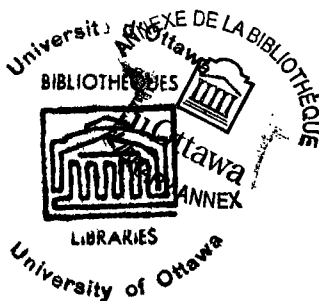


Predictive Validity of the Otis-Ottawa using First
Year Grades of Female Students with Age, Faculty, and
Socio-Economic Status as Moderator Variables

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Thesis presented to the School of
Graduate Studies of the University of Ottawa as
partial fulfillment of the requirements for the degree
of Master of Arts



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Abstract

The Examen Otis-Ottawa d'habilité mentale, Examen Supérieur formule A, has been used since 1966 by the University of Ottawa Counselling Service in educational and vocational counselling. Past research indicated that it had a low correlation with academic achievement. The joint moderator model proposed by Rock (1967) was used in conjunction with a double blind cross-validation design to analyse the predictive validity of the Otis-Ottawa. Some 658 French speaking first year female students of the University of Ottawa were selected and divided randomly into two samples. Using the faculty in which they registered, their age, and the total family income as potential moderator variables, their raw scores on the Otis-Ottawa were correlated with their average grade at the end of their first year. The results showed that the faculty they registered in operated as a moderator variable; the coefficient of correlation for students in the Science Faculty rose to .54 whereas the coefficient of correlation for the whole population was in the area of .20. This was interpreted as follows: (a) the joint moderator model is useful to identify moderator variables, (b) the Otis-Ottawa has predictive validity for some segment of the university community, and (c) the Otis-Ottawa could benefit from some reworking.

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Predictive Validity of the Otis-Ottawa using First
Year Grades of Female Students with Age, Faculty, and
Socio-Economic Status as Moderator Variables

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The purpose of this study is the analysis of the predictive validity of the Examen Otis-Ottawa d'habileté mentale, Examen Supérieur formule A, as determined by joint moderator methodology. The applied nature of the study has particular relevance to vocational and educational counselling; this is especially so at the University of Ottawa Counselling Service because it has used this test extensively since 1966. The assessment of the abilities of individual students may benefit the students themselves as they are often unaware of the conditions necessary for scholastic success; this study may also benefit the institution in as much as it uses the test for selection and prediction purposes. By the same token this study can provide validation data for one of the few psychological instruments available in French in this country.

Consequences arising from this research could range from the identification of those moderator variables which produce increments in the predictive validity of the test, to the decision to restrict the use of the test because it lacks predictive validity. As the concern is global

prediction of academic performance, the criterion will be the academic achievement in the first year at the University of Ottawa.

In the first chapter, the Examen Otis-Ottawa d'habileté mentale, Examen Supérieur formule A, will be reviewed. The claim that it is the equivalent of the original American instrument will be examined: (a) to evaluate critically those studies which used both tests indiscriminately, and (b) to insure that this research project is not redundant considering the numerous studies involving the Otis Self-Administering Tests of Mental Ability, Higher Examination form A. If the Otis-Ottawa can be shown to be different from the Otis, it becomes evident that it is in dire need of research. Other psychometric characteristics of the instrument, i.e., reliability and construct validity, will also be examined before the actual concern of this study, predictive validity, is presented. The Moderator model will also be reviewed as a recent strategy designed to improve prediction. The difficulties that researchers have encountered and a further development of the model will be presented prior to the statement of the problem. The second, third, and fourth chapters will present the Method, the Results, and the Discussion respectively.

Review of the Literature

In this chapter, the Examen Otis-Ottawa d'habileté mentale was first surveyed and then newer prediction strategies were reviewed. This led to the stating of the problem of concern in this study.

The Examen Otis-Ottawa d'habileté mentale

Shevenell (1943, 1948) has translated and adapted for a French speaking Canadian population the Otis Self-Administering Tests of Mental Ability (Otis, 1928). The translation is similar to the original tests with regards to scope, content, presentation, administration, scoring, and interpretation.

The Examens Otis-Ottawa d'habileté mentale are paper-and-pencil, self-administering group tests of general mental ability. Most of the 75 items are of the multiple choice type and are placed in a spiral omnibus arrangement so that the easier items appear in the beginning of the test and the more difficult ones later. These items are made up of antonyms, synonyms, arithmetics problems, general information, syllogisms, analogies, proverbs, and directions. Answers are recorded by the testee in a single column beside the corresponding question in the test booklet. Correction is done manually by means of a key and, provided that the instructions have been followed, the raw score is equivalent to the total number of correct answers.

