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Development and validation of a veterinary medical aptitude test

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NOTE TO USERS

DEVELOPMENT AND VALIDATION OF A

VETERINARY MEDICAL APTITUDE TEST

by

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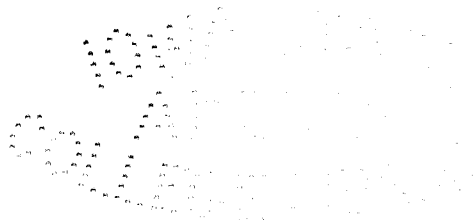
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I. INTRODUCTION

In 1947, the ten recognized colleges of veterinary med-
icine within the United States were able to admit into vet-
erinary medicine only one out of each eight students seeking
admission. The high ratio of applicants to admissions (8 to
1) resulted in a careful re-examination of selection proce-
dures and aided in the establishment of eight new colleges of
veterinary medicine.

Two of the major problems facing the admissions commit-
tees of veterinary schools are the selection of applicants
who are able to satisfactorily meet the academic requirements
for graduation and the selection of applicants who, after
graduation, will enjoy their work and will tend to remain
within the profession. The second phase has been carefully
studied in a thesis written by Dr. T. E. Hannum titled "Dif-
ferential Responses of Veterinarians to the Strong Vocational
Interest Blank for Men".(1)

The development and ultimate utilization of a veterinary
medical aptitude test has been the purpose of the following
study. At the time this study was initiated (1947), the high
school scholastic average, the pre-professional grade point
average and the scores made on standard psychological exam-
inations were being used to determine the qualifications of
the applicant. All of these indices, with the possible
exception of the last, tend to indicate past performance on

the part of the student. Their value is questionable in
determining the aptitude for veterinary medicine which the
applicant might possess. Schools which hold personal inter-
views with all applicants are able to determine the person-
ality of the student, his appearance and his ability to ex-
press himself. The interview, however, does not accurately
determine the student's true ability.

The Iowa State Veterinary Medical Aptitude Test was not
developed to replace these before-mentioned methods of selec-
tion. It was developed to be used as an aid in the selection
of students for veterinary medicine.

The term aptitude has been defined many times. Accord-
ing to Bingham (2, p. 16)

> aptitude is a condition symptomatic of a person's
> general fitness of which one aspect is his readi-
> ness to acquire proficiency, his general ability
> and another is his readiness to develop an interest
> in exercising that ability.

According to Freeman (3) "an aptitude is the ability or
collection of abilities required to perform a specified
practical activity". As can be seen from those definitions
we are looking at the future possibilities of the student
and not at his past performance. Aptitude should be con-
sidered as a dynamic trend of the whole personality. In
some instances a student who has met all of the pre-pro-
fessional requirements for admission into veterinary med-
icine may still not possess the native ability to meet the
scholastic requirements for graduation in veterinary medicine.

Likewise, it should be understood that a student may rank very high in his ability to meet the scholastic requirements but, through lack of initiative or some other cause, may ultimately fail in the curriculum of veterinary medicine.

II. REVIEW OF LITERATURE

In reviewing the literature concerning aptitude test-
ing, no specific information was found which dealt with
veterinary medicine. Many textbooks and articles have been
published on the general topic and some information is
available concerning aptitude testing in the medical schools.

The Association of American Medical Colleges has long
recognized the importance of aptitude testing in the selection
of students for entrance into medical colleges. A pioneer in
the development of specialized medical aptitude tests was Dr.
F. A. Moss. Dr. Moss designed the medical aptitude test bear-
ing his name in 1930 and secured its sponsorship by the
Association of American Medical Colleges. The Moss Medical
Aptitude test was first administered in the fall of 1929 to
the applicants for admission to the entering medical classes
of fourteen different institutions. A correlation of 0.59
was reported by Moss between the initial aptitude test scores
and the final grades obtained within the several schools of
medicine. The number of students being tested soon increased
to 10,853 distributed among 627 institutions, and the pro-
portion of students admitted with the aid of the test increased
to 84 per cent. The Moss Medical Aptitude Test functioned
with varying degrees of success throughout the country. In
certain schools it did a creditable job of predicting. In
other schools it did not appear to give satisfactory results.

Individual schools then began to construct their own medical aptitude tests or to assemble a test battery of their own choice.

The Executive Council of the Association of American Medical Colleges voted in 1946 that the Association Committee which was charged with the responsibility of medical aptitude testing be discontinued August 31, 1946 and that a new committee on student personnel practices be appointed. The first chapter in the history of medical aptitude testing in the United States thus came to a close.

During the academic years of 1946, 1947, and 1948 the medical aptitude testing program was administered by the graduate record office of the Carnegie Foundation for the Advancement of Teaching. The association embarked upon a program of long term test development and research with regard to the selection of medical students. Different or new examinations are now incorporated in the association's test battery whenever they appear to offer promise.

