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16. Abstract This longitudinal study of 2,352 air traffic control specialist recruits (1,858 En Route and 494 Terminal) who entered the FAA Academy basic training phase in 1969 examined the validity of educational level, recency of education, and major areas of college study for the prediction of success in air traffic control (ATC) training (defined by Academy graduation status and/or retention in FAA ATC work 3 to 4 years after Academy training). All educational variables, both before and after consideration of age effects and pre-FAA experience, were found to be negligibly and/or inversely related to ATC success. The 181 college graduates had the highest Academy attrition rate (30.9 percent), followed by the 208 nongraduates of high school (24.5 percent) whereas the lowest attrition rate (18.0 percent) pertained to the 876 subjects having high school diplomas only. Post-Academy rates followed a similar pattern. College majors listed by 925 of the 1,265 recruits who attended college revealed little potential for prediction of ATC success; even those 53 recruits whose majors were judged to be aviation related had a retention rate of only 56.6 percent compared to the 56.7 percent retention rate of all recruits indicating college work. None of the education variables had a significant interaction effect on the validities of other selection factors. Moreover, all types of aviation-related experience except ATC were found to be unreliable for prediction of training outcomes. Other findings clearly illustrated that candidacy for ATCS training should be restricted to aptitude-screened applicants no older than 30 and that a case can be made for precontinuing the awarding of credit points toward eligibility for all types of preentry experience except air traffic control.					
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## EDUCATION AS A FACTOR IN THE SELECTION OF AIR TRAFFIC CONTROLLER TRAINEES

### I. Introduction.

Aviation safety is the prime mission of the Federal Aviation Administration (FAA). This mission entails responsibility for the safe and efficient utilization of the Nation's airspace. To facilitate accomplishment of this mission, the FAA maintains a complex system of air navigation and air traffic control (ATC) officially referred to as the National Airspace System (NAS). The overall effectiveness of the system is contingent on the proficiency of personnel and the equipment they use in performance of their tasks. While the services of personnel in every occupational specialty are important, none are more critical to the FAA's mission than those rendered by air traffic control specialists (ATCS). Controllers not only outnumber all other FAA employees but also bear direct responsibility for the safe, orderly, and expeditious flow of air traffic. For these reasons, there has never been a period of laxity in the search for progressively improved methods of ATCS selection and training.

The present report pertains to a study undertaken in connection with the FAA's continuing efforts to develop increasingly more effective procedures of screening and selecting personnel for controller training. More specifically, this investigation was conducted to determine the extent to which the probabilities of ATC success (as defined by training performance measures and also retention status in control work several years subsequent to recruitment) might vary in accordance with the educational backgrounds of trainees having various types of preentry experience and differential aptitude-test-screening scores.

Several previous studies<sup>1 3 9 10 12 15 17</sup> focusing on the validation of other selection factors but including "level of education" as a variable for *peripheral study* have yielded findings (discussed in the next section of this report) that suggest, yet fail to demonstrate conclusively, that the existing educational standards are in need of revision. Despite the unavailability of detailed information concerning the educational backgrounds of ATCS trainees, the present study was undertaken on the assumption that analyses more comprehensive than those accomplished in the earlier studies would produce results indicating whether the existing educational standards are validly serving their purpose and, if not, the nature and extent of revisions having the greatest potential for enhancement of the selection process.

Throughout the history of the FAA, applicants for ATCS training have been provided a variety of optional, or alternate, methods (i.e., various sets of qualification standards) from which to choose when seeking to establish their candidacy. This being so, it would be difficult to fully understand the rationale underlying the planning of the current study or achieve a meaningful interpretation of the findings obtained without first considering the extent to which other factors, separately and in combination with education, have served as determinants in the selection of ATCS-trainee personnel.

A. *ATCS Selection and Recruiting History.* Numerous revisions have been made during the past 15 years in the methods and standards employed in the screening and selection of personnel for ATCS training. However, some of the selection procedures, and particularly those relating to education, are remarkably similar to those of the past.

Current eligibility standards for ATCS training prescribe that an applicant (1) be no older than 30, (2) hold a high school diploma or be able to show evidence (e.g., General Education Development, or G.E.D., certificate) of education, abilities, and/or skills deemed comparable with those of most high school graduates, (3) satisfactorily pass a rigid medical examination, which includes screening for personality abnormalities, and (4) achieve a composite raw score no lower than 210 on a Civil Service Commission (CSC) battery of six aptitude tests. The test battery is designed to assess a candidate's aptitudes for learning the types of tasks involved in control work. The composite measure of aptitudes is converted to a percentile score, with 210 corresponding to a minimally qualifying percentile score of 70, which is then supplemented by credit points reflecting evaluations of pre-employment experience and education to derive the applicant's overall eligibility rating.

During the last 15 years, the FAA Civil Aeromedical Institute (CAMI) has accomplished a great deal of research bearing on the validation of age, preentry work experience, education, and aptitude-test measures as ATCS selection factors.<sup>2-16</sup> Certain standards among those currently employed in the selection of trainees, and also some of the selection standards of the past, were formulated on the basis of findings obtained in various CAMI studies (some of which went unpublished due to the few researchers involved and the need to pursue other high priority research).

1. Age. Perhaps the most important of the CAMI studies were those that demonstrated the effects of age on training and job performance. A series of investigations, dating back to 1961, indicated that the training attrition rates of groups of subjects of age 31 and older were generally two to three times higher than those of the younger trainees.<sup>7 9 10 14 15 16</sup> Other studies in which experimental ratings of job performance were collected on journey-level ATCS's from both their supervisors and their peers revealed that the mean performance ratings of controllers within every age category beyond 40 were significantly lower than those of the younger subgroups.<sup>4 11 14</sup> Such findings played a decisive role in obtaining congressional legislation per-

mitting the establishment of an optional early retirement program for controllers and also the imposition of an upper age limit of 30 in the recruitment of controller trainees. The latter standard, as well as the early retirement program, have been in effect since April 1973.

Implementation of the standard precluding the training eligibility of any applicant older than 30 has been viewed by many within the FAA as representing the most significant step ever taken to improve the selection process. This belief stems from consideration of findings obtained in a number of CAMI studies. Due to the standards prescribed for evaluating and weighting various types of aviation-related experience as a selection factor, relatively high proportions of the selectees who established their candidacy ratings during periods preceding imposition of the age limitation were more than 30 years old, including appreciable percentages in their forties and some who were more than 50. However, the followup studies of groups recruited during 1960 to 1971 always revealed significant inverse relationships between training-entry age and training performance measures.<sup>4 11</sup> The effects of age pervaded all experience subgroups, indicating the need for establishment of a standard to preclude qualification and selection of older applicants, regardless of their experience backgrounds.<sup>10</sup> Moreover, research<sup>4 11</sup> has also demonstrated that the job proficiency of full-performance-level (FPL) ATCS's, or journeyman-level controllers, generally tends to decline progressively after age 40. Such findings retrospectively attest to the validity of the FAA's current policy of recruiting only relatively young personnel for ATCS training.

2. Aviation-related experience. Throughout the history of the FAA and that of its predecessor organization, the Civil Aeronautics Administration (CAA), ATCS selection programs have included standards predicated on the philosophy that almost any type of aviation-related experience should be of value for predication of success in ATC training and work. Inasmuch as previous experience in air traffic control (usually acquired in military service) has always been considered of paramount importance, standards have invariably prescribed that it be heavily weighted, directly or indirectly, as a



selection factor. Other types of aviation experience traditionally regarded as important, but generally weighted more moderately than prior ATC work, include experience (military or civilian) as an aircraft pilot, a navigator, a communications expert, a radar surveillance specialist, and a flight dispatcher. Prior to implementation of mandatory aptitude-test screening procedures in 1964 (and exclusive of brief trial periods for procedures resulting in the selection of relatively few trainees), the eligibility ratings of medically qualified ATCS applicants were determined primarily on the basis of assessments of aviation-related experience and education.

Briefly stated, selection programs have always been formulated to result in the recruitment of as many controller trainees as possible from applicants who, in addition to other qualifications, possessed previous ATC experience. The appropriateness of this policy has been repeatedly confirmed by the results of CAMI followup study of personnel who entered ATCS training during the decade ending in 1970. Unfortunately, however, the manpower pool of former military controllers has progressively diminished during the past 15 years and the FAA has therefore recruited increasingly greater proportions of its ATCS trainees from candidates having other aviation backgrounds and also from those having no aviation experience of any type—but who qualified on the basis of aptitude-test measures and assessments of education.

Although CAMI followup studies have provided ample evidence attesting to the validity of ATC experience as a selection variable, the same studies have indicated all other types of aviation experience (e.g., pilot, navigator, air defense surveillance, etc.) to be virtually worthless for prediction of training outcomes or retention in FAA ATCS work several years subsequent to recruitment.<sup>4 9 10 15 16</sup> More important, variables reflecting experience in aviation-related areas other than ATC (and also in fields unrelated to aviation) were frequently found to correlate inversely (sometimes at statistically significant levels) with the criterion variables. This was particularly true with respect to aircraft-pilot experience. Moreover, when statistical procedures were employed to theoretically nullify the effect of age, the validity coefficients of variables

representing “years of pilot experience,” “logged hours,” and “pilot ratings” were nonetheless found to be in either the low negative range or very low positive range. Such findings have prompted a committee, which the FAA Administrator established in late 1974 to ascertain methods of improving the ATCS selection and training programs, to recommend that selection procedures be revised to preclude consideration of any type of preemployment experience except that directly involving air traffic control. Such a recommendation, however, runs counter to the CSC’s traditional policy of evaluating virtually all types of preemployment experience in the selection of personnel for almost any occupational specialty within the Federal service. If the CSC expresses unwillingness to approve the proposed change, the FAA should nonetheless press vigorously for changes whereby aviation experience other than ATC would be very conservatively weighted in the selection process.

3. Development of aptitude-test screening procedures. ATCS selection procedures prior to 1964 generally involved no formal assessment of the aptitudes or mental abilities of applicants. The battery of tests used in the screening of most applicants since that time was implemented on the basis of findings obtained in CAMI experimental-testing-and-followup research on personnel recruited during 1962 and 1963. In that research, the six tests that now compose the CSC ATC Aptitude Test Battery were identified from among 27 experimentally administered instruments as yielding the best composite measure of aptitudes for prediction of performance in the Academy’s basic training courses in En Route and Terminal ATC procedures.

The six tests were administered to 893 subjects as they enrolled in the Academy training courses. It was later found that 271 of the 893 were attrited during the basic training phase. When the test performance data of the Academy graduates and attritions were compared, results clearly indicated that the best point on the score distribution for differentiation purposes was between 189 and 190. Scores of 190 or higher were achieved by 489 subjects, representing 54.8 percent of the entire validation sample. The 489 included 400 (64.3 percent) of the 622 graduates

and only 89 (32.8 percent) of the 271 who failed to successfully complete the initial training phase. Although 404 (45.2 percent of the 893) scored 189 or lower, the 404 included 182 (67.2 percent) of the 271 attritions and 222 (35.7 percent) of the 622 Academy graduates.

Operational use of the battery, however, was initiated long before validation results became available for the entire group of 893 subjects. An earlier analysis, in which the aptitude test scores of the first 302 examinees were validated against the Academy training criteria, yielded findings (highly similar to those later obtained for the complete sample) that prompted CSC and FAA officials to authorize use of the battery, beginning in July 1962, in the screening of *only* those applicants unable to establish training eligibility in terms of the normally prescribed qualification standards (i.e., qualifications with respect to aviation-related experience and/or education). Several thousand such applicants were operationally examined with the battery during the following 18 months and, although about half of them established training eligibility by achieving raw composite scores of 190 or higher (i.e., percentile scores of 70 or better), very few were selected. Candidates qualifying on the basis of previous ATC work and other aviation experience generally attained higher overall CSC eligibility ratings than those screened with the battery. Moreover, training quotas continued to decline and were usually met by selecting candidates having CSC ratings no lower than 90. To attain a percentile rating of 90, an applicant having insufficient ATC-related experience to qualify for any credit points was required to achieve an exceptionally high aptitude test score of 257. Aptitude-screened subjects were, therefore, seldom able to effectively compete for the available training positions. In fact, most of the relatively few aptitude-screened candidates selected for training prior to January 1964 possessed at least some ATC-related experience that, although insufficient for exemption of the test screening requirement, warranted credit points to supplement ratings reflecting excellent levels of performance on the test battery.

Academy training performance records for the last of the 893 subjects examined with the CSC test battery for research purposes only were not

available until October 1963. By that time, CAMI had collected post-Academy training progress information, experimental ratings of job performance, and other data for several hundred of the examinees who had successfully completed their basic training course some 12 to 18 months earlier.

A series of validation analyses completed shortly thereafter yielded findings of timely interest to officials seeking to improve ATCS selection. Perhaps the most important of the analyses was that which, as mentioned earlier, revealed that about two-thirds of the 271 Academy attritions among the 893 experimentally examined subjects scored no higher than 189 on the CSC battery, whereas a similar proportion of the 622 graduates scored 190 or higher. In another analysis based on the entire sample, statistically significant ( $p < .05$ ) correlations were obtained between the aptitude test variable and most of the Academy training-performance measures (i.e., grades). However, when dealing with data of the *Academy graduates only*, the aptitude-test scores (particularly those above 210) proved very unreliable for prediction of Academy training performance or promotions, ratings of job performance, and/or attrition-retention status during the first 12 to 18 months of facility training. Yet, the latter findings were of the general type expected because the deletion of data for the Academy attritions, the majority of whom were low-aptitude subjects, resulted in an attenuated distribution of test scores.

Entry age proved to be inversely related to both the aptitude-test variable and the criterion measures.<sup>6</sup> Some 668 (74.8 percent) of the 893 examinees were no older than 30 and the remaining 225 were almost equally distributed among the age brackets "31-35," "36-40," and "41 and older." Although only 148 of the 668 youngest subjects were Academy attritions, 63.5 percent ( $N=94$ ) of the 148 scored 189 or lower on the CSC test battery, compared to 35.8 percent ( $N=186$ ) of the 520 youngest graduates. Subjects of the successively older age brackets had progressively higher Academy attrition rates and lower mean scores on the test battery. Almost 78 percent ( $N=59$ ) of the 76 trainees aged 41 and older (many of whom were military retirees with lengthy ATC experience) failed to success-

fully complete Academy training and only 22 (37.3 percent) of the 59 attained test scores of 190 or higher, including 9 with scores of 210 and higher.

After viewing the results of the validation analyses, selection officials decided that the CSC battery should be used in the screening of all applicants, beginning in January 1964. They considered the battery to have great potential for the screenout of applicants who, should they be recruited, would most likely fail the basic training phase solely because of low-level aptitudes. They *did not* advocate use of the test scores for prediction of differential levels of training performance; to have done so would have implied limited interest in developing the best possible test-performance screening standards.