Although Shevenell (1943, 1948) maintained that there are eight examinations of 75 items each, Isabelle (1960) correctly pointed out that there are only four examinations available (p. 10). Two equivalent but

more difficult tests are called "Examens Supérieurs" and are labelled A and B respectively; they are intended for individuals who have completed primary school. Two equivalent but easier tests are called "Examens Intermédiaires" and are also labelled A and B respectively; they are intended for pupils in the last four grades of primary school. Because of the lack of norms, scores on these translated tests are interpreted tentatively according to the norms developed by Otis (1928). The Examen Intermédiaire has a 30-minute time-limit; the Examen Supérieur has provision for either a 20 or 30-minute time limit.

Since the individual items are not too difficult, and since one must answer as many as possible in the allotted time, Shevenell (1948) held that his tests yielded such information as reading ability, general knowledge, span of attention, extent of vocabulary, speed and accuracy of performance, and consequently could provide a measure of scholastic aptitude (p. 10). In fact Otis (1928) described as follows his thinking in the construction of his tests:

Now it is the rate at which a student can progress through school that the mental-ability test is chiefly used to predict. Therefore this is believed to be the best criterion by which to judge the validity of each item that goes into the test...Each item justified its inclusion, therefore, because it distinguished between students who progressed slowly and those who progressed rapidly. (p. 3)

Certainly, such a procedure lends support to Shevenell's aforementioned statement.

Shevenell (1943) had previously suggested that his tests could be used for any of the following purposes: to identify problem learners,

overachievers, and underachievers; to classify students in homogeneous average, above-average, and under-average groups; to chart longitudinally mental development of individuals; and, to assess the intellectual maturity of individuals requesting vocational counselling (p. 9-10). He had also suggested that, for the time being, his translations be considered as the equivalent of the original American instruments (p. 20).

Yet, as of today, few studies have examined the psychometric characteristics of the Otis-Ottawa, or for that matter, the claim of its equivalence with the Otis. Still fewer studies have dealt with the Examen Otis-Ottawa d'habileté mental, Examen Supérieur formule A. Among others Shevenell (1943), Dumont (1967), and Therrien (1970) examined the claim for equivalence; Shevenell (1943) and Isabelle (1961) provided reliability coefficients; Charbonneau (1968), Boulais (1970), and Duclos (1970) investigated construct validation; finally, Saint-Norbert (1949), Vaillancourt (1955, 1961), Isabelle (1960, 1961), Marineau (1966), Gagnon (1967), Bourgeois (1968), Labelle (1968), Beauchesne (1970), and Boulais (1970) studied the predictive validity of the Otis-Ottawa.

In the following pages, the Otis-Ottawa will be examined in terms of the claim of equivalence, reliability, construct validity, and predictive validity.

Claim of Equivalence. Shevenell (1943) reported two studies comparing the Otis and the Otis-Ottawa for bilingual groups. In the first research, 100 bilingual students from a Teacher's College completed the Otis, form C, and the Otis-Ottawa, forms A and B. The coefficient of correlation, corrected with the Spearman-Brown formula, was .90. In the

second research, a bilingual population and a similar design were used again; "the results were slightly greater than in the other study" (p. 20).

There was no description of either the sample or the methodological procedures used. For example, controls for sex and/or degree of bilingualism were not reported. In the second study, specific results were not reported either. However, regardless of the methodological soundness of the studies, the high coefficients indicated at most that the English and French forms have a strong tendency to covary. They did not reveal whether most subjects scored consistently higher on one of the forms or whether most subjects scored consistently the same on each form.

Dumont (1967) wanted to know if the Otis-Ottawa was the equivalent of the Otis when administered to a bilingual population. She defined those students whose mother tongue was French and who claimed fluency in English as bilingual. Twenty-nine female nursing students in their first year of training were administered the Otis-Ottawa sometime between May and August 1966, and the Otis on February 1, 1967; the higher examination form A was used in both cases. Correlating the raw scores of the two tests yielded a Pearson coefficient of .67 ($p < .01$) and a Spearman rho of .76 ($p < .01$). On the basis of these results she concluded that (a) the coefficients were high, and (b) the tests were equivalent.

However, one must remember that finding coefficients significantly different from zero does not ipso facto make them high. Furthermore Dumont herself cautioned that the Spearman rho could be spuriously high as a large number of raw scores were identical. It must also be emphasized

again that high coefficients of correlation are not per se a guarantee of the equivalence of two tests. She also introduced confounding variables that further limited the impact of her study: (a) the two tests were given in the same sequence to all students, (b) the sample size was quite small, and (c) there was no empirical determination of the fluency in English. These factors had an unknown and unaccounted influence on the outcome of her study.

