition rates between candidates in the two categories of depth perception test results. Regression analyses will also allow the use of a smaller sample size than that predicted using binomial proportions to detect significant differences in attrition rates at a given power.

If an excess risk for UPT attrition is associated with one type of depth perception test, that test may be eliminated as an acceptable screening criterion for UPT. These analyses will therefore be used to predict the increased risk of attrition from UPT given the ability to pass only the DPA-V screening test for stereopsis rather than for modelling UPT outcome.

ANTICIPATED PROBLEMS

Not all students passing the Verhoeff (near) will have previously failed the VTA (distant) test of stereopsis. Some of this group would have passed the VTA if it was administered first. Including this group in the high risk (DPA-V pass, VTA fail) cohort will cause a classification bias in the study in favor of the null. Excluding them form the analysis or including them as a third group should not bias the study but will decrease the power of the study.

Because UPT students attending Euro-NATO pilot training have been selected for their demonstrated flying ability, I would expect lower attrition rates in this group. I do not know *a priori* whether this group will have higher proportions passing one stereopsis test or another and, therefore, cannot predict the direction of bias. I suspect a bias in favor of the null but a frequency analysis for this subpopulation will reveal the direction of the bias early in the study.

Coding from medical records is subject to operator input error. Time restrictions due to space limitations on storage of medical records at HQ ATC forcing destruction of the records by Nov 91 may preclude me from double entering the data. I will code the last name of each student and read back the data entered to a technician at HQ ATC prior to destroying an individual's record. I see no bias in this study in favor of the alternate hypothesis.

AREAS FOR FURTHER STUDY

I do not suspect the differences in UPT attrition will differ as much as 8% in the two groups. With the sample size available fixed, I do not expect to disprove the null hypothesis. Two potential future studies readily evolve from this pilot study. First, a longer duration of study utilizing a similar structure is possible. This has two distinct advantages. One, the sample size and power will increase so that differences in attrition rates of as low as 5% could be detected with a power of 0.80. Two, all candidates entering UPT from FY 91 and later will have taken the VTA distant test for stereopsis and only those failing this will take the Verhoeff. This will yield a more homogenous classification of the independent variable of interest.

Secondly, a study of UPT outcomes to include aircraft of assignment (fighter/bomber vs tanker/transport) is more likely to show an association with type of depth perception test passed at screening, similar to Carretta's study[26]. Stereopsis is only required for a small portion of the UPT syllabus, but that portion constitutes a significant input to aircraft of assignment after UPT. Pilots excelling in this portion of the syllabus presumably use superior stereopsis in addition to other skills to distinguish themselves from their contemporaries, thus generating instructor recommendations and personal preferences for the fighter/bomber track. If this study could be completed prior to institution of SUPT with candidate pre-selection and classification of aircraft type, a difference in the predictive value of one of the two types of stereopsis testing would allow better classification of candidates and presumably lower track specific attrition rates.

SUMMARY

Type of stereoacuity test passed at medical screening for UPT may be predictive of success versus attrition from UPT. Because distant stereoacuity is presumably utilized in certain military UPT flight operations while near stereoacuity is not, UPT candidates passing the VTA test for stereoacuity at distance may pass training at higher rates than candidates who fail the VTA but pass the DPA-V test for stereoacuity at near. This study tests this hypothesis. Limitations of the study including fixed sample size, selection and classification bias,and distribution of proportions of the independent variable weigh heavily in favor of the null hypothesis. A more comprehensive study utilizing a uniform classification of type of depth perception test passed at screening, particularly if both tests were administered to every candidate, could show a stronger association with UPT outcome. A study of UPT performance as measured by aircraft of assignment on graduation would be more likely to disprove the null hypothesis tested in this study. A failure to disprove the null hypothesis in this study could result from several reasons: 1) inadequate power and sample size; 2) adequate compensation during flight training for lack of distant stereopsis in candidates only passing the Verhoeff test; or 3) the erroneous assumption that distant stereopsis is required and advantageously used during military flight training.

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UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER

MASTERS OF SCIENCE IN PUBLIC HEALTH

This research proposal, prepared by Quay C. Snyder, Jr., has been approved by the undersigned examination committee towards fulfillment of the final examination requirement in the Masters of Science in Public Health program. This proposal represents an agreement as to the nature and scope of the required research project. In addition to implementing the project as outlined in this proposal, the student will defend the project in an oral examination and submit a final written report in the form of a thesis or publishable research paper. This proposal is approved for completion as a:

Thesis ________ Publishable paper ___✓___

EXAMINATION COMMITTEE DATE

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Dennis C. Lezotte, Ph.D., Chairperson

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Jill N. Kostraba, Ph.D.

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Murl E. Leibrecht, M.D., M.P.H.

Brooks AFB, TX

Original Signed by DCL

JNK

MEL