III. INVESTIGATION

A. Methods:

The practical application of aptitude testing is dependent, to a large degree, upon the criteria which the test interpreter is seeking. Various types of aptitude tests have been developed. Some are intended to appraise scholastic, classical, mechanical, artistic, musical or professional aptitude.

1. Overview

The great importance which the American Medical Association has attached to aptitude tests and the role they play in the selection of medical students is evidence of their value to a closely similar group. W. S. Guthrie (4) in the Applications to the Professional Schools and Colleges for the fall of 1952 lists the number of complete applications for admission into medical schools as 64,913, all of whom were required to take the medical aptitude test. The schools of veterinary medicine, however, have been slow in recognizing the importance of such testing. This slowness may have been due in part to the fact that prior to 1948 there were no specific tests adapted to use in the selection of students for veterinary medicine.

It was then decided that if a reliable and valid aptitude test could be developed especially for veterinary medicine, the admissions boards or committees could make use of

it in the selection of students, and in this way, help to put the veterinary schools more nearly on a par with medical schools. The development of such a test was the purpose of this study.

The preliminary study was made to determine the validity of Form 20 of the Moss Aptitude Test for Medical Professions (ATMP) as it pertained to predicting success of students in veterinary medicine. If this test proved acceptable, it could be an adequate instrument to aid in the selection of veterinary students. If the validity of this test in the new context was found to be lower than desired, the development of a new specialized veterinary medical aptitude test was to be undertaken.

The next investigation carried out was the evaluation of the following grades as predictors of success in the first year of veterinary medicine: English, botany, chemistry, zoology, and the raw score on the A.C.E. examination. The total pre-professional grade point average was also correlated with the first year professional grade point average.

The subsequent development of the Iowa State Veterinary Medical Aptitude Test was based on the results of the first two investigations. Four special purpose sub-tests were constructed. The first two sub-tests were based on the two most predictive pre-professional courses, i.e. chemistry and zoology. The third sub-test was based on content similar to section 6 of the Moss ATMP, understanding of printed material.

The fourth sub-test was based on material similar to section
3 of the Moss ATMP, namely comprehension and retention. Of
all eight sections of the Moss ATMP, sections 3 and 6 yielded
the highest correlations (3 gave an r of 0.22 and 6 gave an
r of 0.38) when checked against the freshmen veterinary grade
point average. As these two sections suggested functions to
be measured by the new aptitude test for veterinary medicine,
sub-tests three and four were constructed along similar lines.

Following the preliminary study based on these four sub-
tests, the first two tests were shortened, revised and com-
bined into one, entitled The Iowa State Veterinary Medical
Achievement Test. The third test was revised and shortened
and called the Iowa State Veterinary Medical Aptitude Test 1,
or Paragraph Comprehension. The fourth test was likewise
evaluated, revised, and called the Iowa State Veterinary
Medical Aptitude Test II, or Verbal Memory Test.

All sections of this test are entirely new and their
content was judged by members of that staff of Iowa State
College to be representative veterinary content. The usual
psychometric procedures relative to the establishment of
time limits, the analysis of items and general revision were
employed following a cross-sectional experimental study of
the four tests in 1947 and 1948 and prior to a longitudinal
study of their validity in 1948, 1949 and 1953. It must be
noted that none of these test results has been employed in
the selection of students entering the curriculum of veter-

inary medicine. The present data are in this regard uncon-
taminated.

The next phase of this study was to determine the
validity and reliability of the Iowa State Veterinary Medical
Achievement Test and both Aptitude tests. For a test to be
valid, it must measure as nearly as possible what it proposes
to measure without unreasonable deflection. A test must also
be constructed in such a way that the variable error is re-
duced to a minimum. This latter condition measures the re-
liability of the test.

In order to determine the value of these three sub-
tests, they were administered to pre-professional students in
five cooperating colleges before any selection of the students
was made. In the spring of 1952 when the students who had
taken the test before entering veterinary medicine in 1948
were seniors, the total cumulative grade-point averages for
the first three and one-half or three and two-thirds years in
veterinary medicine were used. These grade point averages
were used as the criterion in the validation of this test.
All 260 students were placed in one group and the analyses
were made on the total number. In the second group each
school was handled individually and the within values of the
grade point averages were used as such.

Having analysed the sub-tests in several different ways,
discriminate function weights were determined for each
section. From these results, a probability table was devel-

oped which lists the chances out of 100 that a student has of being in the upper quarter of the group, the middle half of the group, or the lower quarter of the group, depending upon the raw score obtained on both the Achievement Test and Aptitude Test 1.

The final investigation has been to determine how well the probability table achieved its function. The raw score results on two sub-tests along with their professional grade point average were obtained for students admitted into Texas A & M and Iowa State College in the fall of 1949. The prediction of their success was made from the probability table and a comparison was made with their actual rank within the class.

This section entitled "Overview" thus outlines the general procedure and methods followed in this study.

2. Subjects

The preliminary findings of this study are based on the records of all freshmen and sophomore students enrolled in the Division of Veterinary Medicine of Iowa State College during the academic year of 1947-48. (N=133)

The analyses involving the validation and reliability studies are based upon the academic records of 260 students, enrolled in Veterinary Medicine at the five cooperating schools, who reached the senior year in the fall of 1951.