4. Revised aptitude-screening procedures. Although the screening program instituted in January 1964 required that all applicants for ATCS training be examined with the CSC battery, they were screened in terms of three different aptitude-test-performance qualification standards. In accordance with procedures prescribed for each specific training option and entry pay grade being applied for, an individual's preemployment experience and/or level of education determined which of three tables was to be used in converting his/her composite raw score on the test battery to a percentile score. A percentile score of 70, considered a mandatory eligibility requirement, corresponded to a raw score of 210 on one conversion table, to 225 on another, and to 240 on the third. For example, candidacy for Tower or Center training at the GS-6 (General Service rating; i.e., pay grade) entry level required that ATC-rated applicants (usually former military controllers) score at least 210 on the battery, whereas 225 was considered minimally qualifying for instrument-rated aircraft-pilot personnel and also applicants having navigator or air-dispatcher certificates, and 240 served as the screening standard for those having low-to-moderate amounts of aviation-related experience and/or 4-year college degrees and also others having diverse experiential and educational backgrounds. Moreover, the procedures stipulated that each applicant's percentile score, if 70 or higher, be supplemented with credit points awarded for those types of experience that had

warranted use of either of the two lower test-score screening standards to derive his/her overall eligibility rating. Inasmuch as the majority of the applicants possessed aviation experience of some sort, the dual consideration of that experience in the qualification process enabled them to establish training candidacy in far greater numbers, and generally with higher eligibility ratings, than those with nonaviation backgrounds.

The relatively high aptitude-test-score screening standards of 210, 225, and 240 (for each of the training options) remained in effect from January 1964 until August 1968, resulting in the screenout of more than half the applicants. However, no shortage of qualified candidates developed. Due to continuing budgetary limitations, training quotas remained unusually low throughout the entire 56-month period and consequently nearly all ATCS trainees were selected from among candidates having commendably high eligibility ratings—reflecting exceptional qualifications with respect to aptitudes and also experience and/or education.

In August of 1968, a program for rapid expansion of NAS was initiated and a revised set of trainee-selection standards was adopted. In many respects, the new selection program was highly similar to that of the preceding 56 months. However, two new screening standards were implemented as a means of insuring an adequate supply of candidates. First, according to one of the new standards, applicants having highly specialized ATC experience (particularly in radar control) could be granted waivers of the aptitude-screening phase and could also be appointed to training at pay grades of GS-9 or higher rather than the normally prescribed entry grades of GS-7 or lower. It was reasoned that such personnel would be able to complete developmental training more rapidly than others and thereby more quickly alleviate the shortage of FPL controllers. Second, a score of 210 on the CSC test battery was adopted as a common screening standard for most other applicants. The screening standard of 210 applied to (1) former military controllers unable to qualify under the "specialized experience" standard, (2) pilots, navigators, air dispatchers, and others who would have confronted a test-score screen-

ing hurdle of 225 if they had applied in earlier years, (3) 4-year college graduates with records of superior academic achievement, and (4) applicants having master's degrees. A test score of 240 was prescribed for use in the screening of few applicants except those devoid of aviation-related experience, most of whom were college graduates with no evidence of superior academic achievement.

The ATCS selection procedures remained essentially unchanged from August 1968 until April 1973. Throughout that time, however, slightly less than one-fourth of the selectees entered at grade GS-9 or higher on the basis of "specialized experience." The majority, entering at grade GS-7 or lower, were recruited from aptitude-screened candidates having ATC or other aviation-related experience. The "specialized experience" standard was abolished on April 2, 1973. Simultaneous with the reinstatement of mandatory aptitude-screening procedures, a new standard was implemented that automatically precluded the eligibility of any applicant more than 30 years old. With the exception of the two standards just mentioned, the 1973 selection program was highly similar to that of 1968. Also, none of the current (1975) screening standards differ significantly from those of 1973. Nonetheless, recruiting demands have so drastically declined since 1968 that a current-day candidate has virtually no chance of being appointed to training unless his overall eligibility rating far exceeds that which would have warranted selection during the 1968-1972 period.

5. Level of education as a selection factor. The ATCS selection programs of all time periods have included the mandatory requirement that an applicant either hold a high school diploma or provide evidence (e.g., G.E.D. certificate) of an educational background deemed equivalent to that of a typical graduate of a high school. Education beyond the high school level (although not mandatory) has traditionally received significant weighting, directly or indirectly, as a factor in the derivation of each applicant's overall eligibility rating. Selection programs have invariably included provisions whereby the "general experience" requirements, specified for applicants not having backgrounds in aviation, could be met wholly or in part by

the substitution of college-level education. Regardless of experience, however, applicants with 4-year college degrees have usually been provided a variety of standards helpful in establishing training candidacy. As mentioned earlier, there was a period during which college graduates with records of superior academic achievement were screened in terms of an aptitude-test-score standard that was considerably below that designated for screening of their comparably experienced and otherwise equally qualified colleagues. Also, a similar policy prevailed at one time that pertained to *all* college graduates, irrespective of academic records. However, the greatest emphasis of education as a selection factor was during 1971 and 1972 when applicants with 4-year college degrees having at least 1 year of graduate work and 12 months of specialized ATC experience could be granted waivers of the aptitude-test-screening phase and also be appointed to training at grade GS-9 rather than GS-7.

B. *Issues Concerning Education as a Selection Factor.* Throughout the history of the FAA and the CAA, education has received notable consideration as a factor in the selection of ATCS trainees. However, virtually all the selection procedures relating to education except those concerning records of superior academic achievement have pertained to *levels* of education, or years of education completed. The types of studies (e.g., college courses, areas of major and minor study, etc.) pursued by the applicants have generally received little or no consideration. Level of education and assessments of experience and/or performance on the battery of aptitude screening tests have, for many years, served as the prime determinants of each medically qualified applicant's training eligibility (and sometimes the pay grade to which appointed on entry into controller training). While relevant experience has usually been deemed more important than education as a selection factor, applicants lacking qualifying preentry experience, but meeting other prerequisites, have generally been allowed to substitute college education (as measured by years) for experience, in accordance with differential rates prescribed for the various types of experience.

Although the selection procedures pertaining to education have varied from time to time, they have consistently reflected an implied assumption that success probabilities in ATC training and work tend to vary in accordance with levels of education attained by personnel considered equally qualified in other respects. However, the belief that educational level is indeed appropriate and valid for selection purposes has apparently never been confirmed through research. To the contrary, various phases of previous CAMI research on ATCS selection in which level of education was included as a variable for "peripheral study" in analyses relating to the validation of age, preemployment experience, and aptitude-test performance indicated that the training attrition rates of ATCS personnel tended to *increase* (rather than decrease) in accordance with the preentry levels of education.<sup>3 9 10 15</sup> Several unpublished CAMI studies involving trainees recruited during various time periods have shown that college graduates generally have significantly higher attrition rates than selectees having either high school diplomas only or 1 year or less of college.

Such findings, however, do not necessarily imply the need for reformulation of selection procedures relating to education. In fact, the findings cannot be reliably interpreted because they are undoubtedly confounded by (unassessed) interaction effects of age, experience, aptitudes, and other factors considered in the selection process. Virtually all the validation data pertaining to education were derived in conjunction with research undertaken primarily for other purposes. Some of the CAMI studies in which level of education was included as a variable for ancillary study involved determination of the coefficients of correlation for the educational variable versus Academy training-performance measures and other criteria.<sup>3 9 10 15</sup> Certain phases of research also included determination and comparison of attrition rates of subjects categorized in terms of educational level.<sup>10</sup> In none of the studies, however, were analyses conducted to assess the effects of other selection factors on the validity of the educational variables or the influence of the latter on the validities of the former. Moreover, selection procedures bearing on education have traditionally included con-

sideration of *level only* and, due in part to that fact and the ready availability of data not requiring transposition, investigators have invariably refrained from dealing with other aspects of education when conducting research under taken primarily for other purposes.

Research findings to date concerning education admittedly suggest, but fail to demonstrate conclusively, that level of education has little or no validity for prediction of success in ATCS training. It is important not only to resolve this basic issue, but also to ascertain the validities of other variables that can be derived from other data and information pertaining to the preentry educational backgrounds of ATCS-trainee personnel.

*C. Purposes of the Present Study.* The current study was undertaken for three basic purposes: (1) to assess the validity of level of education as a selection factor, separately and in combination with other factors officially considered in the selection of ATCS-trainee personnel; (2) to determine whether data and information relating to other aspects of education (e.g., recency, major courses of study, etc.) are sufficiently related to training attrition-retention status to warrant consideration in the establishment of eligibility ratings; and, if so, (3) to derive a set of factor weights, reflecting their relative importance, for recommended use in future revisions of the ATCS selection standards.

## II. Methodology.

*A. Subjects.* This report pertains to a longitudinal study of 2,352 former students of the Academy's basic training courses in En Route and Terminal ATC procedures. The group, representing the combined enrollments for the two training courses during calendar year 1969, includes 1,858 En Route and 494 Terminal recruits. The study concerns the validation of education for prediction of training outcomes and attrition-retention status in control work 3 to 4 years following recruitment.

*B. Reasons for Limited Scope of the Study.* Data and information reflecting each subject's qualifications for ATC training and his/her Academy attrition-graduation status and post-Academy attrition-retention status (as of Jan-

uary 1, 1973) were collected in conjunction with previous studies that focused on the validation of preemployment experience, aptitude-test measures, and other selection factors. The present study was facilitated by the availability of such data and also the results of certain analyses conducted in connection with the earlier research. On the other hand, the current study is admittedly somewhat restricted in scope. Various types of information and data desirable for inclusion in the validation analyses were *not* available nor even feasible to collect by the time the study was conceived. The need for a comprehensive study of educational factors was foreseen when the previous research was undertaken and, consequently, the subjects were requested to provide relatively little educational background information. Although required to deal with the data at hand, we felt that certain types of analyses (described in later sections of this report) would yield results of timely and informative value to the FAA in its current quest for methods of improving the ATCS selection program.

*C. Background Variables.* In conjunction with the earlier research, CAMI administered a lengthy biographical questionnaire to each incoming class of Academy trainees to obtain first-hand information regarding each subject's educational background, preemployment experience, training-entry age, and other background data.

Questionnaire items pertaining to education were few in number. The subject was asked to give the name and location of the high school(s) attended, highest grade completed, if she/he received a diploma, and, if so, the year of graduation. Each subject claiming a G.E.D. certificate in lieu of a high school diploma was requested to indicate the year in which the document was awarded. Trainees with college backgrounds were asked to give the name and location of each institution attended, dates attended, credits earned, degrees conferred and to indicate briefly his/her major courses of study. Information of a similar nature was solicited with respect to "non-college education" (e.g., vocational schools and military special training schools).

When formulating plans for the present study, we realized that much of the available educational background information was neither amenable to coding nor sufficiently important to warrant inclusion in the validation analyses. However, little difficulty was encountered in coding the data for derivation of the two variables deemed most critical for study. These were "Level of Education Attained Prior to Recruitment" and "Recency in Attainment of Highest Level." The prime variable, "Level of Education," was coded on a nine-point scale, with code "1" indicating "no high school diploma," code "2" denoting a G.E.D. certificate (indicating an educational background comparable to that of a typical graduate of a high school), "3" representing a formal high school diploma, "4" reflecting less than 1 full year (30 credit hours) of college work, codes "5" through "7" denoting progressively greater amounts of college education not resulting in a bachelor's degree, "8" representing a bachelor's degree, and "9" indicating a master's degree. "Recency of Education" represented the time lapse, expressed in years, since attainment of highest level of education. Plans also stipulated that the subjects indicating college credits be categorized on the basis of cited majors (principal areas of study) for comparison of their attrition-retention rates relative to both level and recency of education.

Among the most important of the scheduled analyses were those designed to assess the interaction effects of preemployment experience, age, and aptitude-screening-test performance on the validities of the three educational variables. However, it should be emphasized that this aspect of the study was somewhat restricted in scope due to the limited types and amounts of data collected in conjunction with CAMI's previous research.

Detailed information concerning preemployment experience was not available for study. Fortunately, however, the biographical questionnaire that CAMI administered to all incoming Academy classes included a section in which each trainee was requested to indicate whether she/he has ever held a license, certificate, or rating in "air traffic control work" (e.g., military or civilian control) and/or as an aircraft pilot or in

the field of communications (e.g., radio, air surveillance, etc.). These are the types of experience the FAA has traditionally weighted most heavily in the ATCS selection process. Every incoming Academy group included at least a few students who replied "No" to each of the three areas, whereas the majority checked "Yes" for one or more. Generally, a sizable proportion of each Academy class indicated ratings in all three areas (i.e., ATC, pilot, and communications). For purposes of the present study, each case was assigned to one of eight mutually exclusive categories, ranging from "no rating in any of the three areas" (i.e., no certificated experience officially deemed relevant to FAA ATC work) to ratings in all three fields or areas.

Age at time of entry into Academy training, rounded to the nearest birthday, was based on questionnaire response data and subsequently verified against data appearing in each trainee's "Evaluation of Performance Record" for the Academy basic training phase.

Scores on the operational CSC ATC Aptitude Test Battery were provided by the FAA regions for only 63.2 percent of the 2,352 subjects involved in the current study. Among the 2,352 were many who qualified for entry into training at grade GS-8 or higher on the basis of the specialized experience standard and whose scores were therefore known to have been disregarded during the selection process. Moreover, the aptitude test scores forwarded to CAMI for research purposes pertained to a far smaller proportion of the Academy attritions than graduates (i.e., 34.7 percent and 67.6 percent respectively). The regions, for various reasons, seldom attempted to assemble and forward the test records of trainees until several months after the trainee entered the 9-week Academy basic training phase; almost one-third of the students failed to successfully complete the basic training phase and were released from FAA service shortly after return to their facilities of assignment; the records of those eliminated were usually discarded within 30 days following termination of employment and consequently most of the test data sent to CAMI pertained to the Academy graduates. Researchers recognized that bias in the collection of such data would preclude an accurate assess-

ment of the battery's validity for prediction of training-course attrition-retention status and also the interaction effects of aptitude level on the validities of variables reflecting level, recency, and type of preentry education. Nonetheless analyses relating to that objective were undertaken with the hope that the outcomes would not be entirely meaningless.

*D. Criterion Variables.* Academy training officials provided CAMI with an "Evaluation of Performance Record" for each trainee. Each record not only indicated whether the student failed or successfully passed the Academy basic training phase but also included a listing of grades reflecting performance on a variety of examinations pertaining to academic materials and "over the shoulder" evaluations (by instructors) of the student's performance as a controller on laboratory-simulated ATC problems. For several reasons, however, the grades were deemed inappropriate for use as criteria in the current study: subjects were frequently permitted "re-takes" of examinations that they initially failed; earlier studies had shown that subjects having unusually high grade averages were sometimes eliminated from training due to repeated failure to pass tests relating to only one or two specific aspects of training; materials and procedures on which En Route students were examined differed from those of the Terminal trainees; and previous research had illustrated that the grades, separately and in various combinations, were unreliable for purposes of individual differentiation. All such grades were, therefore, completely disregarded in the present study. Instead, only one basic-training criterion variable, "Academy Attrition-Retention Status," was employed. Subjects whose records indicated they successfully completed their assigned training course (i.e., graduates) were designated as "Academy Retentions" and all others, as "Academy Attritions." Most of the validation analyses were accomplished with no distinction being made between the data of the En Route and Terminal subjects.

The second criterion variable was "Post-Academy Attrition-Retention Status" on January 1, 1973. The latter had been determined in earlier CAMI research by collating the names and Social Security numbers of the subjects with

those set forth in magnetic tape records for all personnel within the FAA who, at the beginning of 1973, possessed an occupational code of 2152 (denoting the ATCS specialty). Initial plans for the study stipulated that level, type, and recency of education also be validated against indices of career progress (e.g., promotions), lengths of service for attrited subjects as well as those still in ATC work, facility transfers, changes in training option, and other criteria. Soon after the study was underway, however, it became apparent that such data and information would be difficult, and probably impossible, to obtain for many of the subjects, particularly those who were eliminated from training within the first few months after Academy graduation. Considering the difficulties and likelihood of bias in the collection of data, we decided that no attempts should be made to validate education against any post-Academy criteria other than attrition-retention status on January 1, 1973.