Therrien (1970) set out to verify (a) if the order of difficulty of the items was the same in the Otis and the Otis-Ottawa, (b) if each item in its English and French versions had the same difficulty index, and (c) if each item in its English and French versions had the same discrimination index. He made a nonproportional stratified sampling of 194 students from the University of Ottawa who voluntarily participated in a testing program in September, 1969. These students were French or English speaking male freshmen from the faculties of Arts and Sciences. The Otis and Otis-Ottawa, higher examination form A, were administered to English and French subgroups respectively.

By correlating, within each test, the items' actual rankings with modified rankings based on the items' difficulty indexes, Therrien found that the Spearman rho of the Otis was not significantly different from that of the Otis-Ottawa. Thus he concluded that the order of difficulty was similar in both. However he found that the difficulty indexes of the same Otis and Otis-Ottawa items were significantly different in eight cases; the English version was easier more often. Finally he did not

find any significant differences between any discriminant indexes for the same Otis and Otis-Ottawa items.

Therrien thus concluded his study by saying that it was not shown that the items of both tests were perfectly equivalent in all regards (p. 75). However, both tests were administered with a time limit; as a result, not all items were attempted by all students and this caused some of the later items to have spuriously low difficulty indexes. Still, as this condition affected equally both tests, it was legitimate to conclude that the items of these instruments were not all equivalent when administered in twenty minutes.

Because Shevenell (1943) and Dumont (1967) could but suggest that equivalence was possible, and since Therrien (1970) offered a much sounder argument that the tests were not quite equivalent, it seems appropriate to consider the Otis and the Otis-Ottawa as two different though very similar instruments until such time as research shows otherwise.

Reliability. Shevenell (1943) administered the Otis-Ottawa, higher examination forms A and B, to four small groups (ranging from 40 to 70 subjects each) of high school students and to one small group (50 subjects) of Teachers' College students in January 1942. The coefficients of correlation, corrected with the Spearman-Brown formula, ranged from .91 to .93. However, neither the sample nor its selection was described.

Isabelle (1961) examined the reliability of the Otis and the Otis-Ottawa by correlating test-retest results. For the 1959-60 academic year in the Faculty of Science, first and second year students who failed and first year students who were promoted to second year were selected. They

were retested the following year with the same test. Thus, the scores obtained by these students in the October 1959 administration of the Otis or Otis-Ottawa were correlated with the scores obtained in the October 1960 administration. The higher examination form A was given in 20 minutes on both occasions. A reliability coefficient of .843, corrected for restriction of range, was computed for 61 students.

Isabelle treated the Otis and the Otis-Ottawa as equivalent and processed the results of both tests together. Furthermore, he did not identify the sex of the participants. Generally, the two studies provided similar reliability coefficients; this suggested that the Otis-Ottawa does show stability over time. However, it appears imperative to undertake large scale studies to assess adequately the stability and internal consistency of this test.

Construct validity. Charbonneau (1968) pooled the intermediate and higher form A examinations of the Otis-Ottawa; he then assigned the items to one of eleven different subgroups on the basis of their task similarity. The objective was to examine the extent to which groupings of similar items correlated with the total score and with each other. The subgroups all had individual time limits and were administered successively to 70 students in one session. The sample consisted of all the grade nine boys present in the school on the testing day. Charbonneau found coefficients of correlation ranging from .47 to .83, all significantly different from zero ($p < .01$), between each subgroup and the total score. He also found intercorrelations ranging from .06 to .61, six of which were significantly different from zero ($p < .05$), among the different subgroups.

Thus he concluded that the subgroups thus studied demonstrated an acceptable level of independence since they all contributed to the total score without overlapping to a great extent. Charbonneau correctly pointed out that he was not attempting to develop the Otis-Ottawa as a differential aptitude battery, nor that he was investigating the factorial structure of the test. He also made an effort to keep the reader aware that the results could not be generalized to the general population and that they were valid only when the intermediate and higher examinations were considered together. Even though the formulation of the hypotheses was ambiguous and there were too few tests of significance, the study did provide evidence of internal consistency.