Academic records of 46 students who entered Veterinary Medicine at Texas A & M and of 31 students who entered Iowa

State College in the fall of 1949 were obtained. The raw
scores made on the Achievement Test and Aptitude Test I were
used to predict their success. It must be emphasized that
the results for these 77 students were not used in any manner
in the development of the table of probability.

3. Data

The findings of the preliminary studies concerned with
the evaluations of the Moss Test for Medical Professions and
the correlations of the pre-professional grade point averages
(Existing indices) with academic success in the first year
of Veterinary Medicine have previously been reported by
Owens (5) and Payne (6). A summary of the correlations
between various predictors and the grade point average ob-
tained during the first year of Veterinary Medicine is
shown in Table 1.

The confirmatory data included in this thesis and con-
cerned with validation and tests of reliability are pre-
sented in Table 2 and Table 3. These values were obtained
from the test results of the 260 students who took the tests
before entering Veterinary Medicine in 1948.

Table 1

Correlations of Various Predictors with Freshmen Grade
Point Average in Veterinary Medicine (N=133)

Variable	r
Existing indices	
Total pre-professional average	.40
Pre-professional chemistry average	.47
Pre-professional zoology average	.41
ACE raw score	.02
Moss ATMP Sub-tests	
Visual Memory	.13
Memory for Content	.13
Comprehension and Retention	.22
General Information	-.11
Vocabulary	-.01
Understanding of Printed Material	.38
Application of Principles	.17
Logical Reasoning	.02
Four New Tests	
Chemistry Achievement Test	.27
Zoology Achievement Test	.12
Paragraph Comprehension	.47
Verbal Memory	.57
Sum of Paragraph Comprehension and Verbal Memory	.62

Table 2

Raw Scores and Means of the Iowa State Veterinary Medical
Aptitude Test (N=260)

Variable	Sum of Raw Scores	Means
X_1	14406	55.4076
X_2	11942	45.9307
X_3	7375	28.3653
X_4	33723	129.7038
X_5	19317	74.2961

where X_1 = Achievement Test
X_2 = Aptitude Test I
X_3 = Aptitude Test II
X_4 = Sum of all three sub-tests
X_5 = Sum of Aptitude Test I and Aptitude Test II

Table 3

Cross Products and Sums of Squares of the Iowa State Veterinary Medical Aptitude Test (N=260)

Raw Score	Deviation
$\Sigma X_1 X_2^* = 667071$	$\Sigma x_1 x_2 = 5392.40$
$\Sigma X_1 X_3 = 413069$	$\Sigma x_1 x_3 = 4437.27$
$\Sigma X_2 X_3 = 344099$	$\Sigma x_2 x_3 = 5359.58$
$\Sigma X_1^2 = 811658$	$\Sigma x_1^2 = 13454.80$
$\Sigma X_2^2 = 561864$	$\Sigma x_2^2 = 13358.80$
$\Sigma X_3^2 = 219115$	$\Sigma x_3^2 = 9920.30$
$\Sigma X_4^2 = 4447113$	$\Sigma x_4^2 = 73111.00$
$\Sigma X_5^2 = 1469175$	$\Sigma x_5^2 = 33996.20$

*X values are the same as given in footnote of Table 2

Table 4

Data Pertinent to Discriminant Function Weights and Triserial Correlations

School		N	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$	$\bar{X}_5$
1	Top Q.	6	63.00	52.10	36.00	151.16	83.16
	Middle H.	13	62.15	49.00	32.00	143.15	81.00
	Lower Q.	6	61.00	49.50	28.83	139.33	78.33
	Total	25	62.08	49.88	32.30	144.16	81.00
2	Top Q.	8	64.75	51.88	31.75	148.37	83.62
	Middle H.	17	65.64	50.23	35.64	151.52	85.88
	Lower Q.	8	63.00	47.75	28.87	139.63	76.62
	Total	33	64.78	50.03	33.60	147.87	83.09
3	Top Q.	15	58.20	49.80	29.13	137.13	78.93
	Middle H.	31	53.61	45.32	26.54	125.48	71.87
	Lower Q.	15	52.00	41.06	26.33	119.20	67.20
	Total	61	54.34	45.37	27.08	126.80	72.45
4	Top Q.	21	54.19	48.00	27.19	129.38	75.19
	Middle H.	40	51.60	42.60	26.82	121.02	69.42
	Lower Q.	21	49.61	39.19	25.28	114.09	64.47
	Total	82	51.75	43.10	26.52	121.39	69.63
5	Top Q.	15	58.26	49.80	30.02	138.26	80.00
	Middle H.	29	53.51	47.51	28.37	129.41	75.89
	Lower Q.	15	48.73	41.06	25.06	114.86	66.13
	Total	59	53.50	46.45	28.00	127.96	74.45
All Schools	Top Q.	65	58.17	49.69	29.70	137.57	79.40
	Middle H.	130	55.40	45.98	28.77	130.16	74.76
	Lower Q.	65	52.66	42.06	26.20	120.92	68.26
	Total	260	55.41	45.93	28.37	129.70	74.30

4. <u>Statistical treatments</u>

The methods by which the data of this problem were analysed primarily involved the determination of coefficients of correlation and discriminant function.