### III. Results and Discussion.

All but three of the 2,352 trainees returned a completed, or partially completed, copy of the biographical questionnaire to CAMI for research purposes. The three who failed to do so were En Route trainees. The response data submitted by each of the remaining 2,349 (1,855 En Route and 494 Terminal students) was sufficient to permit determination of "Highest Level of Education" attained prior to entry into FAA ATCS training. Consequently, 2,349 represented the maximum number of cases involved in any of the validation analyses accomplished in this study. Moreover, only eight of the 1,855 En Route respondents and just three of the Terminal trainees failed to provide chronological information necessary for ascertaining "Recency of Highest Level of Education Attained." In other words, data reflecting both recency and level of education were available for 2,338 subjects. The group was deemed more than adequate in size for reliable assessment of the validities of the two variables—independently, combined, and also in conjunction with other selection variables—for prediction of training outcomes.

A. *Relationship of Level of Education to Training Outcome.* Figure 1 shows the number and proportion of ATCS trainees in each level-

of-education category who failed to successfully complete the Academy basic training phase, those who passed Academy training but left the air traffic control system before January 1, 1973, and those still working in the ATCS specialty at the beginning of 1973. Before comparing the attrition-retention data of the various sub-groups, however, we should first examine the distribution of educational level.

Some 208 (8.9 percent) of the 2,349 ATCS recruits of 1969 indicated they had failed to meet the requirements for graduation from high school; however, 195 of the 208 stated they held G.E.D. certificates that, according to ATCS selection standards, indicated their educational development to be comparable with that of most high school graduates. Inasmuch as training eligibility has generally required that a candidate be able to provide evidence of at least a high school education or its equivalent, we decided that all analyses should be conducted with no distinction being made between the 195 subjects indicating certificates and the remaining 13 subjects who also failed to receive a high school diploma.

Trainees who terminated their formal education with graduation from high school numbered 876 and represented 37.3 percent of the total group (percentages are not shown in the figure). However, more than half (53.9 percent) of the 2,349 had attended college. Of these, 459 declared credits equating to less than 1 full year of college work; 307 had completed at least 1 full year but less than 2 years of college; 203 possessed at least 2 but less than 3 years; 115 indicated 3 to 4 years but no degree; and 181 were college graduates. Inasmuch as only five of the 181 held master's degrees, they were not dealt with as a separate subgroup. Although not depicted in Figure 1, the mean of the coded educational levels of the 2,349 trainees was 3.4 (median: 3.2), representing slightly less than one-half year of college.

In comparing the Academy attrition rates of the subjects by level-of-education category (shown in Figure 1), none exceeded the 30.9-percent rate of the 181 college graduates; the next highest, 24.5 percent, pertained to the 208 who failed to complete high school. Differing



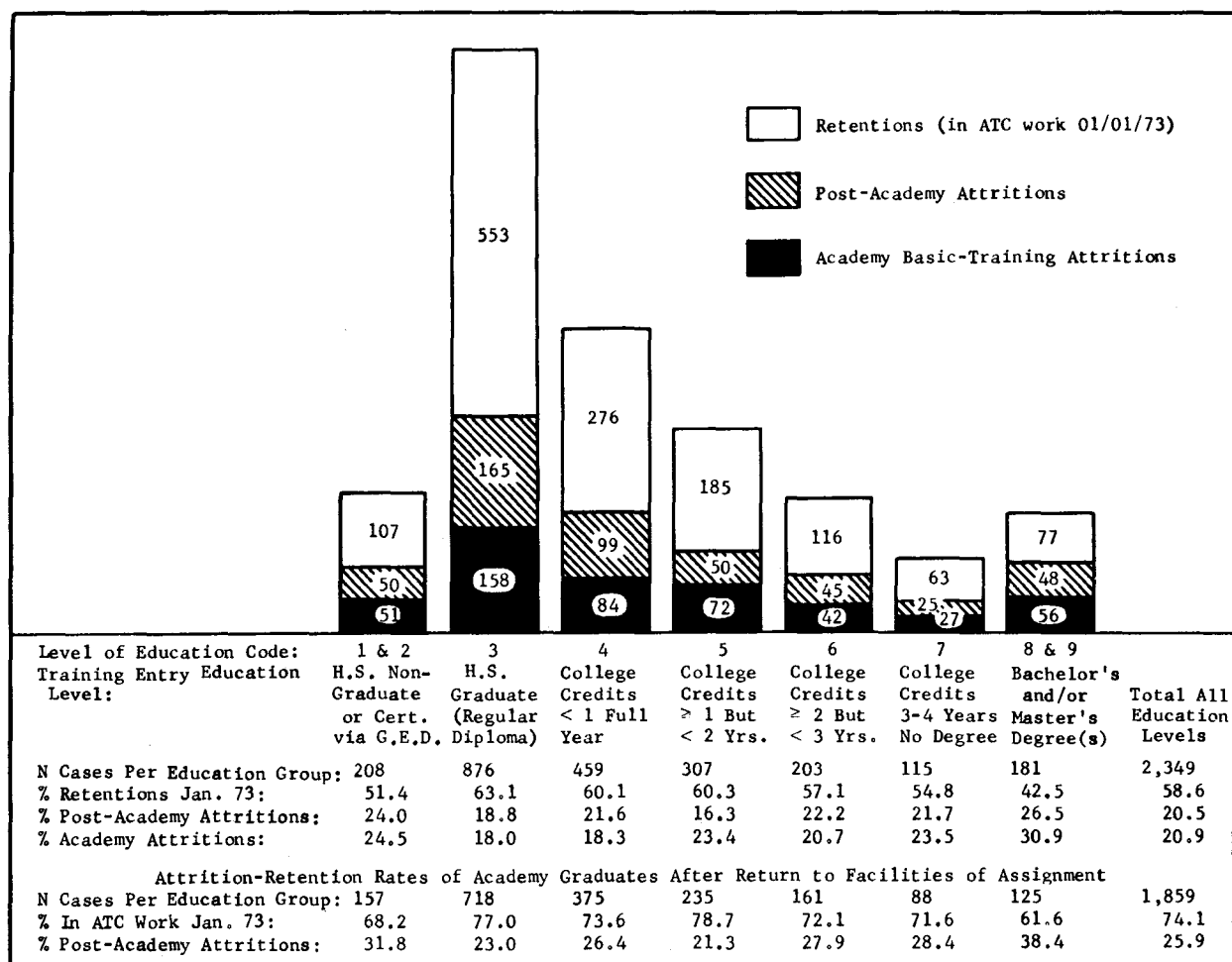


FIGURE 1. Distribution of ATCS attritions and retentions relative to highest level of education attained prior to 1969 entry into Academy basic training in En Route or Terminal ATC procedures. (Three cases were not included in the analysis due to lack of data reflecting educational level.)

significantly ( $p < .05$ ) from either of the former was the rate of 18.0 percent obtained from the 876 high school graduates. In fact, the 876 included proportionately fewer Academy attritions than any other subgroup. Moreover, only 18.3 percent of the 459 stating they had less than 1 full year of college were attrited during the basic training phase and the corresponding rates of subjects in the three remaining categories (with progressively more college credits) ranged from 20.7 to 23.5 percent. The post-Academy attrition rates (based on entrants into training) followed a somewhat similar rank-order pattern and the retention rates, being complementary to the overall attrition rates, tended to follow an inverse

rank-order pattern. Only 42.5 percent of the college graduates were still in ATC work at the beginning of 1973, and the same was true with respect to 51.4 percent of the 208 devoid of high school diplomas. Differing significantly ( $p < .05$ ) from either of the latter were the retention rates of 63.1 percent for the high school graduates, 60.1 percent for those having less than 1 full year of college, and 60.3 percent for those having at least 1 year but less than 2 full years of college. Slightly more than 57 percent of the subjects in the next highest educational-level category were "retentions," compared to 54.8 percent of the 115 having 3 to 4 years of college but no degree.

Figure 1 also presents the results of an ancillary analysis in which the post-Academy attrition and retention rates were determined by level of education for *Academy graduates only*. Slightly more than 38 percent of the 125 college graduates who successfully completed the Academy basic training phase terminated their ATC careers before January 1, 1973. Second in rank order was the post-Academy attrition rate of 31.8 percent obtained for the nongraduates of high school. Differing significantly ( $p < .05$ ) from either of the latter was the facility-training attrition rate of 21.3 percent that pertained to the trainees having more than 1 year but less than 2 full years of college and also the rate of 23.0 percent obtained for those having high school diplomas only. The post-Academy attrition rates of the remaining subgroups ranged from 26.4 percent (for subjects declaring less than 1 full year of college) to 28.4 percent (for those having 3 to 4 years of college but no degree).

Most of the findings shown in Figure 1 appear to contradict, rather than support, the hypothesis that education facilitates the learning of ATC work. The relatively high attrition rates of subjects not having high school diplomas admittedly suggest that the recruitment of ATCS personnel should be restricted to those qualifying applicants having at least a high school education. Moreover, data of the remaining subgroups seemingly appear to dictate the need for implementation of revised standards under which education beyond the high school level would either be negatively weighted as an eligibility factor or entirely disregarded. Yet, the results of analyses discussed thus far fail to constitute a sound basis for any conclusion whatsoever regarding the appropriateness or inappropriateness of current standards relating to education. None of the results summarized in Figure 1 can be reliably interpreted because they are undoubtedly confounded by interaction effects of age, recency of education, experience, aptitude level, and possibly other background factors. If the issue concerning education is to be definitively resolved, we must also consider the results of analyses undertaken to assess the influence of various selection factors on the validity of education as a predictor of training outcomes.

*B. Recency of Education.* As indicated earlier, 13 of the respondents to the questionnaire failed to state when they last attended school or college. However, 16 respondents indicated they had been in school until 1 month or less prior to Academy enrollment and four indicated that 31 years had elapsed since termination of their formal education. The mean time lapse for the 2,338 subjects was 85 months, slightly more than 7 years. For purposes of analysis, we coarsely grouped the recency data as follows: 0-3 years, 4-6 years, 7-9 years, 10-12 years, 13-15 years, and 16 years or more.

Figure 2 presents data relating to recency of education. The first two recency categories included more than half (56.9 percent) of the cases. Some 668 (28.6 percent) had attended school or college within 3 years of their Academy entry date and 663 (28.4 percent), within 4 to 6 years. Recency categories 7-9, 10-12, and 13-15 years included 405, 251, and 155 cases respectively. The remaining 196 terminated their education 16 years or more prior to initiation of ATC training.

Slightly more than 37 percent of the subjects having no formal education within the preceding 16 years failed to successfully complete the Academy basic training phase. Next in order of magnitude, but not significantly different from the former, was the Academy attrition rate of 29.7 percent pertaining to those in the recency-of-education category of 13-15 years. The subjects in all remaining categories had significantly lower Academy attrition rates. The rates of those having educational recency of 10-12 and 7-9 years were 20.7 and 19.5 percent respectively. Only 16.7 percent of the 663 who terminated their education 4 to 6 years before recruitment were attrited during the basic training phase and the same was true with respect to 19.0 percent of the 668 having educational recency of 3 years or less.

The post-Academy (i.e., facility training) attrition rates for subjects of the various recency-of-education categories ranged from 16.5 percent to 29.1 percent. The highest of such rates (each of which was based on number of *entrants* into training per category) pertained to the subjects who last attended school or college at least 16

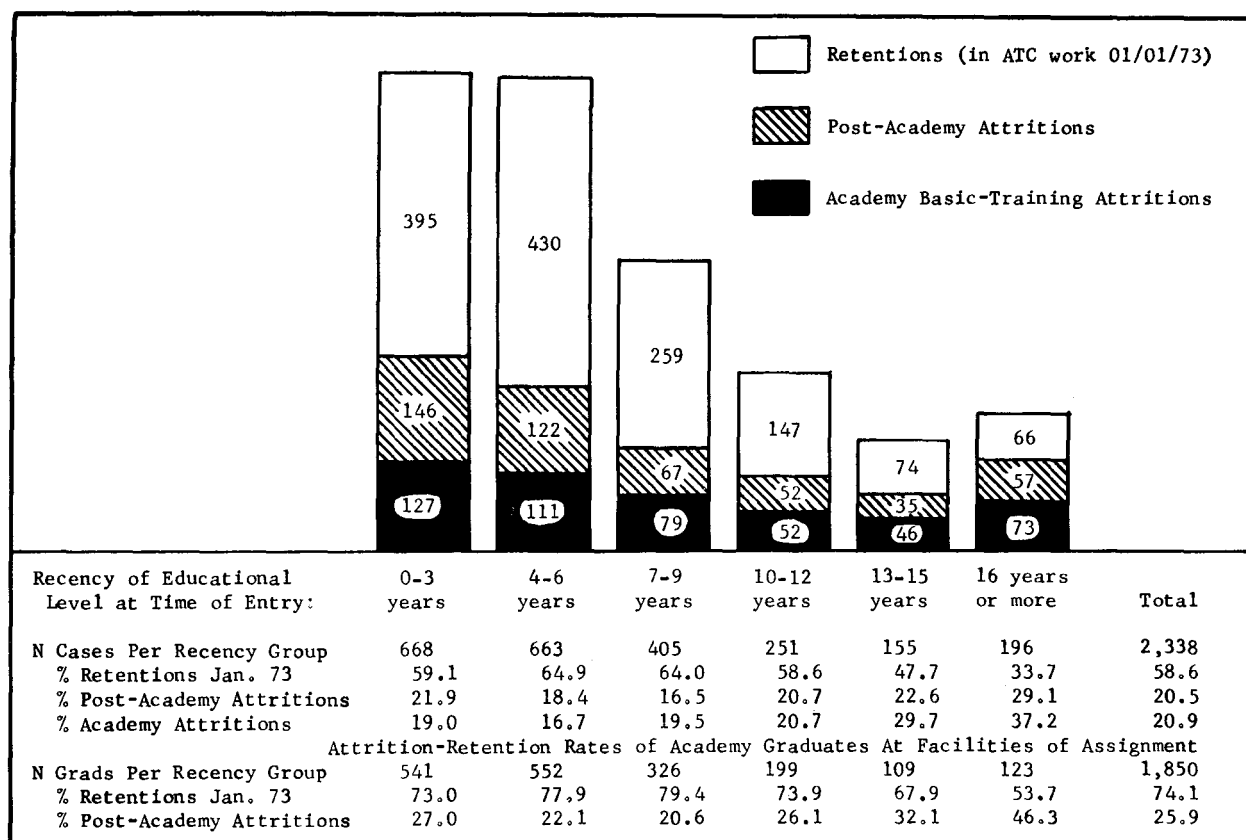


FIGURE 2. Distribution of ATCS attritions and retentions relative to recency of education (i.e., lapsed years, at time of entry into training, since attainment of educational level). (Fourteen cases were not included in the analysis due to lack of information pertaining to level and/or recency of education.)

years before recruitment. Progressively lower rates of 22.6, 20.7, and 16.5 percent respectively pertained to those of recency categories 13-15, 10-12, and 7-9 years. Slightly more than 18 percent of the 663 who terminated their education 4 to 6 years before recruitment were attrited after returning to their facilities of assignment, compared to 21.9 percent of the 668 with education recency of 3 years or less.