Boulais (1970) looked into the claim of increasing item difficulty and Duclos (1970) examined each item's discriminant validity. They analyzed the test results of 212 students randomly selected by the high school authorities from the total high school population; the boys were from grades nine to twelve. Boulais and Duclos administered the Otis-Ottawa, higher examination form A, in the 30-minute time-limit and then allowed another 30-minute period to complete the test after changing pencils. Thus, all the students had time to attempt all questions. The sample size was reduced to 201 as eleven tests had to be rejected.

Boulais (1970) computed difficulty indexes, corrected for chance success, and found that there was a progressive increase in the item difficulty when considering the whole test at a glance but that there was considerable variability from one item to the other. In fact 35 items could move up or down by more than ten places.

Duclos (1970) computed discriminant indexes by means of bi-serial coefficients of correlation, and found that all but eight items discriminated significantly ($p < .01$) between the high and low scores. Unfortunately Duclos derived his bi-serial coefficients from point bi-serial coefficients; the difficulty lies in the fact that, whereas the bi-serial is independent of the value of p , the point bi-serial depends on the correlation between the variables and the size of p from item to item (Dayhaw, 1969, p. 189). Consequently, statistical procedures introduced an uncontrolled variable which may have influenced the results in ways that remain ignored. On the other hand, the sampling appeared adequate although exactly how the authorities randomly selected the students could have been explained. Boulais could also have benefited from the computation of a Spearman rho to empirically support his claim that, although the Otis-Ottawa generally conformed to spiraling item difficulty levels, it is in need of reworking.

Generally speaking, the studies of Charbonneau (1968), Boulais (1970), and Duclos (1970) suggest that the Otis-Ottawa has construct validity. However, it must be pointed out that more sophisticated research is needed to assess the limits of the instrument.

Predictive Validity. As this study is concerned with overall academic achievement prediction, only those studies using the grade average as the criterion were deemed pertinent. Saint-Norbert (1949) compared the IQ scores of 62 first year female students enrolled in a Teachers' College and their average grade at the end of the first and

second years of their program. The predictor was the average IQ score taken from the Otis-Ottawa higher examination forms A and B. By categorizing the Otis-Ottawa results in four classes (80-90; 90-100; 100-110; 110 or more) and the academic results also in four classes (success; supplemental; failure; withdrawal), she developed and analyzed a double entry table for each year. In the first year, she found that those with scores of 100 or more "succeeded reasonably well", while those with scores of 96 or less "failed or barely succeeded". In the second year, she found that a group of 50 students had been promoted. Those with scores of 110 or more "succeeded reasonably well", those with scores of 96 or less "failed or barely succeeded", and those with scores between 96 and 110 "succeeded in as much as they studied hard". (p. 150, 152)

Saint-Norbert concluded that the Otis-Ottawa was a help in prediction. However, as no coefficient of correlation was reported, the extent of help the test offered was largely unknown. Furthermore, since the study did not report if the teachers were informed of the students' tests results, it may have been confounded by a halo effect.

Vaillancourt (1955) wanted to determine the value of the Otis and the Otis-Ottawa in predicting college success at the University of Ottawa. From a population of approximately 1,000 male students who attended grade twelve at the University of Ottawa High School between September 1942 and June 1953, Vaillancourt found 309 students who (a) were administered the Otis or Otis-Ottawa, higher examination, while in grade twelve, and (b) completed their freshman year at the University of Ottawa. For this study, Vaillancourt subgrouped the IQ scores into six categories and the

achievement results (final marks) into four categories ranging from complete success to failure. From the 6x4 table, he computed a χ^2 which he found to be significant ($p < .001$). As this indicated some kind of relationship, he proceeded to compute a contingency coefficient which he found to be .36 and significantly different from zero. He then concluded: "There is a definite but rather low correlation" (p. 55).

However, some methodological procedures could have dampened the findings. By selecting his sample as he did, Vaillancourt omitted all the students who (a) did not come to the University of Ottawa because they did not attend the University or because they went elsewhere, and (b) did not complete their freshman year at the University of Ottawa. Moreover, Vaillancourt considered the Otis and Otis-Ottawa as equivalent instruments when they may not be quite so. Still, the study generally presented evidence that the Otis-Ottawa had some predictive validity.

Isabelle (1960) analysed data gathered four years earlier in the Faculty of Science of the University of Ottawa. In March 1956, all students registered in first and second year were invited to participate in a testing program. Depending on their mother tongue or their fluency in French or English, the participants were administered an Otis or an Otis-Ottawa, higher examination form A. The individual IQ scores were correlated with the average grade, obtained from all final marks, and dichotomized as pass or fail, by means of a point-biserial coefficient. This procedure was repeated the following September.