As previously mentioned (page 8) the criterion used in the validation of this test is the cumulative grade point average for the first three and a fraction years in veterinary medicine. The division of students into the usual survival and attrition groups is almost impossible for those enrolled in Veterinary Medicine. Less than 2% of the students which begin Veterinary Medicine fail to finish the four years. Hence, the survival-attrition method of differentiation is not feasible.

The preliminary investigation involved the determination of the correlations between various predictors and freshmen veterinary grades. These correlations were of the Pearson product-moment type and were determined according to the standard method of computation from deviation scores.

The dichotomous categories used in this study were the upper 3/4 vs. the lower 1/4 according to grade point average

and

upper 1/4 vs. the lower 3/4 according to grade point average.

Two methods of determining the triserial correlations were used. As the method given by Wert, <u>et al.</u> (7) was shorter than that of Jaspen, (as described by Peatman (8)) it was used for all r_{tri} determinations. The trichotomous categories

were established according to grade point average, these
being the upper 1/4 of the group, the middle 1/2 of the
group and the lower 1/4 of the group, both within schools
and for the total. The formula which was used is as follows:

$$r_{tr1} = \frac{\Sigma\left[(Z_l - Z_h)\,\overline{X}\right]}{(\sigma)\Sigma\left[\dfrac{(Z_l - Z_h)^2}{p}\right]}$$

where Z_l = height of ordinate at lower end of interval

   Z_h = height of ordinate at upper end of interval

   σ = standard deviation of the continuous variable

   p = proportion of total group in a category

   $\overline{X}$ = mean score of X_l

   The discriminant function equation as developed by
Fisher (9) was used to determine the appropriate weights to
be assigned each remaining section of the test. The dis-
criminant function equations are as follows:

$$Nzd_1 = a\Sigma x_1^2 + b\Sigma x_1 x_2$$

$$Nzd_2 = a\Sigma x_1 x_2 + b\Sigma x_2^2$$

where N = total number of cases

   z = height of the ordinate dividing the normal curve
into p and q parts

   d_1 = difference in the means of the upper and lower
quarters on Achievement Test

   d_2 = difference in the means of the upper and lower
quarters on Aptitude Test I

   x_1 and x_2 = deviation scores

   a and b = discriminant weights to be solved for

For the convenient use by the college counselor or the admissions board of a veterinary medical school, a probability table was developed.

The probability table which is shown in Table 8 was developed according to the formula previously outlined. The probability of a student being in the upper quarter of the group was determined for the Achievement Test scores ranging from 30 to 69 and for Aptitude Test I scores ranging from 21 to 60. The next step was to determine the probability of a student being in the upper three-quarters of the group for the same raw scores. Subtracting this probability from 100, gave the chances out of 100 that the student would be in the lower quarter. Likewise, subtracting his chances of being in the upper quarter from his chances of being in the upper three-quarters gave his chances of being in the middle half of the group. This is the method used to develop the probability table.

B. Results:

The tables, charts or numbers which result from any statistical analysis have little meaning by themselves. However, they serve as an essential part of the study from which all interpretations and conclusions must be drawn. Hence in this section of the thesis, the numerical results of the analyses will be given and the interpretation will be discussed within a separate section.

The first analysis determined on this data showed the comparison of the means and the standard deviations between the total group of students taking the test in 1948 and those that were accepted into veterinary medicine and had reached the senior year. This comparison is shown in Table 5.

The next analysis was the determination of biserial correlations between the upper 3/4s versus the lower 1/4 according to grade point average, and the upper 1/4 versus the lower 3/4s according to grade point average. This was determined for within school values and for the total group. These values are shown in Table 6.

After studying the correlations determined thus far, it was noted that Aptitude Test II was the best predictor in the two schools testing only those students scholastically eligible for admission, whereas it was the poorest predictor in those three schools testing all applicants. It was decided to test the significance of the gain by inclusion, or the loss by elimination of Aptitude Test II. This was accomplished according to the formula given by Wert, *et al.*(7) as follows:

$$F_{n,\ N-m-1} = \frac{(\Delta m - \Delta m-n)\ (N-m-1)}{(\frac{Nz^2}{pq} - \Delta m)\ n}$$

where   m -- number of variables (3)

n -- number of variables dropped (1)

Δ -- $a_1 Nzd_1 + a_2 Nzd_2 + a_3 Nzd_3$

p-q -- proportionate values

Table 5

Comparison of the Means and Standard Deviations of All
Students That Took the Test and Those Accepted and Reaching
the Senior Year