Inasmuch as both the facility-training and Academy-training attrition rates tended to increase in accordance with the time lapse since termination of education, the retention rates, as expected, tended to be inversely related to recency. Slightly more than 59 percent of the subjects who had attended school within 3 years or less of recruitment were still in FAA ATC work at the beginning of 1973, compared to 64.9 percent of those having educational recency of

4 to 6 years (the difference between the rates of the two groups was statistically significant ( $p < .05$ )). The rates of subjects in each of the remaining and successive categories were 64.0, 58.6, 47.7, and 33.7 percent respectively. The rate of 33.7 percent for subjects who had terminated their education at least 16 years earlier was found to differ significantly ( $p < .05$ ) from the rates of subjects in each of the preceding categories, and the same was true with respect to the 47.7-percent rate established by those subjects having educational recency of 13 to 15 years.

The post-Academy attrition and retention rates determined by recency-of-education category for the *Academy graduates only* are shown in Figure 2. Inasmuch as the two percentages per category are complementary, and total 100 percent, the findings based on comparison of the retention rates would parallel findings based on attrition

data. Consequently, we have chosen to discuss the retention rates only. Exactly 73 percent ( $N=395$ ) of the 541 Academy graduates having educational recency of 3 years or less were still in FAA ATC work at the beginning of 1973, compared to 77.9 percent of those who attained their highest level of education 4 to 6 years before recruitment. However, the subjects with educational recency of 7 to 9 years had an even higher retention rate of 79.4 percent (higher than that for subjects of any other category) that proved to differ at statistically significant levels from the rates of subjects having educational recency of 0-3 years ( $p<.05$ ) and also those with recency of 16 years or more ( $p<.01$ ). The retention rates of Academy graduates within recency categories 10-12 and 13-15 years were 73.9 and 67.9 percent respectively. Differing significantly from the rates of subjects in each of the preceding recency categories, however, was the 53.7-percent rate (lowest of all rates) that pertained to those subjects who terminated their education 16 years or more before entry into training.

The results of the analysis summarized in Figure 2 seemingly imply that recency of education is a major determinant of training success and that its importance in this respect is appreciably greater for initial training than for post-Academy training. Such an interpretation, however, is difficult to accept. The results concerning recency of education must be considered in conjunction with those of the earlier analysis (shown in Figure 1) that pertained to level of education. The results of the two analyses appear to be irreconcilable. If *level* of education is indeed inversely related (or even negligibly related) to each of the criterion variables, how, then, can we explain the apparent relevancy of these variables to *recency* of education? Logic would suggest the likelihood that the results would be confounded by the effects of some other time-related factor(s), most probably chronological age, which previous CAMI studies<sup>7 9 14 15 16</sup> had consistently shown to be inversely related to training success.

*C. Effects of Age Versus Educational Level and Recency.* The ages (at time of Academy entry) for the 2,349 respondents to the CAMI questionnaire ranged from 20 to 52 and averaged

28.5 years. However, the age distribution (not shown) was highly skewed, in a positive direction; almost 72 percent of the subjects were 30 or younger and an additional 22 percent were 31 to 39 years old.

The application of Pearson product-moment correlational procedures resulted in an "r" (i.e., correlation) of  $-0.38$  for age versus level of education and an  $r$  of  $0.69$  between age and recency of education. The coefficient of  $-0.38$  implied that about 14 percent of the variance in age was associated with that of the level-of-education variable and the  $r$  of  $0.69$  indicated that almost 48 percent of the age variance was common to that of the recency variable. The two educational variables were virtually unrelated; the  $r$  was  $-0.03$ .

The two educational variables and age were also compared with respect to validity for prediction of training outcomes. With Academy attrition-graduation status serving as the criterion, age yielded a validity coefficient (i.e., point-biserial coefficient) of  $-0.25$ , whereas the coefficients for level and recency of education were  $-0.06$  and  $-0.12$  respectively. The post-Academy criterion variable (attrition-retention status as of January 1, 1973) correlated  $-0.24$  with age,  $-0.07$  with level of education, and  $-0.13$  with the recency factor. All the validity coefficients, although of low or very moderate magnitude, proved to be statistically significant ( $p<.05$ ) because of the large numbers of cases involved.

The validity coefficients obtained for each respective variable were virtually impossible to compare meaningfully because of lack of normality in the distribution of the basic data. Although level and recency of education were also not normally distributed, attenuation effects were most visible in the age distribution. The vast majority of the trainees were relatively young; in fact, less than 13 percent were 36 or older. Consequently, the correlation of  $-0.24$  between age and the Academy criterion variable must be regarded as a gross underestimate of the relationship that would have existed had the range of age for the trainees been less restricted. Moreover, less than half the subjects composing the total sample had attended college, only 181 had attained college degrees, and all but 43.3 percent

had terminated their education 6 years or less before entering ATCS training. Considering the impact of such attenuation effects, plans were revised to exclude those analyses of a correlational nature.

The next analysis, the results of which are shown in Figure 3, involved a comparison of the attrition and retention rates by level and recency of education for those subjects aged 30 and younger versus those 31 and older. The decision to dichotomize age was made following a preliminary analysis that indicated if the 296 cases aged 36 and older were categorized with respect to level and recency of education, the resulting frequencies for many of the cells (i.e., cate-

gories) would be so small as to preclude reliability of the attrition-retention rates. For the same reason, we also chose to group the subjects more coarsely in terms of educational level, and also recency of education, than they had been in the previously discussed analyses.

In examining Figure 3, one should first note that there is no level-of-education category nor any recency-of-education category within which the subjects aged 30 and younger failed to have a lower Academy attrition rate than the older subjects. All differences between the Academy attrition rates of the younger versus older subjects of the various level-of-education categories except that pertaining to the college graduates

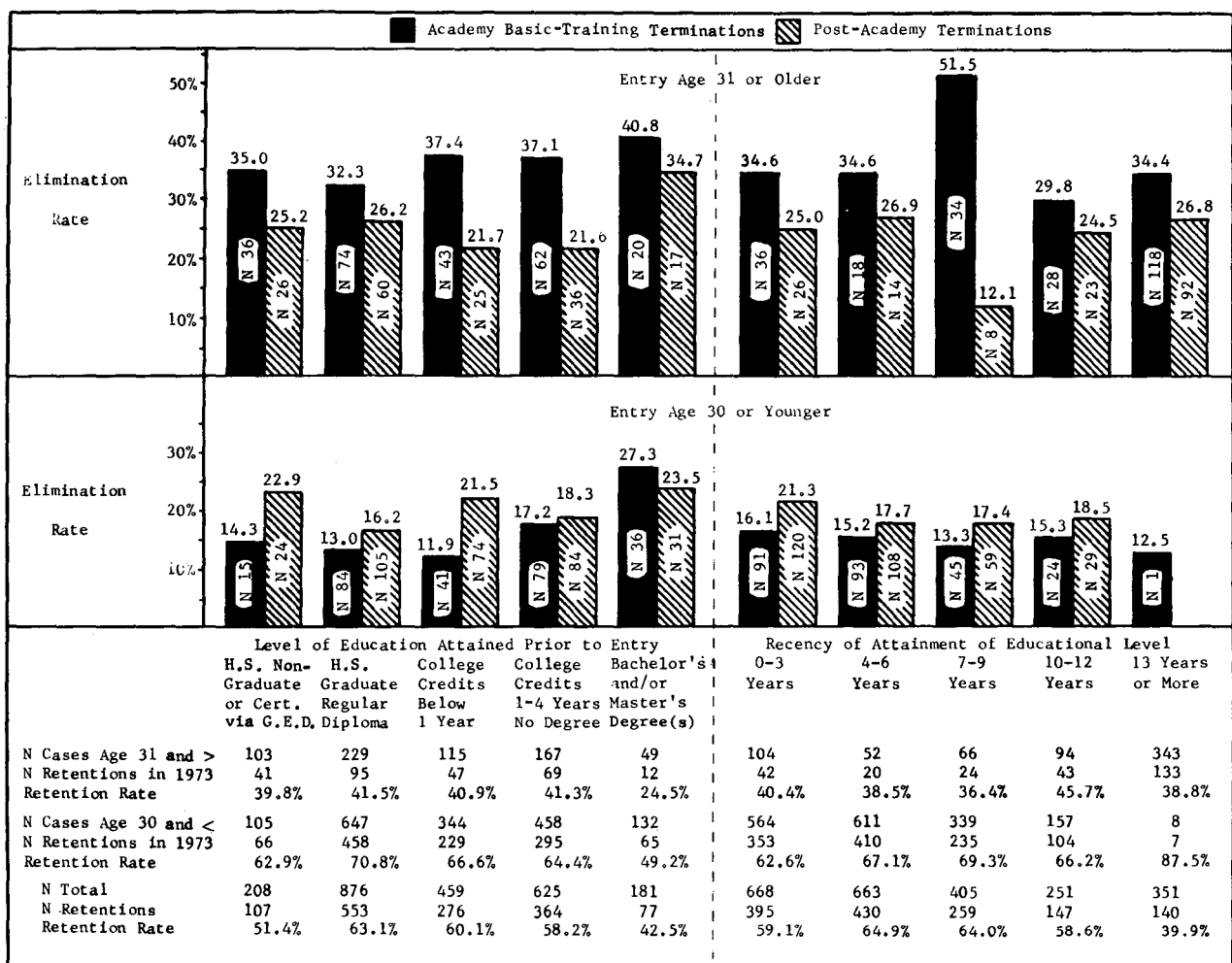


FIGURE 3. Attrition rates by level and recency of education and dichotomized age grouping for En Route and Terminal ATCS personnel recruited during 1969. (Three of the 2,352 subjects failed to indicate either level or recency of education and an additional 11 failed to provide recency information only.)

(27.3 versus 40.8 percent) proved to be statistically significant. Similarly, all but one of the differences between the Academy attrition rates of the younger versus older subjects of the various recency-of-education categories were statistically significant. The exception pertained to subjects who terminated their education at least 13 years before entry into training; only one of the eight younger subjects was attrited, yielding a rate of 12.5 percent; the latter percent, being based on such a small number of cases, failed to differ significantly from the 34.4-percent rate of the 343 older subjects.

When comparing the Academy attrition rates of the older subjects only with respect to level of education, none was found to exceed the rate of 40.8 percent established by the college graduates. Moreover, 37.1 percent of the trainees aged 31 and older who indicated 1 to 4 years of college credits (but no degree) failed to successfully complete the basic training phase, compared to 37.4 percent of those who attended college less than 1 year. Corresponding rates of 32.3 and 35.0 percent respectively were obtained for the older subjects having high school diplomas only and those who failed to graduate from high school. None of the attrition-rate differences was statistically significant.

The Academy attrition rates of the younger subjects (aged 30 and less) within the various level-of-education categories were substantially lower than those of the older subjects and, to a greater extent than the latter, tended to reflect a positive relationship with educational level. Some 27.3 percent of the 132 youngest college graduates failed to successfully complete the basic training phase; their attrition rate differed significantly from those of the younger subjects within each of the lower level-of-education categories. Next in rank order, and also differing significantly from all others except that for the high school nongraduates (14.3 percent), was the rate of 17.2 percent for subjects having 1 to 4 years of college (but no degree). Corresponding rates of 13.0 and 11.9 percent respectively were obtained for the high school graduates and those having less than 1 year of college.

There was no level-of-education category in which the older subjects failed to have a higher post-Academy (facility training) attrition rate

than that of the younger subjects. Most of the age-related differences were statistically significant. For neither age group, however, did there appear to be a clear relationship between such rates and educational level. Nonetheless, the college graduates aged 31 and older had a post-Academy attrition rate of 34.7 percent, whereas the corresponding rates for the older subjects of other educational levels ranged from 21.6 percent (for those having 1 to 4 years of college) to 26.2 percent (for the high school graduates). For the younger subjects, highly comparable post-Academy attrition rates of 23.5 and 22.9 percent respectively were obtained for the college graduates and those not having high school diplomas, whereas the rates of the remaining subgroups ranged from 16.2 (for the high school graduates) to 21.5 percent (for those having less than 1 year of college).

There appeared to be no relationship between the Academy attrition rates and recency of education for either the older or younger subjects. As mentioned, however, there was no recency category in which the younger subjects failed to have an appreciably lower Academy attrition rate than that of the older subjects. Much the same was true with respect to the post-Academy (i.e., facility training) attrition rates of the younger versus older subjects of each recency category. In other words, both types of training attrition rates seem to be unrelated to educational recency but highly associated with age.

The findings presented in Figure 3, when supplemented by those obtained in the two previous analyses (shown in Figures 1 and 2), appear to contradict, rather than support, the hypothesis that education is beneficial and helpful to ATCS personnel during training. Such a conclusion, however, should be held in abeyance pending review and consideration of results of other analyses relating to the interaction effects of aviation-related experience and aptitudes (mental abilities) on the validities of education as a predictor of training outcomes.

*D. Aviation Experience and Age Versus Education as Selection Factors.* As discussed earlier in this report, FAA ATCS selection programs have always included standards reflecting a philosophy that almost any type of aviation-

related experience should be helpful to personnel during ATC training. CAMI studies of trainees recruited during various time periods prior to 1970 have generally shown that 65 to 85 percent of the selectees possessed rated experience in air traffic control (usually military ATC), as a pilot, or in communications work. Although research has repeatedly shown ATC experience, particularly radar control, to be appreciably valid for prediction of training outcomes, all other types of aviation experience (e.g., pilot, navigator, communications, air defense surveillance, air dispatcher service, etc.) have proved virtually worthless for prediction of training success. At the time the current study was being conducted, we considered the likelihood that new selection procedures would soon be implemented under which most types of aviation-related experience other than ATC would be either disregarded or very negligibly weighted as components of the applicants' overall eligibility ratings. We therefore proceeded with the next analysis, bearing on experience effects, by first assigning each of the 2,349 cases to one of three (mutually exclusive) categories: "No Type of Rated Pre-FAA Experience," "Non-ATC With Rated Pilot and/or Communications Experience," and "Rated ATC Experience With or Without Pilot and/or Communications Experience."

Figure 4 shows the retention rates by level-of-education category for the subjects within each of the three experience categories. The retention rates, as in the earlier analyses, represent the proportions of the various subgroups still in FAA ATC work at the beginning of 1973. As may be noted, there was no level-of-education category within which those subjects having rated pre-FAA ATC experience failed to have a higher retention rate than those having pilot and/or communications (but no ATC) experience and also those devoid of rated aviation-related experience of any type. Although differences between the retention rates of the differentially experienced subjects of each educational level were tested for statistical significance (via the two-tailed "t-test"), all but two sets of differences were nonsignificant. The rate of 71.4 percent for the high school graduates who held ATC ratings differed significantly ( $p < .01$ ) not only

from the rate of 51.7 percent for the high school graduates whose aviation backgrounds included no rated ATC experience, but also from the rate of 53.7 percent established by the remaining subjects within that educational level who had no type of rated aviation experience. Similarly, the retention rate of 71.0 percent for the ATC-rated trainees having less than 1 full year of college was found to differ significantly ( $p < .01$ ) from the rate of 47.7 percent established by those having pilot and/or communications ratings and the 55.8-percent rate that pertained to subjects of the same educational level who had no aviation ratings.

In comparing the retention rates of the ATC-rated subjects by level of education (i.e., between educational categories), the two lowest, 47.1 percent for the college graduates and 54.0 percent for those not having high school diplomas, were found to differ significantly from both the 71.4 percent of the high school graduates and the 71.0 percent obtained for those having less than 1 year of college. The relatively high retention rate of 61.7 percent for those having 1 to 4 years of college differed significantly from that of only one subgroup, the high school graduates (71.4 percent). With level of education disregarded, the ATC-rated subjects numbered 1,020 and 66.9 percent (not shown) were still in the air traffic control system at the beginning of 1973.