For the 1955-56 first year students ($n = 55$) the coefficient was .23 (N.S.); for the 1955-56 second year students ($n = 45$) the coefficient was

.00 (N.S.). For the 1956-57 first year students ($n = 58$) the coefficient was .23 (N.S.); and for the 1956-57 second year students ($n = 57$) the coefficient was .08 (N.S.). Thus Isabelle (1960) concluded: "On the basis of these results, it is apparent that there is little or no actuarial predictive value in using the Otis ... for the prediction of success of failure." (p. 42)

However, a number of confounding variables arose in this study: for example, male and female students were treated as one homogeneous group; similarly French and English speaking students were treated as one homogeneous group. Furthermore, the environmental conditions in which the tests were given were very poor and the dichotomized criterion unnecessarily restricted the range of the criterion.

Isabelle (1961) correlated Otis and Otis-Ottawa raw scores, gathered from all Science first and second year students at the University of Ottawa in October 1959, with the average grade on December and April examinations. He also correlated Otis and Otis-Ottawa raw scores, gathered for all Science first and second year students at the University of Ottawa in October 1960, with the average grade on December examinations. Isabelle used a point-biserial coefficient as he again dichotomized the criterion as pass or fail. Table 1 presents the results.

The study was carried out in more favourable conditions but Isabelle again grouped male, female, French, and English speaking students together and used the point-biserial coefficient. Also he did not mention in his description of the sampling if there were any drop outs in his groups.

Table 1

Bi-serial coefficients of correlation found by Isabelle (1961)
 between Otis and Otis-Ottawa IQ scores and
 academic performance in December and April examinations

University Year	<u>n</u>		December	April
1959-60				
First	117		.04	.07
Second	99		.33**	.28*
1960-61				
First	121	First	.13	_a
Second	96	Second	.11	_a

^a not computed

* $p < .05$

** $p < .01$

Vaillancourt (1961) used interchangeably the Otis with the Otis-Ottawa in the testing of all first and second year Science students at the University of Ottawa in October 1959. Of the 216 students originally tested, 36 were omitted because they had incomplete test data or dropped out of the program. He computed product-moment coefficients between the IQ scores and the final average grade by class and by sex. For first year male students ($\underline{n} = 85$) the coefficient was .15 (N.S.); for first year female students ($\underline{n} = 10$) the coefficient was .53 (N.S.). For second year male student ($\underline{n} = 77$) the coefficient was .44 ($\underline{p} < .01$); and for second year female students ($\underline{n} = 8$) the coefficient was .46 (N.S.).

Although he studied the sexes separately, the female samples were too small to provide any adequate information. Moreover, Vaillancourt again considered the two tests as equivalent and eliminated the drop outs from the study. It is unfortunate that these students who quit sometime during the academic year cannot be included in designs like that of Vaillancourt's because their inclusion could provide valuable information. Generally this research provided more evidence of the "definite but rather low correlation" (Vaillancourt, 1955, p. 55) he had previously found.

Marineau (1966) studied the predictive validity of the Otis-Ottawa, higher examination form A, by comparing IQ with academic achievement in 1961-62 for 133 male students in their first year of high school. He computed three product-moment coefficients. When using the total sample, he found a coefficient of .47; when using the students with academic achievement above 75% or below 65%, he found a coefficient of .52; and

when using the students with IQ at the extremities of the distribution, he found a coefficient of .87.

However, Marineau did not report any tests of significance whatsoever. Furthermore, it seems that he used academic achievement as the predictor of IQ to compute the second coefficient, and that he used a very small sample ($n = 18$) to compute the third coefficient. Generally Marineau presented very sketchy descriptions of the sample, designs, and results.

Gagnon (1967), while pursuing research other than a predictive validity analysis of the Otis-Ottawa, gathered information on the academic records of 122 first year students enrolled in a Teachers' College. She correlated the Otis-Ottawa, higher examination (form not specified), IQ results with the Quebec grade eleven average. She found a coefficient of .00. She also correlated the same IQ results with the first semester average in Teachers' College and found a coefficient of .14. Gagnon did not report any tests of significance.

This type of backward analysis introduced uncontrollable variables as only those in that college took the Otis-Ottawa at that time while a much larger group of students had written the grade eleven examinations. The selected few in Teacher's College were probably a more homogeneous group which tended to decrease the magnitude of the coefficients of correlation. Furthermore male and female students were pooled in one sample so that any existing relationship, particular to one sex, may have been obscured.