School #		Achievement		Aptitude I		Aptitude II	
1		All*	Acc.**	All	Acc.	All	Acc.
		(79)	(25)				
	Mean	58.78	62.08	48.28	50.00	30.71	32.76
	St. d.	6.30	5.99	7.18	5.29	6.75	6.70
2		(87)	(33)				
	Mean	61.32	64.79	49.24	49.73	31.17	32.76
	St. d.	7.04	5.00	5.93	5.56	7.50	7.26
3		(142)	(61)				
	Mean	52.51	54.34	44.53	45.53	26.25	27.26
	St. d.	5.71	5.50	6.97	6.71	5.38	5.07
4		(121)	(82)				
	Mean	51.20	63.40	41.53	42.93	26.16	26.63
	St. d.	5.96	5.04	8.51	7.41	5.00	4.75
5		(135)	(59)				
	Mean	51.87	53.51	44.90	46.46	25.56	28.00
	St. d.	7.00	6.57	7.42	7.30	6.32	6.25

*Refers to number of students who took the test
**Refers to number of students accepted and reaching the
senior year

Table 6

Biserial Correlations Between the Upper and Lower Quarters
According to Grade Point Average and Raw Scores Obtained on
the Iowa State Veterinary Medical Aptitude Test

School	Upper 3/4 vs. lower 1/4					Upper 1/4 vs. lower 3/4				
	X_1	X_2	X_3	X_4	X_5	X_1	X_2	X_3	X_4	X_5
1	.14	.06	.38	.30	.28	.12	.34	.43	.44	.45
2	.28	.31	.06	.13	.12	.01	.25	.14	.03	.04
3	.34	.43	.21	.51	.44	.39	.54	.02	.56	.47
4	.56	.86	.20	.78	.69	.55	.26	.60	.42	.46
5	.58	.59	.34	.64	.56	.58	.37	.26	.50	.37
Total	.50	.43	.28	.14	.42	.30	.41	.17	.18	.35

where X_1 = raw score obtained on Achievement Test
X_2 = raw score obtained on Aptitude Test I
X_3 = raw score obtained on Aptitude Test II
X_4 = composite score obtained by adding raw scores on
above tests
X_5 = composite score obtained by adding raw scores of
Aptitude Test I and Aptitude Test II

Table 7

Triserial Correlations Between the Upper Quarter, Middle Half,
and Lower Quarter According to Grade Point Average and Scores
Obtained on the Iowa State Veterinary Aptitude Test

School	N	X_1	X_2	X_3	X_4	X_5
1	25	.13	.20	.40	.37	.37
2	33	.14	.28	.43	.29	.26
3	61	.44	.52	.24	.54	.46
4	82	.36	.49	.17	.54	.45
5	59	.59	.48	.33	.57	.47
Total	260	.30	.42	.22	.39	.38

With the degrees of freedom of one and 256, (F$_1$, 256) F at the 1% level is 6.76 and at the 5% level is 3.89. Hence there is no significant loss by eliminating Aptitude Test II.

For the total group, the relative effectiveness of each variable used in the prediction was shown to be as follows:

Achievement Test   20.57%

Aptitude Test I   70.78%

Aptitude Test II   8.59%

The results of the discriminant function equations are as follows:

N = 260

z = .3176

d_1 = 5.5077

d_2 = 1.6307

x_1^2 = 13,454.8

x_2^2 = 13,358.8

$x_1 x_2$ = 5,392.4

Substituting for the appropriate values,

(260)(.3176)(5.5077) = a (13,454.8) + b (5,392.4)

(260)(.3176)(1.6307) = a (5,392.4) + b (13,358.8)

solving for a and b yields:

a = .01777344

b = .03999439

Having solved for a and b, the discriminant function can then be solved from the following equation:

$$v = ax_1 + bx_2$$

or

$$v = .01777344 \; x_1 + .03999439 \; x_2$$

In this formula v is equal to x which is a deviation value.
As most predictions will be made from the raw score made on
the test, it is desirable to convert this deviation formula
to the raw score form. This is done as follows:

$$V - \overline{V} = a(X_1 - \overline{X}_1) + b(X_2 - \overline{X}_2)$$

For this determination, all values have been determined with
the exception of $\overline{V}$. The value for $\overline{V}$ is determined from the
data available from the sample in which the discriminant
function was determined.

The value for $\overline{V}$ is obtained by determining from a normal
probability table the deviate for the percentage of students
which have survived or are in the upper group. With 25% of
the students in the upper quarter and 75% of the students in
the lower three-quarters, the deviate gives a value of .675
for the value of $\overline{V}$.

Thus the deviation of any individual from the mean can
be determined from the raw scores made on the Achievement
test and Aptitude I. Upon consulting a table of the normal
curve, this deviation in sigma units will yield the prob-
ability of the student being within the upper quarter of the
group.

The original discriminant function formula and analysis
used in this thesis involved the total group of 260 students

and the probability table was developed from these resulting
figures. However, it was thought that certain schools might
wish to predict the success of future students from the
results obtained within that school. Hence, prediction con-
stants were developed for the within values. These constants
are as follows:

School	N	Prediction K*
1	25	-1.4003
2	33	-1.4356
3	61	-1.1881
4	82	-1.0966
5	59	-1.2093

*V = .675

By the use of these constants, the prediction formula
then becomes for school #1, $V = aX_1 + bX_2 - 1.4003$.