The retention rates of subjects having pilot and/or communications but no ATC ratings ranged from 40.5 percent for the college graduates to 59.9 percent for those having 1 to 4 years of college. The difference between the rates of the two subgroups proved statistically significant and the same was true regarding the difference between the highest of the two just mentioned versus the 47.7-percent rate established by those having less than 1 full year of college. Only 44.8 percent of the ATC-rated subjects lacking high school diplomas were still in FAA ATC work at the beginning of 1973, compared to 51.7 percent of the high school graduates. Although not shown in the figure, the mean retention rate for the 624 subjects of all education levels within this experience category was 52.4 percent, significantly ( $p < .01$ ) different from the 66.9-percent rate of the ATC-rated trainees.

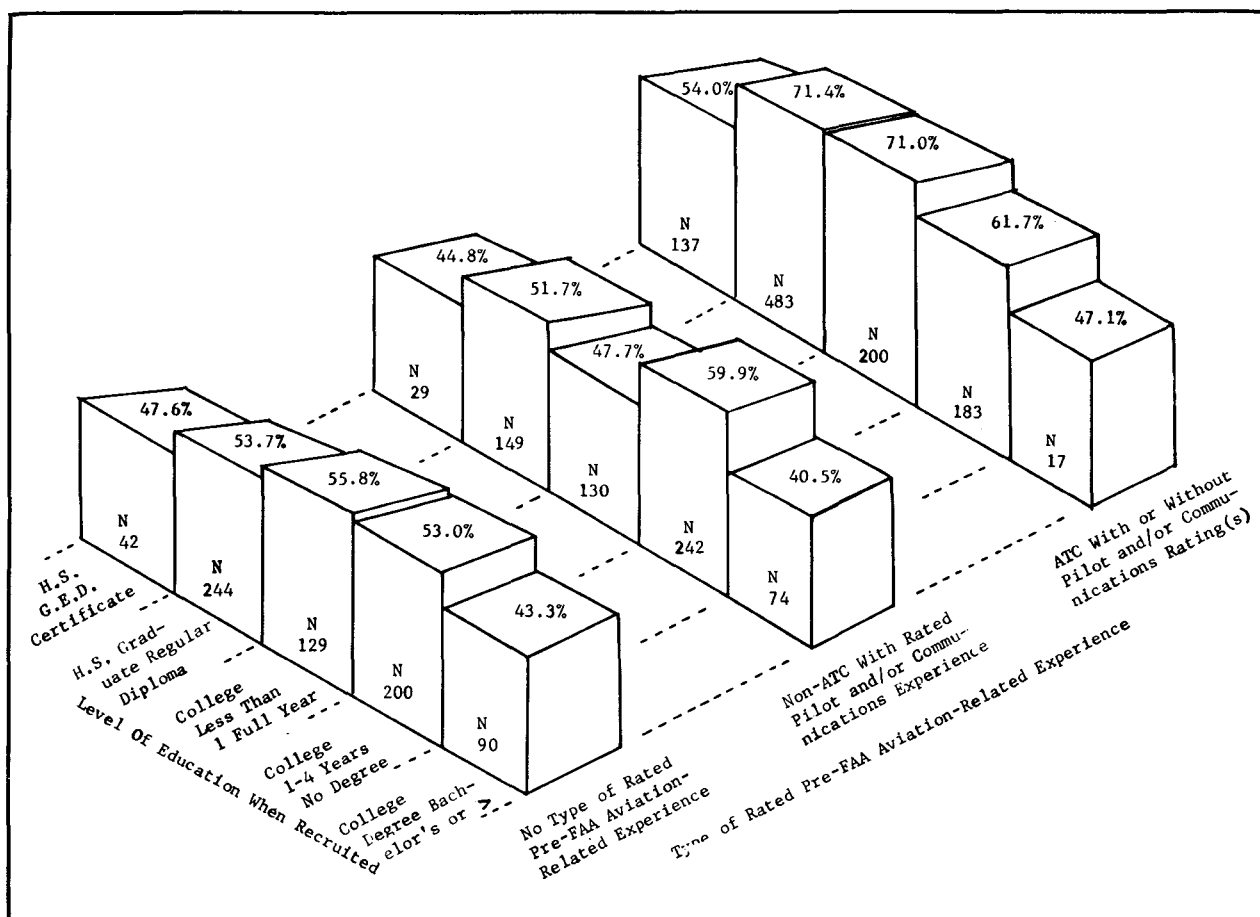


FIGURE 4. Retention rates by level of education and type of rated pre-FAA aviation-related experience for 2,349 subjects who entered Academy basic training in En Route or Terminal ATC procedures during 1969. (Rates reflect proportions in each subgroup still in FAA ATC work as of January 1973.)

The 705 nonrated subjects fared as badly in training as did the pilots and communications experts who held no ATC ratings. As of January 1, 1973, only 52.2 percent (not shown) of the 705 were continuing their ATC careers. The difference between their retention rate and that of the ATC-rated subjects (66.9 percent) was statistically significant ( $p < .01$ ). In comparing the retention rates of these nonrated subjects by level-of-education category, it should be noted that the lowest, 43.3 percent, pertains to the college graduates and that the next lowest, 47.6 percent, pertains to those who failed to obtain high school diplomas. The retention rates of trainees in the three other level-of-education categories ranged from 53.0 to 55.8 percent. All differences between rates of the various subgroups of this experience category were non-significant.

When considered as a body, the analysis results depicted in Figure 4 seemingly imply a need for abolishment of those selection procedures currently prescribing that an applicant be awarded credit points toward his/her training-eligibility rating for either pilot or communications ratings. Moreover, the findings relating to education provide no support for the current policies whereby applicants are permitted to substitute college education for aviation experience. The college graduates within each of the three experience categories had lower, not higher, retention rates than their colleagues of every lower level-of-education category. It is also of interest to note that within each experience category, the subjects who held G.E.D. certificates rather than high school diplomas had lower retention rates than any other subgroup except the college graduates.



Nonetheless, the results of analyses thus far discussed fail to constitute conclusive proof that education, as defined by level, is indeed invalid for selection purposes. The interaction effects of both age *and* experience have yet to be examined simultaneously. The results of such an analysis are presented in Figures 5a and 5b. In conducting this analysis, we assigned each of the 2,349 cases to one of four mutually exclusive experience categories. Two of the four are identical to those established in the earlier analysis but, for reasons that will be obvious later, were relabeled as "No Rated Pre-FAA Experience in ATC Work or as a Pilot or in Communications" and "No Previous ATC-Rated Work but Rated Pilot and/or Communications Experience." As may be recalled, the first of the two categories contains 705 cases, while the latter includes 624. However, each of the remaining 1,020 cases, all of which were assigned to a single category in the preceding analysis, were assigned to either of two new categories: "Pre-FAA ATC Rating Only" or "Pre-FAA ATC Rating With Pilot and/or Communications Rating(s)." Some 169 of the 1,020 ATC-rated subjects also held pilot and/or communications ratings and 851 held ATC ratings only.

In reviewing the results of this analysis, we should tentatively defer consideration of those relating to age and education. First, we should compare the retention rate of the 169 subjects having two or more ratings, one of which was an ATC rating, with the rates of subjects having only a single rating. If we consider each type of experience as being valid for selection purposes, then the 169 subjects should have a higher retention rate than those of any other category (see Figures 5a and 5b). As may be noted, they did not. Their retention rate was 62.7 percent, whereas that of the 851 having ATC ratings only was 67.7 percent. Corresponding rates of 52.4 and 52.2 percent respectively pertained to the 624 non-ATC-rated subjects having pilot and/or communications ratings and the 705 having no rated experience of any of the three major types. Differences that proved statistically significant were those involving each of the latter versus those in each of the ATC-rated categories.

The subjects aged 31 and older within each of the four experience categories had significantly ( $p < .05$ ) lower retention rates than their younger colleagues. Of the 169 ATC-rated subjects who also claimed pilot and/or communications ratings, 56 were 31 or older and 50 percent of the 56 were still in FAA ATC work at the beginning of 1973, compared to 69 percent of the 113 aged 30 and younger. The respective retention rates of the younger versus older subjects were 46.8 and 73.5 percent for the subgroup having ATC ratings only, 33.2 and 62.4 percent for those having pilot and/or communications ratings but no ATC ratings, and 37.7 and 58.2 percent for those not having ratings in any of the three aviation-related areas.

Such results (Figures 5a and 5b) clearly demonstrate that attrition-retention status is far more contingent on training-entry age than experience. Although the 2,349 subjects involved in the current study were recruited in 1969, long before adoption of the standard restricting training candidacy to personnel no older than 30, only 663 of the 2,349 were 31 or older. The remaining 1,686 (71.8 percent) were 30 or younger and the majority of the 1,686 also possessed rated aviation-related experience. With experience disregarded, the retention rate of the older subjects was 39.8 percent, whereas that of the 1,686 younger subjects was 66.0 percent. Some 665 of the 1,686 held ATC ratings only and their retention rate was 73.5 percent; this was slightly (but not significantly) higher than the 69.0-percent rate established by the 113 having ATC ratings in conjunction with pilot and/or communications ratings. Some 62.4 percent of the 410 subjects of the same age grouping who held pilot and/or communications ratings but no ATC ratings were still in FAA ATC work at the beginning of 1973, compared to 58.2 percent of the 498 subjects aged 30 and younger who had no ratings in any of the three areas. The rate of 58.2 for the 498 differed significantly from those of both ATC-rated subgroups.

Preparatory to a comparison of the attrition-retention data of the subjects within each rated-experience category by age and educational level, we noted that only 17 of the 181 college graduates possessed ATC ratings—12 held ATC ratings only and five were ATC-rated subjects with

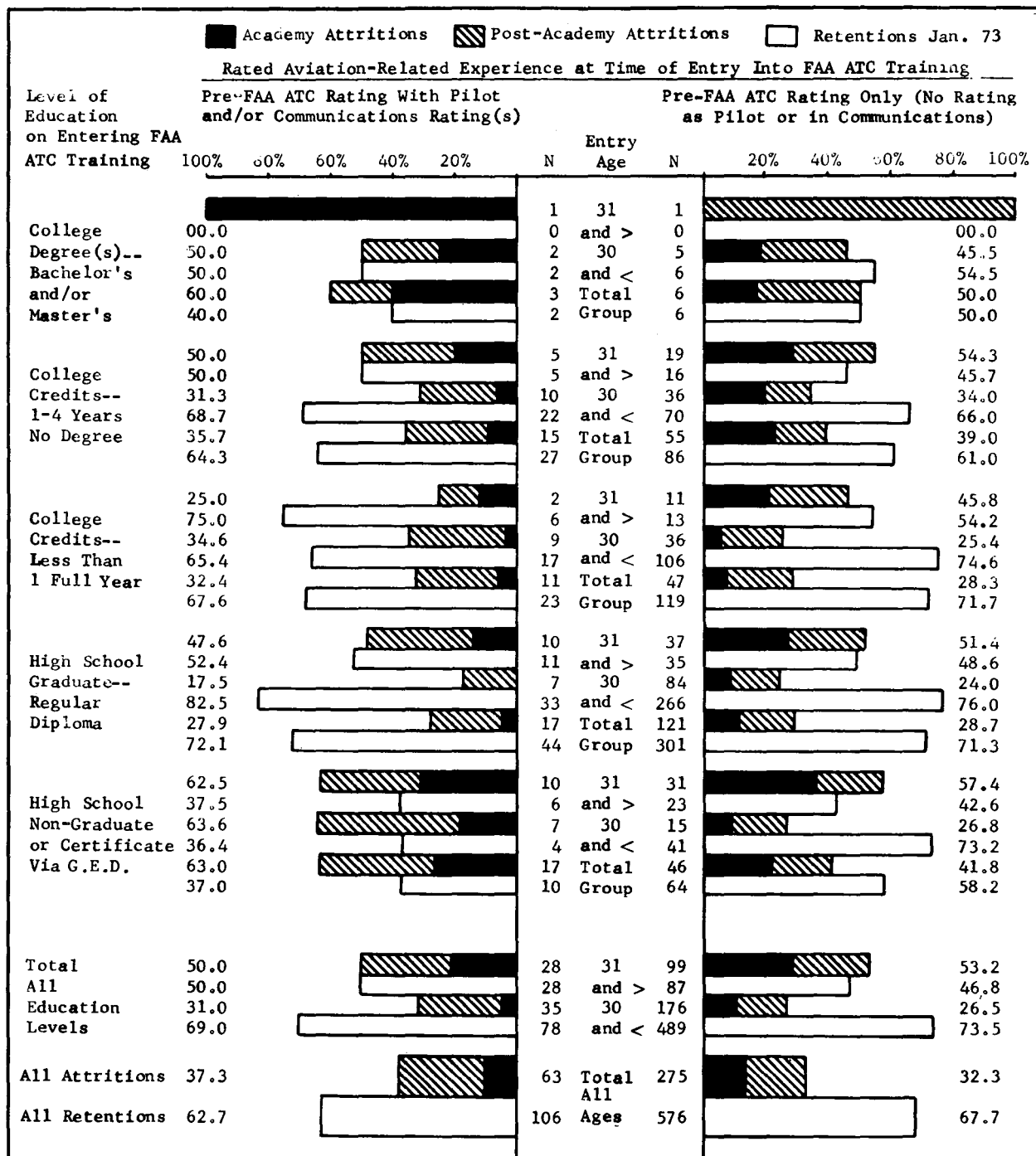


FIGURE 5a. Attrition and retention rates by age and educational level for 1,020 subjects who held pre-FAA ATC ratings, with or without rated pilot and/or communications experience, at time of entry into Academy basic training in En Route or Terminal control procedures.