Bourgeois (1968) administered the Otis-Ottawa, higher examination form A, to 70 male students in grades eleven and twelve. He correlated the IQ scores with the final results of the preceding academic year and the December results of that academic year for 52 students (the criterion data were not available for all subjects). He found product-moment coefficients of .14 (N.S.) and .24 (N.S.) for 26 grade eleven students on previous year and past semester results respectively; he also found product moment coefficients of .42 ($p < .001$) and .01 (N.S.) for 26 grade twelve students on the same criteria. Again, this type of backward analysis omitted any student who failed, went to another school, or just arrived in that school: these students could have had characteristics bearing significantly on the results.

Labelle (1968) found a coefficient of correlation of .18 (N.S.) between the Otis-Ottawa, higher examination form B, and the average grade of four core nursing courses for 24 French speaking female nursing graduates. The Otis-Ottawa had been administered to all the students who started the program but 10 withdrew over the course of three years; perhaps they had characteristics different from those who remained.

Beauchesne (1970) randomly selected 30 male Science students, 50 male Arts students, and 50 female Arts students from the group of freshman students of the University of Ottawa who participated in a testing program in September 1968. The 130 selected students completed their first year with more than four courses. Beauchesne correlated Otis-Ottawa, higher examination form A, IQ results with the average grade of the final examinations. He found the following product-moment coefficient: male

Science students, .04 (N.S.); male Arts students, .11 (N.S.); and female Arts students, .00 (N.S.). However the small sample sizes may have unnecessarily restricted the range and consequently the magnitude of the coefficients of correlation.

Finally, Boulais (1970) correlated the IQ scores of the students in a sample described in a preceding section (see Construct validity) with their average grade. He found a product-moment coefficient of .52. However he did not test for significance nor did he describe the criterion.

To summarize, inspection of Tables 2 and 3 reveals that:

1. the predictive validity studies have been done in High School, Nursing School, Teachers' College, and University settings;
2. no study included cross-validation analysis;
3. eleven studies have examined 23 different samples and have reported 27 different coefficients of correlation;
4. 73% of the samples had less than 100 participants;
5. 39% of the samples had male subjects only, 39% disregarded the sex of the participants, and 22% had female subjects only;
6. 11% of the coefficients of correlation were not tested for significance, 19% of the coefficients were significantly different from zero, and 70% of the coefficients were not significantly different from zero;
7. the significant coefficients ranged from .28 to .44 with a mean of .36; and,
8. All studies used the classical validation model, i.e., predicting one set of data from another, to assess the predictive validity of the

Table 2

Summary description of predictive validity studies of the
Otis-Ottawa in High School, Nursing School, or Teachers' College settings

Study	<u>n</u>	Sex	Coefficient of Correlation ^a	
High School Studies				
Marineau (1966)	133	male	.47 ^b	
Bourgeois (1968)	26	male	.14	.24
	26	male	.42 [*]	.01
Boulais (1970)	196	male	.52 ^b	
Nursing School Study				
Labelle (1968)	24	female	.18	
Teachers' College Studies				
Saint Norbert (1948)	62	female	- ^c	- ^c
Gagnon (1967)	122	mixed	.00	.14 ^b

^a those studies using two criteria report two coefficients.

^b the test of significance of the coefficient was not reported.

^c the coefficient was not available.

* $p < .001$

Table 3

Summary description of predictive validity studies of
the Otis-Ottawa in a University setting

Study	<u>n</u>	Sex	Coefficient of correlation ^a	
Vaillancourt (1955) ^b	369	male	.36*	
Isabelle (1960) ^b	55	mixed	.23	
	45	mixed	.00	
	58	mixed	.23	
	57	mixed	.08	
Vaillancourt (1961) ^b	85	male	.15	
	10	female	.53	
	77	male	.44**	
	8	female	.46	
Isabelle (1961) ^b	117	mixed	.04	.07
	99	mixed	.33**	.28**
	121	mixed	.13	
	96	mixed	.11	
Beauchesne (1970)	30	male	.04	
	50	male	.11	
	50	female	.00	

^a those studies using two criteria report two coefficients.

^b studies where Otis or Otis-Ottawa were used.

* significance level not reported

** $p < .01$

Otis-Ottawa.

It further reveals (a) that 80% of the studies in a University setting used indiscriminantly the Otis or the Otis-Ottawa, and (b) that 19% of the samples in this setting consisted of female participants only - and small samples at that. It seems then, that although more than 3,600 tests have been administered to University of Ottawa students, the Otis-Ottawa has not been thoroughly validated and that predictive validity studies, among others, are necessary. This is especially so with regards to a female population.