The results of the 46 students from Texas A & M and the
31 students from Iowa State College that took the test in
1949 may be summarized in Table 9.

Table 8

Probability table for Achievement and Aptitude I raw scores.

Achievement Test (raw score)		Aptitude I (raw score)													
		21	24	27	30	33	36	39	42	45	48	51	54	57	60
69		8	10	12	14	17	20	24	28	32	36	41	46	50	55
		39	42	44	47	48	50	50	49	49	48	48	43	41	38
		53	49	44	39	35	30	26	23	19	16	11	11	9	7
66		7	9	11	13	16	19	22	26	30	36	39	43	48	53
		38	41	43	46	48	49	50	50	50	47	47	45	42	39
		55	50	46	41	36	32	28	24	20	17	14	12	10	8
63		6	8	10	12	15	17	21	24	28	32	37	41	46	50
		37	41	42	45	46	49	49	50	50	49	47	46	43	41
		57	51	48	43	39	34	30	27	22	19	16	15	11	9
60		6	7	9	11	13	16	19	23	26	30	35	39	44	49
		35	38	41	44	46	48	49	50	50	50	48	47	44	41
		59	55	50	45	41	36	32	27	24	20	17	14	12	10
57		5	6	8	10	12	15	18	21	25	29	33	37	42	46
		34	37	40	43	46	47	49	50	50	50	49	48	45	44
		61	57	52	47	42	38	35	29	25	21	17	15	13	10
54		5	6	8	9	11	14	17	20	23	27	31	36	40	45
		31	35	38	41	44	46	47	49	50	50	49	47	46	44
		64	59	54	50	45	40	36	31	27	23	20	17	14	11
51		4	5	7	9	10	13	15	18	22	25	29	33	38	43
		31	34	37	40	43	45	47	49	49	50	49	49	47	45
		65	61	56	51	47	42	38	35	30	25	22	18	15	12
48		4	5	6	8	10	12	14	17	20	24	27	32	36	41
		29	32	36	38	41	44	47	48	49	50	50	49	48	46
		68	63	58	54	49	44	39	35	31	26	23	19	16	13
45		3	4	5	7	9	11	13	16	19	22	26	30	34	39
		29	31	35	37	41	43	46	47	49	50	50	49	49	47
		69	65	60	56	50	44	41	37	32	28	24	21	17	14

These numbers represent the chances out of 100 that the student will be in one of the following:

#--the top quarter of the group
#--the middle half of the group
#--the bottom quarter of the group

Table 8 (Continued)

Achievement Test (raw score)		Aptitude I (raw score)													
		21	24	27	30	33	36	39	42	45	48	51	54	57	60
42		3	4	5	6	8	10	12	14	17	20	24	28	32	36
		26	29	33	36	41	42	44	47	49	50	50	50	49	48
		71	67	62	58	51	48	44	39	34	30	26	22	19	16
39		3	3	4	5	7	9	11	13	16	19	22	27	30	35
		24	29	32	35	38	41	44	47	48	50	50	50	49	48
		75	68	64	60	55	50	45	40	36	31	26	23	21	17
36		2	3	4	5	7	8	10	12	15	18	21	25	29	33
		24	27	30	33	37	40	42	45	47	48	49	50	49	49
		74	70	66	62	56	52	48	45	39	34	30	26	22	18
33		2	3	3	4	6	7	9	11	13	16	19	23	26	30
		22	24	29	32	34	38	41	44	47	48	50	50	50	50
		76	73	69	64	60	55	50	45	40	36	31	27	24	20
30		2	2	3	4	6	7	9	11	12	15	18	22	25	29
		20	24	26	30	33	36	39	41	45	47	48	48	50	50
		78	74	71	68	61	57	52	48	45	40	34	30	25	21

Table 9

Predicted and Actual Placement of Students Who Took the
Iowa State Veterinary Medical Aptitude Test in 1949
(N = 77)

Predicted	Actual		
Top Quarter	Top Quarter	Middle Half	Lower Quarter
Texas	42%	50%	8%
I.S.C.*	75%	12.5%	12.5%
I.S.C.**	75%	12.5%	12.5%
Middle Half			
Texas	32%	45%	23%
I.S.C.*	0%	87.5%	12.5%
I.S.C.**	0%	80%	20%
Bottom Quarter			
Texas	8%	50%	42%
I.S.C.*	0%	62.5%	37.5%
I.S.C.**	0%	87.5%	12.5%

* Prediction of those that actually took the test
** Prediction of those that actually took the test within
the entire class of 60 students

Table 10

Frequency Distribution of Grade Point Averages of Students
Entering Iowa State College Fall of 1949