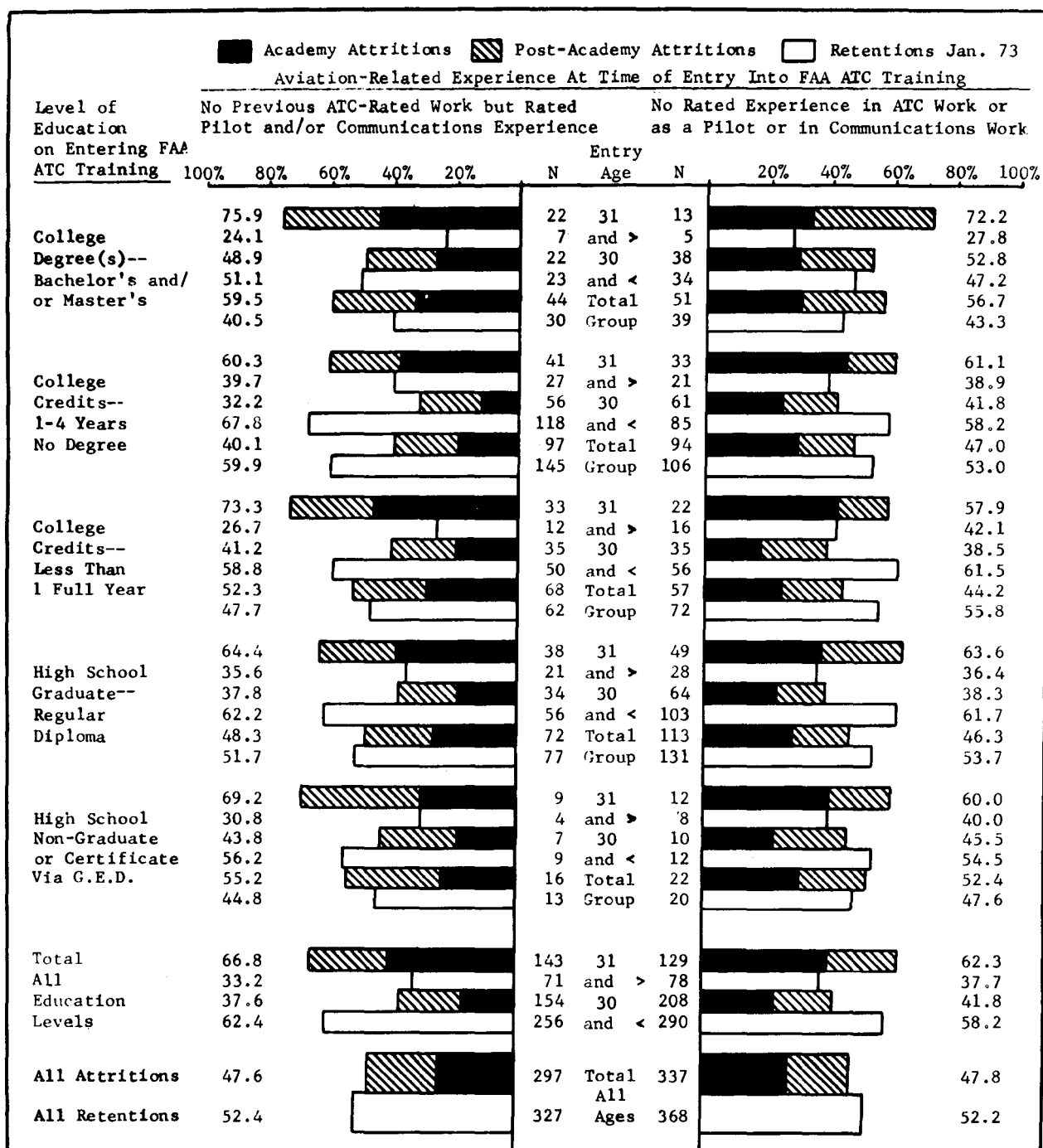


FIGURE 5b. Attrition and retention rates by age and level of education for 1,329 subjects having no rated ATC experience on entry into FAA ATC training in 1969. The group of 624 having pilot and/or communications ratings, but no ATC ratings, included 73 rated as pilots only, 94 rated in communications only, and 457 having both pilot and communications ratings. Although not depicted the retention rates of the respective subgroups were 49.3, 54.3 and 52.5 percent.

pilot and/or communications ratings. Of the 181, 74 were non-ATC-rated subjects with pilot and/or rated communications experience and the remaining 90 failed to possess a rating in any of the three areas. The retention rates of the college graduates aged 31 and older within each of the rated-experience categories were generally substantially lower than those of the younger graduates.

Due to the pervasiveness of age effects, we focused on a comparison of the retention rates of the younger subjects only to determine the extent to which the validity of education, as defined by level, might vary in accordance with types of rated aviation-related experience. The retention rates of the college graduates of every experience category were relatively low; they ranged from 47.2 percent for the 72 having no ATC, pilot, or communications ratings to 54.5 percent for the 11 holding ATC ratings only. In fact, there was only one experience category in which the retention rate of the college graduates failed to be lower than those of comparably aged subjects of every other level-of-education category. The exception pertained to the 36.4-percent rate established by the 11 non-graduates of a high school (less than 31 years old) who held ATC ratings and also pilot and/or communications ratings. Within each of two experience categories, the younger subjects without high school diplomas had an attrition rate exceeded only by that of the college graduates. However, the 56 youngest subjects of the lowest level-of-education category who held ATC ratings only had a very respectable retention rate of 73.2 percent.

There was only one experience category within which the high school graduates aged 30 and younger did not have a higher retention rate than did subjects of all other educational levels. The exception pertained to 90 high school graduates having pilot and/or communications ratings but no ATC ratings; their retention rate of 62.2 percent was exceeded by the rate (67.8 percent) established by 174 having 1 to 4 years of college. Slightly more than 82 percent of the 40 high school graduates of age 30 and younger having ATC and pilot and/or communications ratings were still in FAA ATC work at the beginning

of 1973, compared to 76.0 percent of the 350 (youngest) high school graduates who entered with ATC ratings only and 61.7 percent of the 167 of the same age and educational categories not having an ATC, pilot, or communications rating.

A fact warranting emphasis is that many of the 705 nonrated subjects were not necessarily devoid of aviation-related experience. According to response data to various questions on the CAMI questionnaire, some of these subjects had limited ATC experience but possessed no ATC rating; some were student pilots who had relatively few hours of flying time (and were not categorized as pilots in the current study), and many stated they had communications experience of various types but failed to indicate they held a rating in that area. Moreover, a significant proportion declared other types of aviation-related experience, most frequently as air dispatchers or navigators or in radar surveillance work associated with air defense systems. Yet, the vast majority indicated they had no aviation-related experience whatsoever. For purposes of the present study, no distinction was made between the various subgroups because none of the 705 claimed to have *rated* aviation experience of the types for which ATCS selection standards have long prescribed the award of credit points toward derivation of an applicant's overall eligibility rating. In terms of selection standards, these subjects were generally "less qualified" with respect to "job-related experience" than those who entered with ATC, pilot, and/or communications ratings. Education (as defined by level) might therefore be expected to validate rather impressively as a predictor of their training outcomes. However, the validation results were not of the nature that formulators of the selection standards would probably have forecast.

The retention rates of the 207 nonrated subjects aged 31 and older ranged from 27.8 percent for the 18 college graduates to 42.1 percent for the 38 who had less than 1 full year of college. When placed in rank order, however, the retention rates of the older subjects failed to reflect either a positive or an inverse relationship with level of education.

The retention rates of the 498 nonrated subjects aged 30 and younger were generally higher than those of their older colleagues but, in contrast with the latter, followed a pattern reflecting a moderate *inverse* relationship with educational level. At the beginning of 1973, only 47.2 percent of the younger nonrated subjects having college degrees were still in the air traffic control system. The nonrated subjects aged 30 and younger of all other educational levels had substantially higher retention rates. Even those (N=22) lacking high school diplomas fared better than the college graduates (54.5 percent versus 47.2 percent).

Rates of the remaining subgroups (of the same age category) were 58.2 percent for 146 having 1 to 4 years of college, 61.5 for 91 having less than 1 year of college, and 61.7 percent for 167 who terminated their education after receiving their high school diplomas. Although only that difference between the latter versus the 47.2-percent retention rate of the college graduates was statistically significant ( $p < .05$ ) the nature and trend of the findings contradict, rather than support, the philosophy that training-success probabilities tend to increase in accordance with educational levels.

*E. Educational Level Versus Aptitudes, Age, and Experience.* We encountered several encumbrances when attempting to assess possible interaction effects of aptitudes (as measured by the CSC Aptitude Test Screening Battery) on the validity of education level for prediction of training success. The FAA regional offices forwarded CSC ATC test performance data to CAMI for only 1,484 of the 2,349 subjects for whom educational information was elicited through use of the background questionnaire. Moreover, the test data were presumably biased; scores were provided CAMI for disproportionately fewer Academy attritions than graduates (34.7 percent versus 67.6 percent respectively). Test records were seldom forwarded until several weeks, sometimes months, after the trainees had enrolled at the Academy; training-course failure usually led to termination of FAA employment; records were rarely retained on personnel beyond 30 days following their release and were no longer available when efforts were belatedly and sporadically

undertaken to extract, roster, and forward the information needed for research purposes. Thus, the test scores received by CAMI for 1,484 subjects yielded an attenuated distribution. Even if scores of all selectees had been available, however, the resulting score distribution would have been rather drastically attenuated relative to that expected for a typical applicant group. On the basis of findings obtained in several unpublished CAMI studies, we estimate that slightly less than half the applicants examined with the battery during the past 10 years have scored at least 210 (usually considered minimally qualifying) and that less than 20 percent of the examinees achieved scores in the range of 230 and higher, from which the FAA has selected about 70 percent of its trainees.

The failure of the FAA regions to provide CAMI with complete records on all, or at least most, of the 2,352 subjects involved in the study also resulted in other problems and research difficulties. The lack of sufficient data precluded determination of the number of subjects who established their candidacy under the "specialized experience standard." By resorting to a review of CAMI questionnaire response data and also information obtained from the Academy training records, we finally determined that at least 582 of the 2,352 entered under the specialized experience standard, presumably with their aptitude test scores being disregarded in the selection process. The 582 were appointed to training with General Service ratings (i.e., pay grades) of GS-8 or higher. Although entry into training at the GS-8 level or higher implied (beyond doubt) that a subject qualified under the specialized experience standard (e.g., ATC work, Ground Control Intercept Director experience, etc.), we had no way of ascertaining precisely how many of the GS-7 rated subjects might also have qualified for waiver of the aptitude screening requirement.

When the CSC test scores that the regions forwarded for 1,484 subjects were arrayed, the majority (67 percent) were found to be within the relatively narrow range of 210 to 259 and only 151 (10.2 percent) were below the normally prescribed screening cut of 210. Only 27 of the 151 nonqualifying scores pertained to those in

grade GS-7. As mentioned, however, it is reasonable to suspect that some additional GS-7 rated subjects with nonqualifying scores were among those for whom the regions failed to forward test data and/or complete background information.

Considering the incompleteness and irregularities of the background information on subjects for whom records were received and in view of the extent to which bias had presumably occurred in the collection of aptitude test data, it seemed rather illogical to proceed with plans for a detailed analysis that would have involved computation of the intercorrelations of the aptitude-test variable, age, educational level, and other variables.

Instead, we decided to undertake an analysis to determine and compare the retention rates of the subjects by age category and by rated experience grouping and level-of-education category within each of three major groupings: those hired at grade GS-7 and lower for whom qualifying CSC test scores of 210 or higher were received, those (with or without test scores) hired at the GS-8 level or higher with waivers of the aptitude screening requirement, and those of GS-7 level and lower for whom no CSC test scores were received. The results of this analysis, from which the 27 GS-7 rated subjects having nonqualifying scores were excluded, appear in Table 1.

TABLE 1. Subjects' Retention Rates by Educational Level, Age, and Preentry Experience Background\*

Entry Age		Subjects Hired at the GS-7 Level or Lower Having Qualifying Scores of 210 or Higher on CSC ATC Aptitude Test Screening Battery						Subjects Hired at the GS-8 Level or Higher Whose Specialized Job-Related Experience Warranted Waiver of Aptitude Test Qualification						Subjects Hired at the GS-7 Level or Lower for Whom the Regions Provided No Record of Scores on the Aptitude Test Battery**					
		Type of Aviation Rating(s) Held Prior to Entry Into FAA ATCS Training																	
		ATC Rating w/wo Pilot and/or Communications Rating		No ATC Rating; Rated as Pilot and/or in Communications		No Rating as ATC or Pilot or in Communications		ATC Rating w/wo Pilot and/or Communications Rating		No ATC Rating; Rated as Pilot and/or in Communications		No Rating as ATC or Pilot or in Communications		ATC Rating w/wo Pilot and/or Communications Rating		No ATC Rating; Rated as Pilot and/or in Communications		No Rating as ATC or Pilot or in Communications	
		Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate	Retention Rate
Level of Education Attained Prior to Entry Into Academy Basic Training		N	Rate	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
31 Or Older	H.S. G.E.D.	4	75.0%	7	28.6%	11	54.5%	54	38.9%	3	00.0%	10	30.0%	6	33.3%	6	33.3%	19	21.1%
	H.S. Diploma	3	33.3%	39	46.2%	48	41.6%	77	51.9%	10	40.0%	11	36.4%	19	15.8%	29	21.1%		
	< 1 Yr College	4	75.0%	24	29.2%	22	59.1%	27	59.3%	3	00.0%	3	00.0%	18	22.2%	13	23.1%		
	1-4 Yr College	5	80.0%	44	52.3%	34	47.1%	31	41.9%	2	50.0%	9	44.4%	24	16.7%	18	22.2%		
	College Degree			13	15.4%	11	27.3%	1	00.0%	3	66.7%	2	00.0%	1	00.0%	13	23.1%	5	40.0%
Total		16	68.7%	127	40.9%	126	46.0%	190	47.4%	6	50.0%	20	25.0%	32	34.4%	80	20.0%	61	24.6%
30 Or Younger	H.S. G.E.D.	19	73.7%	11	63.6%	17	58.8%	36	66.7%	1	100.0%	10	60.0%	4	25.0%	5	40.0%	47	31.9%
	H.S. Diploma	134	81.3%	66	74.2%	109	76.1%	161	76.4%	4	75.0%	10	40.0%	85	70.6%	20	20.0%	47	31.9%
	< 1 Yr College	56	71.4%	63	65.1%	57	70.2%	71	73.2%	1	00.0%	3	100.0%	35	74.3%	21	42.9%	31	41.9%
	1-4 Yr College	43	76.7%	127	72.4%	105	68.6%	61	70.5%	2	100.0%	1	100.0%	31	48.4%	45	53.3%	40	30.0%
	College Degree	5	60.0%	25	64.0%	46	56.5%	9	55.6%	2	50.0%	4	75.0%	1	00.0%	18	33.3%	22	22.7%
Total		257	77.4%	292	70.2%	334	69.1%	338	73.1%	10	70.0%	18	61.1%	162	66.0%	108	40.7%	145	32.4%
All Ages	H.S. G.E.D.	23	73.9%	18	50.0%	28	57.1%	90	50.0%	1	100.0%	3	00.0%	20	45.0%	10	30.0%	11	36.4%
	H.S. Diploma	137	80.3%	105	63.8%	157	65.6%	238	68.5%	4	75.0%	20	40.0%	96	66.7%	39	18.0%	66	28.8%
	< 1 Yr College	60	71.7%	87	55.2%	79	67.1%	98	69.4%	4	25.0%	6	50.0%	36	72.2%	39	33.3%	44	36.4%
	1-4 Yr College	48	77.1%	171	67.2%	139	63.3%	92	60.9%	2	100.0%	3	66.7%	40	47.5%	69	40.6%	58	27.6%
	College Degree	5	60.0%	38	47.4%	57	50.9%	10	50.0%	5	60.0%	6	50.0%	2	00.0%	31	29.0%	27	25.9%
Total		273	76.9%	419	61.3%	460	62.8%	528	63.8%	16	62.5%	38	42.1%	194	60.8%	188	31.9%	206	30.1%

\*The analysis pertains to 2,322 of the 2,352 entrants of the Academy's En Route and Terminal basic training courses during 1969; excluded are three subjects who failed to indicate educational level and 27 at the GS-7 level for whom the Regions forwarded nonqualifying aptitude test scores of 209 or lower.

\*\*Inasmuch as the Regions seldom forwarded the records of subjects as they entered Academy training and since it was not the practice to retain records beyond 30 days following termination of employment, aptitude scores were unavailable for a large proportion of the subjects who were attrited during basic training.