Summary. It appears that the Otis-Ottawa is a scholastic aptitude measure not quite identical to the original American instrument. It also appears that the reliability and the construct validity of the Otis-Ottawa, though in need of more extensive research, are sufficient to warrant its use. However, studies in the area of predictive validity are not too conclusive. On one hand, research concerning the Otis-Ottawa would benefit from better methodological designs, and on the other hand, investigation of newer prediction strategies could reveal significant improvements over the traditional single predictor correlational model (classical validation model).

Recent Prediction Strategies

Reviewing the area of academic achievement prediction, Romine, Davis, and Gehman (1970) have found that it "has progressed very little during the past 20 years, either with regards to its methodology or its findings" (p. 337). The usual methods that investigators of college academic

achievement prediction have used are high school grades and/or scores on a standardized measure of scholastic aptitude as the prediction of freshman average grade in a multiple regression analysis. On the average a multiple correlation of .55 was usually obtained, rarely more, often less. Romine et al. (1970) found that current reports continue to advocate the use of these methods resulting in similar findings.

It appears as if the "prediction ceiling" of .50 found in other areas of psychological research, notably industrial, holds true in academic prediction. Ever since James McKeen Cattell coined the word "mental test" and introduced individual differences measurement, predictive validity coefficients rarely exceeded .50. Ghiselli (1966) published the reasonably solid validity coefficients he found and concluded:

Taking all jobs as a whole...the maximal power of tests to predict success in training is of the order of .50 and to predict success on the job itself is of the order of .35. (p. 125)

Ghiselli (1973) later reviewed his findings considering the studies published between 1966 and 1972 and came to similar conclusions.

Rundquist (1969) reported that there "have been three major strategies to improve predictors: item analysis, factor analysis, and the moderator variable approach" (p. 110). Saunders (1956) noticed that:

There are many examples of situations in which the predictive validity of some psychological measure varies systematically in accord with some other independent psychological variable. (p. 209)

He went on to coin the term "moderator variable". These variables are, by definition, the group of predictors which are supposed to moderate the influence of the original predictors of the criterion variable.

Similarly, Anastasi (1968) defined the moderator variable as that interaction, in the prediction model involving people and tests, which implies that the same test may be a better predictor for certain classes or subsets of persons than it is for others.

These definitions provide a reasonably clear understanding of what moderators are but they do not explain how they operate. A common conception is that moderators sort heterogeneous aggregates of individuals into homogeneous subgroups (Berdie, 1961; Saunders, 1956). Another explanation was provided by Ghiselli (1963): moderators could differentiate those individuals in a group for whom error of measurement or prediction is small from a group for whom it is large. He presumed that error of measurement or prediction varied from small for some individuals to large for others.

However, it appears that the crucial determinant of the operation of moderators depends on whether discrete or continuous variables are examined. In essence, there is a continuous (linear or curvilinear) relationship between scores on the moderator and scores on some predictor-criterion combination. For qualitatively different groups classical psychometric theory still is appropriate as there is no moderator effect; as the heterogeneous population is divided into smaller homogeneous subgroups that interaction between the moderator and the predictor-criterion combination disappears. Ghiselli (1968) claims that the true moderator is a continuous qualitative variable, and that individuals are distributed all along its continuum. This conceptualization is similar to Saunders' (1956) position that a moderator variable is a generalized case of

analysis of covariance, with the basic parameter being a score on a continuous variable rather than group membership.

Still other explanations involve linking off-quadrant analysis to analysis of variance (Marks, 1964) and to discriminant analysis (Lykken & Rose, 1963; Hobert & Dunnette, 1967) although Zedeck (1969) has found the latter ineffective in his multipredictable group validation model. Considering these many suggestions as to how moderators operate, one can but realize how elusive they remain.

The Moderator model. In any case, this new psychometric theory has sparked considerable research and statistical strategies designed to improve the classical validation model. The thrust naturally was towards the identification of homogeneous sets of individuals for whom the prediction would be better because the classical validation model provides but a single index of the relationship between predictor and criterion, and ignores factors intervening between behaviors on the two variables. However Zedeck (1971) found that the procedures, developed from different concepts of the moderator variable, were different and lead to dissimilar results. He categorized these procedures in terms of whether they belonged to: (a) differential validity techniques, (b) differential predictability techniques, or (c) moderated regression techniques.