Grade Point Average	Students who took I.S.C. Aptitude Test	Students who didn't take test
2.10	1	1
2.15	0	3
2.20	1	2
2.22	0	1
2.25	4	0
2.26	0	1
2.27	1	0
2.30	1	2
2.31	1	0
2.35	2	1

Table 10 (Continued)

Grade Point Average	Students which took I.S.C. Aptitude Test	Students which didn't take test
2.40	3	1
2.42	0	4
2.45	2	1
2.46	0	1
2.50	0	1
2.55	1	2
2.60	2	0
2.65	1	0
2.68	1	0
2.70	1	0
2.71	0	1
2.72	0	1
2.75	0	1
2.77	0	1
2.80	0	1
2.85	1	0
2.86	1	0
3.00	1	0
3.01	1	0
3.03	1	0
3.08	1	0
3.13	0	1
3.20	0	1
3.24	1	0
3.34	1	0
3.53	1	0
3.72	0	1

IV. DISCUSSION

The interpretation of the results of any statistical analysis may be subject to criticism in that at this point the exact science of mathematics is discontinued and the mechanics of the human mind are engaged. In an effort to minimize any misunderstandings, two factors which may have biased the data should be listed before the discussion of the results.

The most serious factor involved in the final analysis of these data was the nature of the population selected for this study. In 1947 the five schools which agreed to co-operate in this study were sent the revised and shortened aptitude tests, which were to be administered to the pre-professional students desiring admission into veterinary medicine. However, it was noted in 1949, when the validation of the test was begun, that two of the schools had tested only those pre-professional students who were scholastically eligible whereas the three remaining schools had tested all students desiring admittance, regardless of their grade point average. This accounts for the large variance in numbers within schools.

The second factor influencing the data is the difference in the methods of assigning grades among schools. In the school which gives the value of 3 for an A grade, it is easy to convert to the 4 point system of grading. However, one of

the schools grades on the actual percentage system (range of those cases studied, 77.36 to 86.52) which makes it difficult to convert grades to the point system.

The results of the preliminary findings are rather easily explained when the criterion for the determination of the correlations is more closely examined. In this study the criterion consisted of the accumulated grade point average made within the first year of Veterinary Medicine. This first year consists basically of Gross Anatomy, Microscopic Anatomy and two courses of Chemistry. Therefore, the correlation between pre-veterinary chemistry grades and freshman veterinary grades may depend upon the fact that chemistry is merely a continuation of the pre-veterinary course work.

Another point in this respect is that the first two years in the curriculum of veterinary medicine are composed of so-called basic course work. That is to say, the subjects which are taken up in these two years are made up largely of memorization (didactic) courses in which the student must understand and retain the information presented to him. This is in contrast to the so-called clinical years, or the junior and senior years of veterinary medicine, in which logical reasoning plays a more important role in determining the grade point average of the student.

Using the first and second year accumulative grade-point average made in Veterinary Medicine again influences the

results obtained from the correlation of these grades with
the Moss Medical Aptitude test. As has previously been
mentioned, the logical reasoning section of this test had
a rather low criterion correlation. If this test had been
correlated with the total grade point average made within
the four years of Veterinary Medicine, or with the basic
course work and the clinical course work separately, differ-
ent values for r would probably have been obtained. It
should be noted, however, that in separating the course
work in Veterinary Medicine into memorization courses and
logical reasoning courses, the first type makes up approx-
imately 66 per cent of the total cumulative grade point
average, and the second part makes up the remaining 34 per
cent. Hence, assuming equal variances, the basic memori-
zation courses influence to that extent the total cumulative
grade point average.

The results of the bi-serial and tri-serial correlations
are listed in Table 6 and Table 7. Little can be said con-
cerning these results other than how the analysis may have
varied or how the original data may have been collected
differently. As can be seen from the number of cases within
the first two schools as compared with the last three, and as
has been previously mentioned, these schools tested only
those applicants which were scholastically eligible. A more
important factor influencing these correlations is the fact
that the criteria were separated according to the cumulative

grade point average of only that group which was tested and not the total group of the class. It was assumed that since these students were selected without the use of the veterinary aptitude test they would represent a good cross section of the total group. The frequency distribution of the freshmen entering Iowa State College in 1949 and the total class grade point averages are listed in Table 10. Of those 31 students that took the veterinary aptitude test previous to entering veterinary medicine, their rank within the class is given and the probability of their being in the upper half, middle or lower quarter is listed in Table 9. These results can then be compared with those for the freshmen enrolled at Iowa State College that took the test prior to 1948.

By examining the tables which give the results of the students enrolled in Texas A & M and Iowa State College, who took the test prior to 1949, and who were selected without the use of the veterinary aptitude test, it can readily be seen that the prediction table is not 100 per cent efficient. For example, one student who ranked rather low according to grade point average had a prediction of 42 chances out of 100 of being in the top quarter of the class. However, it can be seen that those who actually did fall in the lower quarter of the class were predicted to do so in a greater number of cases than otherwise. The use of the prediction table then as an aid in selecting students in veterinary medicine is

bound to result in the selection of some students who will
not fall into the predicted category. However, as long as
it is the attrition group or the lower quarter students
which the Admissions Committee are chiefly concerned with,
the probability of a student being in the middle half or the
upper one-quarter is not as important as the table might lead
one to believe. It will, therefore, be dependent upon the
point at which the cutting score is drawn as to the efficien-
cy of the probability table.