Inasmuch as previous analyses of this study have rather clearly demonstrated that the probabilities of success in ATC training are more associated with entry age and types of aviation ratings than level of education, there is little need to discuss retention-rate differences that would merely further illustrate the influence of those variables. However, it is important to note that with age disregarded, the subjects of GS-7 level and lower having CSC test scores of 210 and higher within two of the experience-rating

categories had retention rates exceeding those of their somewhat comparably experienced colleagues of GS-8 level and higher who entered training with waivers of the aptitude screening requirement. Perhaps the most striking finding concerns the 38 subjects among those hired at grade GS-8 or higher who were nonrated in ATC work, as pilots, or as communications specialists; the retention rate of the 38 (many of whom were former ground control intercept directors) was only 42.1 percent—significantly ( $p < .05$ ) differ-

ent from the 62.8-percent rate of the 460 subjects of lower GS grades who had no aviation ratings. Retention rates of the subjects of GS-7 level and lower for whom no test scores were received were 30.1 percent for the nonrated subgroup (N=206), 31.9 for the 188 who were pilots and/or communications specialists with no rated ATC experience, and 60.8 percent for the 194 holding ATC ratings as well as pilot and communications ratings. Such findings, supplemented by those of a similar nature for subjects of dichotomized age groups, appear to justify the FAA's reinstitution, in April 1973, of the policy whereby qualification on the CSC ATC Aptitude Test Battery is a mandatory training-eligibility requirement.

Knowing that the FAA will be recruiting its future ATCS trainees from among aptitude-screened candidates no older than 30, we should therefore be particularly interested in comparing the retention rates by level-of-education category for those younger subjects (involved in the current study) within each rated experience category, having entry grades no higher than GS-7, who attained qualifying CSC test scores of 210 or higher. As may be noted, the retention rates for the younger ATC-rated subjects having scores of 210 and higher ranged from 60.0 percent for the five college graduates to 81.3 percent for the 134 who terminated their education after graduation from high school; however, the lowest of the intervening rates was 71.4 percent for the 56 having less than 1 full year of college, whereas that of the 19 lacking high school diplomas was 73.7, which compared favorably with the 76.7-percent rate established by 43 having 1 to 4 years of college credits. The group of 292 of the same age and aptitude grouping having pilot and/or communications ratings but no rated ATC experience included 66 with high school diplomas only and their retention rate was 74.2 percent, compared to 72.4 percent for the 127 having 1 to 4 years of college, 65.1 percent for those having less than 1 full year of college, and 64.0 and 63.6 percent respectively for the college graduates and those with G.E.D. certificates. Concerning the nonrated subjects of the same age and aptitude categories, it should be noted that the two lowest ranked retention rates of 56.5 percent and

58.8 percent respectively pertained to the college graduates and those who failed to graduate from high school, whereas some 76.1 percent of the high school graduates were still in ATC work at the beginning of 1973, compared to 70.2 percent of those having less than 1 full year of college and 68.6 percent of those having 1 to 4 years of college. In other words, there was no rated-experience category within which the high school graduates did not have a higher retention rate than the subjects of any other educational level and there was only one rated-experience category (i.e., pilots and communications specialists not having ATC ratings) in which the college graduates failed to have the lowest retention rate.

Such findings—particularly those pertaining to the subjects under 31 years old not having ATC, pilot, or communications ratings (but who scored 210 or higher)—clearly imply, in our opinion, that the ATCS selection process should include little or no consideration of education beyond the high school level. For candidates who are equally qualified in all respects except education, selection standards should be revised in such a manner as to result in relatively lower eligibility for those who failed to receive their high school diplomas. Nonetheless, age, aptitude, and ATC experience are far more valid as selection factors than education. To suggest that restraint be exercised in the selection of college graduates would be absurd; under no circumstances should a college degree place an applicant at a disadvantage. However, in view of the findings obtained in this study, it would seem logical to recommend abolishment of all standards that currently prove helpful to college graduates in establishing their training eligibility.

*F. Major Areas of College Study.* Although the previous analyses had shown educational level (e.g., beyond the high school level) to be invalid for selection purposes, there remained a need to determine the extent to which the retention rates might vary in accordance with the major areas (or types of courses) of college study. The results of an analysis bearing upon this issue are presented in Table 2.

TABLE 2 . Retention Rates by Specific Area of College Study for 1,265 Subjects Claiming College Credits on Entry Into Academy ATCS Basic Training in 1969

Specific Area of Major Studies While in College	Total Group		Reten- tions		Specific Area of Major Studies While in College	Total Group		Reten- tions	
	N	N	%	%		N	N	%	%
<b>Business</b>					<b>Mathematics</b>				
General .....	70	40	57.1		General .....	53	36	67.9	
Accounting .....	37	26	70.3		Computer Technology .....	12	8	66.7	
Finance, Banking, etc. ...	6	2	33.3		<b>Total</b>	65	44	67.7	
Administration or Mgmt. ...	98	54	55.1		<b>Physical Sciences</b>				
Public Administration ....	2	0	0.0		General .....	8	3	37.5	
Marketing .....	9	4	44.4		Earth Sciences .....	15	7	46.7	
Advertising .....	1	1	100.0		Physics .....	13	8	61.5	
Other .....	9	5	55.6		Chemistry .....	13	10	76.9	
<b>Total</b>	232	132	56.9		Other .....	2	0	0.0	
<b>Education</b>					<b>Total</b>	51	28	54.9	
General .....	14	9	64.3		<b>Engineering (except Aeroengr.)</b>				
Educational Admin. ....	1	0	0.0		General .....	52	33	63.5	
Elementary Education ....	2	2	100.0		Civil, Construction .....	8	6	75.0	
Secondary Education .....	11	6	54.5		Mechanical .....	12	5	41.7	
Physical Education .....	13	9	69.2		Electrical .....	25	14	56.0	
Other .....	12	5	41.7		Industrial .....	9	6	66.7	
<b>Total</b>	53	31	58.5		Chemical .....	4	3	75.0	
<b>Social Sciences</b>					Architecture .....	9	7	77.8	
General .....	8	1	12.5*		Other .....	5	2	40.0	
Sociology .....	15	3	20.0**		<b>Total</b>	124	76	61.3	
Psychology .....	37	16	43.2		<b>Aviation-Related Fields</b>				
Anthropology .....	1	0	0.0		Aviation or Aerospace ....	23	13	56.5	
History .....	34	16	47.1		Aeronautical Engineering .	14	10	71.4	
Economics .....	12	6	50.0		Aircraft Maintenance .....	3	2	66.7	
Political Sci. & Govt. ...	18	9	50.0		Aviation Admin. or Mgmt. .	4	2	50.0	
Law Enforcement & Corr. ..	6	5	83.3		Pilot or ATC Training ....	5	3	60.0	
Law and Prelaw .....	7	2	28.6		Flight Operations .....	4	0	0.0*	
Other .....	3	1	33.3		<b>Total</b>	53	30	56.6	
<b>Total</b>	141	59	41.8		<b>Other</b>				
<b>Biological Sciences</b>					Arts & Sciences, General .	41	26	63.4	
Biology .....	18	12	66.7		Fine & Performing Arts ...	22	8	36.4	
Zoology .....	5	2	40.0		Humanities, Philos., etc.	9	4	44.4	
Biochemistry .....	3	2	66.7		Languages .....	12	9	75.0	
Pharmacology .....	3	2	66.7		English &/or Literature ..	37	18	48.6	
Premed. or Predental ....	12	2	16.7**		Journalism .....	7	3	42.9	
Veterinary Medicine .....	2	2	100.0		Home Economics .....	2	0	0.0	
Other .....	1	0	0.0		Industrial Crafts .....	11	6	54.5	
<b>Total</b>	44	22	50.0		Drafting .....	5	3	60.0	
<b>Agriculture &amp; Related Flds.</b>					<b>Total</b>	146	77	52.7	
General .....	6	5	83.3		<b>Unknown (Major Study</b>				
Animal Husbandry .....	2	1	50.0		<b>Areas Not Indicated)</b>	340	209	61.5	
Forestry & Wild Life .....	6	2	33.3		<b>Total With Claims of</b>				
Other .....	2	1	50.0		College Credits	1265	717	56.7	
<b>Total</b>	16	9	56.3						

Difference from the retention rate (56.7%) of the 1,265 claiming college credits is:  
 \*significant at less than the .05 level; \*\*significant at less than the .01 level



Some 925 of the 1,265 subjects declaring college credits listed their major areas of study. Most of the 340 who failed to do so indicated college credits totaling 6 semester hours or less. For research purposes, we classified each of the 925 under 1 of 10 mutually exclusive categories. The 10 categories, each of which contained numerous subcategories reflecting specific areas of study, were: business, education, social sciences, biological sciences, agriculture and related fields, mathematics, physical sciences, engineering (exclusive of aeroengineering), aviation-related fields (including aeroengineering studies), and other (which included a variety of seemingly unrelated studies).

Of the 1,265 subjects who attended college, 56.7 percent (N=717) were still in FAA ATC work at the beginning of 1973. The retention rate of the 340 who failed to indicate their college majors was 61.5 percent, whereas those of the 10 major-area-of-study categories ranged from 41.8 percent for 141 majoring in the social sciences to 67.7 percent for 65 subjects majoring in mathematics. With one exception, however, all differences between the mean retention rate of 56.7 percent for the entire group of 1,265 former college students versus the rates of those in the various major categories fail to prove statistically significant (when subjected to a two-tailed "t-test"); the exception pertained to the 41.8-percent rate relating to those who majored in the social sciences.

Moreover, all but 6 of the 55 retention-rate differences *between* categories were of insufficient magnitude, based on the numbers of cases involved, to be statistically significant. Five of the six differences that were significant pertained to the rate of 41.8 percent for the social sciences majors versus the rates of those in the following categories: business (56.9 percent); education (58.5 percent); mathematics (67.7 percent); engineering (61.3 percent); and the 340 with unknown majors (61.5 percent). Also statistically significant was the difference between the rate of 52.7 percent for the cases categorized as "other" versus the top-ranked retention rate of 67.7 percent established by those majoring in mathematics.

As mentioned, the groups of cases represented in the 10 primary categories (Table 2) were subdivided on the basis of specific types of courses

declared as principal studies while in college. This secondary classification procedure resulted in many subgroups of various sizes and with widely disparate retention rates. In several instances, however, the subgroups comprised so few cases as to preclude reliability of the retention data. Nonetheless, only four of the subgroups were found to have retention rates differing significantly from the 56.7-percent rate of the entire group of 1,265 former college students, and only one of the four included as many as 15 cases. The four statistically significant differences (relative to the overall rate of 56.7 percent) pertained to 8 subjects with majors in "general" social sciences (12.5 percent); 15 who specialized in sociology (20.0 percent); 12 who were "premed" or "predental" majors (16.7 percent); and 4 who indicated "flight operations" as major courses of study (0 retention rate).

In view of the relatively few significant retention-rate differences, we were tempted to conclude that the probabilities of success in ATC training were generally unrelated to the types of courses declared by candidates as their college majors. Such a conclusion, however, was held in abeyance pending completion of a more detailed analysis in which the ATCS retention rates of the 1,265 subjects indicating college credits were examined with respect not only to major courses of college study but also to the type of college attended (i.e., the highest degree offered by the institution attended) and the level of college education completed (i.e., less than 1 full year of college credits, 1 to 4 years of college work, and 4 or more years of college work resulting in the award of at least a bachelor's degree). The results of such an analysis, in which distinction was maintained between the subjects aged 31 and older versus those 30 and younger, are presented in Appendixes A and B.

There may be some among the readers of this report who will find this last analysis to be of sufficient interest to warrant intensive study and comparison of the retention rates of the numerous subgroups (Appendixes A and B). We, the authors, have already done so but will refrain from presenting a lengthy discussion of the numerous retention-rate differences, most of which were relatively minor. When considered as a body, the results of this comprehensive and

detailed analysis indicate the major areas of college study of most college graduates, and also of most others who attended college for 4 years or less, to be negligibly related to the probabilities of training success—regardless of the type of institution (as defined by degrees offered) they attended. Perhaps the most startling finding concerns the disparity between the retention rates of the older versus younger subjects. Some 331 of the 1,265 former college students were 31 or older at time of entry into training and only 38.7 percent ( $N=128$ ) were still in FAA ATC work at the beginning of 1973, whereas the retention rate of the 934 aged 30 and lower was 63.1 percent. However, this retention-rate difference can be attributed primarily to age effects rather than recency-of-education effects. This fact was clearly illustrated by the results of earlier analyses. As may be recalled from our previous discussion of the analysis presented in Figure 3, the total group of 2,349 recruits of 1969 included 663 aged 31 and older; the retention rate of the 663, with educational level disregarded, was only 39.8 percent, whereas that of the 1,686 younger trainees of all educational levels was 66.0 percent. Moreover, it is important to note that the latter is slightly *higher* than the 63.1-percent retention rate established by the 934 younger trainees (among the 1,686) who attended college.

Returning to the issue concerning major areas of college study, we must acknowledge that the retention rate of 48.5 percent for the 101 subjects aged 30 and younger who majored in the social sciences is appreciably, and significantly ( $p<.01$ ), below the 63.1-percent rate of *all* subjects of age 30 and younger who attended college. Similarly, the fact should not be overlooked that those among the 934 who majored in mathematics and engineering had very commendable retention rates of 72.3 and 72.0 percent respectively. Should subjects with such educational backgrounds receive special treatment in the selection process? While this is a question that officials in charge of selection matters must resolve, we suspect that pragmatic considerations will prompt a decision that major areas of college study be entirely disregarded. And we would also hope that they decide to abolish all selection standards relating to education beyond the high school level.

#### IV. Summary and Conclusions.

The ATCS selection procedures relating to education have always tended to reflect an underlying hypothesis that success probabilities in ATC training should tend to vary in accordance with the *levels* of education attained by personnel considered equally qualified for training in other respects. The current study was undertaken in order to test that hypothesis and also to determine whether selection procedures should or should not be revised to include consideration of *recency* in the attainment of education, particularly at the college level, and/or the *major courses of study* of college graduates.

A series of analyses were conducted on data pertaining to 2,352 ATCS recruits who entered the Academy basic training phase in 1969 (1,858 En Route and 494 Terminal trainees). The study revealed all educational variables, both before and after consideration of effects associated with age and other selection factors, to be *negligibly and/or inversely related* to success in ATCS training (as defined by Academy graduation status and/or retention in the ATC system 3 to 4 years following recruitment).

The 181 college graduates among the 2,352 subjects had a higher Academy attrition rate (30.9 percent) than any other subgroup and 208 whose highest level of education was reflected by a G.E.D. (General Education Development) certificate for high school had the next highest Academy attrition rate (24.5 percent), whereas the lowest rate (18.0 percent) pertained to 876 having high school diplomas only, followed closely by the rate of those having less than 1 full year of college (18.3 percent). Post-Academy (i.e., facility training) attrition rates ranged from 16.3 to 26.5 percent and followed a somewhat similar rank-order pattern.

Major courses of study listed by some 925 of 1,265 subjects who attended college were found to have little potential for prediction of training outcomes. The overall retention rate as of January 1, 1973, for the 1,265 former college students was 56.7 percent. When categorized on the basis of major studies, only those ( $N=141$ ) majoring in the social sciences were found to have a retention rate differing significantly from that of the combined categories. Only 41.8 per-

cent of the 141 social science majors were still in FAA ATC work at the beginning of 1973. Moreover, 53 subjects for whom major courses of college study were judged as being more directly related to aviation than were the majors of all others were found to have a retention rate of 56.6 percent, only one-tenth of a point lower than that of the entire group of former college students.

None of the educational variables had a significant interaction effect on the validities of other

selection factors. As determined in previous research,<sup>10</sup> however, all types of aviation-related experience except ATC were found to be grossly unreliable for prediction of training outcomes. Other findings clearly illustrated that candidacy for ATCS training should be restricted to aptitude-screened applicants no older than 30 and that it would also be advisable to discontinue the award of credit points toward eligibility for all types of preentry experience except air traffic control.