It is generally recognized that the mechanical ability
of the student enrolled in Veterinary Medicine becomes more
important and apparent when that student reaches the clinical
years. As a means of checking this the Owens-Bennett Test
of Mechanical Comprehension was administered to 133 students
enrolled in Veterinary Medicine at Iowa State College. These
students were in the first and second year of the veterinary
curriculum. The correlation of the mechanical comprehension
test with the grade point average obtained in these two years
of Veterinary Medicine was relatively low and was considered
insignificant. It is believed, however, that the importance
of this test might be underestimated in this study. The
correlation of the results of this mechanical comprehension
test and the grades obtained in the clinical years of the
veterinary student would, perhaps, yield a much higher re-
lationship.

In the preliminary studies, one test was devised in an attempt to determine the student's interest in Veterinary Medicine. This test was composed of 35 items and was entitled "Animal Interest Test". The test was based on the assumption that if a student was really interested in animals prior to his admission to Veterinary Medicine he would acquire some information about them. Examples of the items in the test are as follows: (1) Which of the following animals does not possess a cloven hoof? (a) bovine (b) caprine (c) ovine (d) equine. (2) What is the number of upper incisor teeth in the ruminant animal? (a) none (b) two (c) four (d) six. (3) What is the number of true stomachs in the cow? (a) one (b) two (c) three (d) four. In the construction of this test the number of items concerning small animals and large animals was equal. The correlation between the animal interest test and the accumulative grade point average was relatively low. The relationship between the farm background and the total score on the test did indicate that farm life was a valuable asset to the applicant, but did not necessarily indicate his scholastic ability. Hence, it was decided that the results of this test should not be used as a predictor of failure or success in Veterinary Medicine. It was decided to use the animal interest test as a part of the personnel data which the applicant was required to supply if information of that type is desirable.

This study used a small number of cases over a relatively short length of time. The original preliminary findings on the relationship of the grade point average in Veterinary Medicine to the Moss aptitude score, and the original validation of the Iowa Veterinary Medical aptitude test were obtained from the results of 133 students enrolled at Iowa State College.

The results of the longitudinal study involving 260 cases in five different veterinary colleges qualifies the data for less criticism.

However, in a problem of this type, as has been found in the aptitude testing within the medical schools, the longer the test is used and the more widespread this use, the greater is the amount of data which is accumulated. Thus not only is the test itself improved but the purpose for which it is constructed becomes more sharply defined. Perhaps it is trite to repeat in such a thesis as this that further study expanding the data which have been collected is in order. However, because this is an original problem there are many facts which could be elaborated upon. One of these which the writer thinks bears great importance to this problem is the correlation between pre-veterinary grades and the grades obtained in each department within the Division of Veterinary Medicine. In the validation of the Iowa State Veterinary Medical aptitude tests, there are contained in the first two years which are concerned, the basic courses

in Veterinary Medicine. The grades obtained in clinical
medicine played no role in this study other than the fact
that they were included in the total of the cumulative grade
point average in the over-all study. It would be of interest
to separately correlate the test results for the so-called
memorization courses and the so-called logical reasoning
courses.

V. SUMMARY AND CONCLUSIONS

The relationship of pre-professional grade point averages between the grades obtained in chemistry, zoology, botany and English with the grades obtained for the first two years of Veterinary Medicine of the 133 students enrolled in the Division of Veterinary Medicine of Iowa State College is given in correlation form.

The relationship between the grade point average of 133 students enrolled in Veterinary Medicine at Iowa State College and the results on the seven sub-tests of Form 20 of the Moss Medical Aptitude test is given in correlation form.

The basic method followed in the construction of four new sub-tests entitled "Iowa State Veterinary Medical Aptitude Test" is listed.

The preliminary results of correlating this test with the grade point average obtained in Veterinary Medicine is given.

The results of the longitudinal study involving 260 students in five different veterinary colleges within the United States and the results obtained by these students on the Iowa Veterinary Medical Aptitude test are given.

The establishment of discriminant function weights of the Achievement section and the Aptitude I section of this test is shown.

The development of a probability table by the use of discriminant function weights from the raw scores obtained on

the Achievement test and the Aptitude I test is given.

The suggested use of the Veterinary Aptitude test by admissions boards of veterinary colleges and points which may require further study are also discussed.

The examination of other aptitude-entrance tests shows the Iowa State Veterinary Medical Aptitude Test to do as good a job at predicting success within veterinary medicine if not better, than any other test yet devised.

It is herewith concluded that this aptitude test for Veterinary Medicine will serve as a very useful aid to the admissions committees in their selection of students for the curriculum of Veterinary Medicine.

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VII. ACKNOWLEDGEMENTS