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## APPENDIX

Appendix A. Attrition and retention rates by area of major study and type of college attended for 331 subjects of age 31 or older who claimed college credits when entering Academy ATCS basic training in 1969.

Major Area of Study in College or University	Type of College (based on highest degree offered by institution)	Level of College Education Attained Prior to Academy ATCS Basic Training												All Levels			
		Less Than 1 Full Year				1-4 Years But No Degree				Bachelor's Degree or Higher							
		N	Acad. Rate	Post-Attr. Rate	Ret. Rate	N	Acad. Rate	Post-Attr. Rate	Ret. Rate	N	Acad. Rate	Post-Attr. Rate	Ret. Rate	N	Acad. Rate	Post-Attr. Rate	Ret. Rate
Business	Ph.D.	5	40.0	40.0	20.0	17	29.4	17.7	52.9	6	33.3	33.3	33.3	28	32.1	25.0	42.9
	Master's	5	60.0		40.0	9	33.3	22.2	44.4					14	42.9	14.3	42.9
	Bachelor's					4	50.0	25.0	25.0					4	50.0	25.0	25.0
	Assoc. or other	8	37.5	37.5	25.0	6	16.7		83.3					14	28.6	21.4	50.0
Education	Total All Types	18	44.4	27.8	27.8	36	30.5	16.7	52.8	6	33.3	33.3	33.3	60	35.0	21.7	43.3
	Ph.D.					6	50.0	16.7	33.3	1	100.0			7	57.1	14.3	28.6
	Master's					5	20.0	20.0	60.0	3	33.3	33.3	33.3	8	25.0	25.0	50.0
	Bachelor's									1		100.0		1		100.0	
Social Sciences	Assoc. or other	1			100.0	1	100.0							2	50.0		50.0
	Total All Types	1			100.0	12	41.7	16.7	41.7	5	40.0	40.0	20.0	18	38.9	22.2	38.9
	Ph.D.	2	50.0	50.0		6	83.3		16.7	10	50.0	40.0	10.0	18	61.1	27.8	11.1
	Master's	5	20.0	40.0	40.0	5		60.0	40.0	4		25.0	75.0	14	7.1	42.9	50.0
Biological Sciences	Bachelor's					1		100.0		3	33.3	66.7		4	25.0	75.0	
	Assoc. or other	1	100.0			3	33.3	33.3	33.3					4	50.0	25.0	25.0
	Total All Types	8	37.5	37.5	25.0	15	40.0	33.3	26.7	17	35.3	41.2	23.5	50	37.5	37.5	25.0
	Ph.D.					3	66.7		33.3					3	66.7		33.3
Agriculture and Related Fields (animal husbandry, forestry, etc.)	Master's	1	100.0			1		100.0		1	100.0			3	66.7	33.3	
	Bachelor's					1			100.0					1			100.0
	Assoc. or other					2	50.0	50.0						2	50.0	50.0	
	Total All Types	1	100.0			2	42.8	28.6	28.6	1	100.0			9	55.6	22.2	22.2
Mathematics	Ph.D.	1	100.0			1	100.0			2	50.0		50.0	3	66.7		33.3
	Master's					2	100.0			1	100.0			5	80.0		20.0
	Bachelor's	1	100.0			1			66.7	2	50.0		50.0	5	40.0	20.0	40.0
	Assoc. or other	4	50.0		50.0	2		100.0		1		100.0		4	25.0	75.0	
Physical Sciences	Total All Types	9	50.0		50.0	8		12.5	87.5	4	50.0	50.0		18	27.8	16.7	55.6
	Ph.D.					3	33.3	33.3	33.3	3	33.3	33.3	33.3	6	33.3	33.3	33.3
	Master's					1	100.0			1		100.0		1		100.0	
	Bachelor's					4	50.0	25.0	25.0	4	25.0	50.0	25.0	8	37.5	37.5	25.0
Engineering (excluding Aeroengineering)	Assoc. or other	2				4	50.0	25.0	25.0					7	37.0	22.2	40.7
	Total All Types	8	25.0	25.0	50.0	16	33.7	25.0	31.3	3	33.3		66.7	7	42.9	14.3	42.9
	Ph.D.					4	50.0	25.0	25.0					7	28.6		71.4
	Master's	3	33.3		66.7	5			100.0	1	100.0			8	37.5	25.0	37.5
Aviation, Aeronautics, and Related Fields	Bachelor's	3	33.3		66.7	5			100.0					9	36.7	18.4	54.9
	Assoc. or other	2		50.0	50.0	6	50.0	16.7	33.3				50.0	3	33.3		66.7
	Total All Types	16	25.0	18.8	56.2	29	41.4	20.7	37.9	4	50.0			11	33.3		66.7
	Ph.D.	1			100.0	1			100.0	1	100.0			2	50.0	50.0	
All Other	Master's					1	100.0							1	100.0		
	Bachelor's					2	50.0	50.0		2	50.0	50.0		4	50.0	25.0	25.0
	Assoc. or other	2	50.0		50.0	2	50.0	25.0	25.0	3	66.7	33.3		10	50.0	20.0	30.0
	Total All Types	3	33.3		66.7	4	50.0	25.0	25.0	1	100.0			11	27.3	36.4	36.4
Unknown Major (S's failed to indicate major areas)	Ph.D.	3	66.7		33.3	7		57.1	42.9	1	100.0			6		66.7	33.3
	Master's					4		75.0	25.0	2		50.0	50.0	4	25.0	25.0	50.0
	Bachelor's	2			100.0	2	50.0	50.0						8	50.0	25.0	25.0
	Assoc. or other	4	25.0	50.0	25.0	4	75.0		25.0					29	27.6	37.9	34.5
Total For All Areas of Study	Total All Types	9	33.3	22.2	44.4	17	23.5	47.1	29.4	3	33.3	33.3	33.3	32	40.6	18.8	40.6
	Ph.D.	17	29.4	23.5	37.1	15	53.3	13.3	33.3					23	43.5	21.7	34.8
	Master's	15	40.0	26.7	33.3	8	50.0	12.5	37.5					14	50.0	7.1	42.9
	Bachelor's	10	50.0	10.0	40.0	4	50.0		50.0					16	25.0	25.0	50.0
Total	Assoc. or other	10	30.0	30.0	40.0	6	16.7	16.7	66.6					66	37.9	21.2	40.9
	Total All Types	52	36.5	23.1	40.4	33	45.5	12.1	42.4					85	40.0	18.8	41.2
Total For All Areas of Study	Ph.D.	37	35.1	24.3	40.5	78	41.0	20.5	38.5	28	50.0	25.0	25.0	143	41.2	22.4	36.4
	Master's	29	41.4	20.7	37.9	38	28.9	31.6	39.5	13	23.1	38.5	38.5	80	32.5	28.8	38.7
	Bachelor's	16	37.5	6.3	56.2	18	33.3	16.7	50.0	8	37.5	62.5		42	35.7	21.4	42.9
	Assoc. or other	33	36.4	27.3	36.4	33	39.4	15.2	45.4					66	37.9	21.2	40.9
	Total All Types	115	37.4	21.7	40.9	167	37.1	21.6	41.3	49	40.8	34.7	24.5	331	37.7	23.6	38.7

Appendix B. Attrition and retention rates by area of major study and type of college attended for 934 subjects of age 30 or younger who claimed college credits when entering Academy ATCS basic training in 1969.

Major Area of Study in College or University	Type of College (based on highest degree offered by institution)	Level of College Education Attained Prior to Academy ATCS Basic Training												All Levels			
		Less Than 1 Full Year			1-4 Years But No Degree			Bachelor's Degree or Higher									
			Acad. Attr. Rate	Post-Attr. Rate	Ret. Rate		Acad. Attr. Rate	Post-Attr. Rate	Ret. Rate		Acad. Attr. Rate	Post-Attr. Rate	Ret. Rate		Acad. Attr. Rate	Post-Attr. Rate	Ret. Rate
		N	%	%	%	N	%	%	%	N	%	%	%	N	%	%	%
Business	Ph.D.	6	33.3	16.7	50.0	46	10.9	21.7	67.4	16	25.0	31.3	43.7	68	16.2	23.5	60.3
	Master's	8	12.5		87.5	18	22.2	22.2	55.6	11	36.4	9.1	54.5	37	24.3	13.5	62.2
	Bachelor's	4	25.0	50.0	25.0	14	35.7		64.3	10	30.0	10.0	60.0	28	32.1	10.7	57.1
	Assoc. or other	17	5.9	29.4	64.7	22	9.1	22.7	68.2					39	7.7	25.6	66.7
	Total All Types	35	14.3	22.9	62.8	100	16.0	19.0	65.0	37	29.7	18.9	51.4	172	18.6	19.8	61.6
Education	Ph.D.	3			100.0	1			100.0	4	25.0	25.0	50.0	8	12.5	25.0	62.5
	Master's	1			100.0	5			100.0	8	12.5	25.0	62.5	14	7.1	14.3	78.6
	Bachelor's	5	20.0	20.0	60.0	3		33.3	66.7					8	12.5	25.0	62.5
	Assoc. or other	1			100.0	4	25.0	25.0	50.0					5	20.0	20.0	60.0
	Total All Types	10	10.0	10.0	80.0	13	7.7	23.1	69.2	12	16.7	25.0	58.3	35	11.4	20.0	68.6
Social Sciences	Ph.D.	4	25.0	25.0	50.0	23	21.7	21.7	56.5	16	31.2	18.8	50.0	43	25.6	20.9	53.5
	Master's	5		60.0	40.0	10	40.0	20.0	40.0	11	36.4	9.1	54.5	26	30.8	23.1	46.1
	Bachelor's	3			100.0	6	33.3	16.7	50.0	10	40.0	30.0	30.0	19	31.6	21.0	47.4
	Assoc. or other	6	16.7	50.0	33.3	7	28.6	28.6	42.8					13	23.1	38.5	38.5
	Total All Types	18	11.1	38.9	50.0	46	28.3	21.7	50.0	37	35.1	18.9	46.0	101	27.7	23.8	48.5
Biological Sciences	Ph.D.	1			100.0	12	25.0	33.3	41.7	3	33.3			16	25.0	31.3	43.7
	Master's	3	33.3	33.3	33.3	3			100.0	3				9	11.1	11.1	77.8
	Bachelor's					1			100.0	2	50.0	50.0		3	33.3	66.7	
	Assoc. or other	3			100.0	4			25.0					7		14.3	85.7
	Total All Types	7	14.3	28.6	27.1	20	15.0	30.0	55.0	8	25.0	12.5	62.5	35	17.1	25.7	57.1
Agriculture and Related Fields (animal husbandry, forestry, etc.)	Ph.D.					2			100.0	5				7	28.6	14.3	57.1
	Master's					1			100.0					1			100.0
	Bachelor's	1			100.0									1			100.0
	Assoc. or other					2			100.0					2			100.0
	Total All Types	1			100.0	5	40.0		80.0	5		20.0	80.0	11	18.2	9.1	72.7
Mathematics	Ph.D.	6	16.7	33.3	50.0	6	33.3		66.7	1				13	23.1	23.1	53.8
	Master's	6	16.7		83.3	6			100.0	1				13	7.7	7.7	84.6
	Bachelor's	3			100.0	3		33.3	66.7	2		50.0	50.0	8		25.0	75.0
	Assoc. or other	6		16.7	83.3	7	28.6		71.4					13	15.4	7.7	76.9
	Total All Types	21	9.5	14.3	76.2	22	18.2	4.5	27.3	4		75.0	25.0	47	12.8	14.9	72.3
Physical Sciences	Ph.D.	2	50.0		50.0	15	26.7	13.3	60.0	4	50.0	25.0	25.0	21	33.3	14.3	52.4
	Master's	2	50.0		50.0	4		25.0	75.0					6	16.7	16.7	66.6
	Bachelor's					3			100.0					3			100.0
	Assoc. or other	5	20.0	40.0	40.0	8	25.0		75.0					13	23.1	15.4	61.5
	Total All Types	9	33.3	22.2	44.4	30	20.0	10.0	20.0	4	50.0	25.0	25.0	43	25.6	13.9	60.5
Engineering (excluding Aeroengineering)	Ph.D.	8	25.0	25.0	50.0	22	9.1	13.6	77.3	2	50.0			32	15.6	15.6	68.8
	Master's	1			100.0	12		16.7	83.3	1				14		14.3	85.7
	Bachelor's	1	100.0			12		8.3	91.7					13	7.7	7.7	84.6
	Assoc. or other	5		20.0	80.0	11	45.5	9.1	45.5					16	31.3	12.5	56.2
	Total All Types	15	20.0	20.0	60.0	57	12.3	12.3	75.4	3	33.3		66.7	75	14.7	13.3	72.0
Aviation, Aeronautics, and Related Fields	Ph.D.	2			100.0	8		25.0	75.0	3				13		15.4	84.6
	Master's	1			100.0	4			100.0	1	100.0			6	16.7		83.3
	Bachelor's	1			100.0	2		50.0	50.0	2		50.0	50.0	5		40.0	60.0
	Assoc. or other	4	25.0	25.0	50.0	15	26.7	33.3	40.0					19	26.3	31.6	42.1
	Total All Types	8	12.5	12.5	75.0	29	13.8	27.6	58.6	6	16.7	16.7	66.6	43	13.9	23.3	62.8
All Other	Ph.D.	7			100.0	20	20.0	20.0	60.0	7	14.3	71.4	14.3	34	14.7	26.5	58.8
	Master's	9		22.2	77.8	12	16.7	16.7	66.6	6	33.3	33.3	33.3	27	14.8	22.2	63.0
	Bachelor's	8	25.0	12.5	62.5	12	25.0	41.7	33.3	3	33.3		66.7	23	26.1	26.1	47.8
	Assoc. or other	14	21.4	28.6	50.0	19	21.0	15.8	63.2					33	21.2	21.2	57.6
	Total All Types	38	13.2	18.4	68.4	63	20.6	22.2	57.1	16	25.0	43.7	31.3	117	18.8	23.9	57.3
Unknown Major (S's failed to indicate major areas)	Ph.D.	34	8.8	32.4	58.8	26	7.7	26.9	65.4					60	8.3	30.0	61.7
	Master's	47	8.5	14.9	76.6	17	11.8	5.9	82.3					64	9.4	12.5	78.1
	Bachelor's	26	7.7	7.7	84.6	12		33.3	66.7					38	5.3	15.8	78.9
	Assoc. or other	75	12.0	26.7	61.3	18	33.3	5.6	61.1					93	16.1	22.6	61.3
	Total All Types	182	9.9	22.0	68.1	73	13.7	17.8	68.5					255	11.0	20.8	68.2
Total For All Areas of Study	Ph.D.	73	13.7	24.7	61.6	181	16.0	21.0	63.0	61	24.6	27.9	47.5	315	17.1	23.2	59.7
	Master's	83	9.6	15.7	74.7	92	13.0	13.0	73.9	42	28.6	16.7	54.7	217	14.7	14.7	70.5
	Bachelor's	52	13.5	11.5	75.0	68	14.7	22.1	63.2	29	31.0	24.1	44.8	149	17.4	18.8	63.8
	Assoc. or other	136	11.8	27.2	61.0	117	23.9	16.2	59.8					253	17.4	22.1	60.5
	Total All Types	344	11.9	21.5	66.6	458	17.3	18.3	64.4	132	27.3	23.5	49.2	934	16.7	20.2	63.1