Differential validity techniques conceive the moderator as a description of the relationship between two variables and imply that subgroups, formed by fractionation on the moderator scores, demonstrate different validity coefficients. These techniques examine the influence of a third variable, qualitative or quantitative, on a predictor-criterion

relationship. That is, $r_{\underline{xy}}$ for Group A is significantly different from $r_{\underline{xy}}$ for Group A' (not A) where A is a qualitative or quantitative description variable. Examples are the "subgrouping variables" of Frederiksen and Melville (1954), the "referrent variables" of Toops (1959), and the "modifier variables" of Grooms and Endler (1960).

Differential predictability techniques also conceive the moderator as a description of relationships between two variables but imply that subgroups formed on the basis of the predictability of the individuals demonstrate different validity coefficients. This second set of techniques also identify groups with differing validities but in this case the subgroups are formed on the basis of the predictability of individuals with respect to a particular predictor-criterion relationship. Thus, $r_{\underline{xy}}$ for relatively predictable individuals (small deviations from the regression line) is significantly greater than $r_{\underline{xy}}$ for non-predictable individuals. Examples are the "predictability variables" of Ghiselli (1956), the "homologizer variable" of Johnson (1960), the "quadrant analysis" of Hobert and Dunnette (1967), the "multipredictable group validation model" of Zedeck (1969), and the "intraindividual variability" of Berdie (1961).

Moderated regression techniques conceive the moderator as a psychometric characteristic of the relationship between two variables and imply that one moderated regression equation, developed for the total group, provides improved prediction over that of ordinary multiple regression. It involves prediction equations for the total sample and does not require explicit subgrouping or differentiating of individuals. Examples are

the "population control variables" of Gaylord and Carroll (1948), and the "moderator variable" of Saunders (1956). In fact, for Saunders the moderator variable is a means of maintaining the integrity of the total population while still maintaining a statistical control on each individual's membership in one of a continuous infinite series of subpopulations defined by his score on the moderator. Saunders (1956) used a multivariate curvilinear regression equation involving cross-products in which the beta weights, instead of being constant, are linear functions of the moderator variables. The regression equation is

$$y = \bar{y} + \sum ax + \sum bz + \sum cxz \quad [1]$$

where a, b, and c are beta weights,

x is the predictor variable,

z is the moderator variable.

Zedeck (1971) found that in general moderated regression has not been successful in improving prediction. Furthermore, differences in results among the different strategies were a consequence of comparing techniques that treat the same variables differently, a victim of which moderated regression may be. Problems arise in that some techniques were appropriate for discrete qualitative variables, and others for continuous quantitative variables. Saunders' (1956) moderated regression equation described the multivariate regression surface with a model that is non-linear in the predictor and moderator variables, whereas differential validity and differential predictability techniques consider each subdivision of the original population to have a different linear relationship between predictor and criterion; thus the effect of any non-

linearity in the relationship between the moderator and the predictor-criterion combination may be ignored.

Problems with the moderator model. Zedeck (1971) identified six problems that arise with regard to statistical and methodological issues.

The first concern is cross-validation. On one hand, few investigators have cross-validated the findings of their studies. On the other hand attempts to replicate some of the other non-cross-validated studies have failed to find the so called moderator variables that were thought to operate. It appears then of the utmost importance to carry out this extra step in current and future research.

A second problem concerns the test for demonstrating differential validities among qualitative subgroups or predictability subgroups. Investigators have used three methods in this regard: (a) significantly different coefficients between subgroups, (b) some significantly different coefficients from zero, and (c) significantly different validity coefficient of a subgroup from the validity coefficient of the total group. Zedeck (1971) claimed that the first way of demonstrating differential validities is more powerful than the second, and that he did not know of a statistic to test the third. Dayhaw, as reported by McInnis (1972), has since developed a statistical test for this purpose.

The third general problem concerns the number of different subgroups that should be formed. The possibility of forming an endless number of subgroups exists, particularly when examining biographical information blanks or demographic variables as potential moderator

variables. Infinite subgrouping is related to the problem of sample size (i.e., subgroup sample sizes eventually become too small to perform significance tests) and stability of the differences. Recent solutions to the above problem suggest considering several moderator variables simultaneously as the basis for subgroups, or advocate the use of a single multiple-moderated regression equation, which maintains the total sample size in the analyses.

The fourth problem pertains to the validity coefficients of the original total sample. Improving upon a validity coefficient that is already relatively high is both difficult and somewhat impractical.

The fifth general problem is that the effect of the potential moderator variable as an independent predictor often is not reported. Applying the potential moderator variable as an independent predictor in an ordinary multiple regression equation could produce equally good results and thus would eliminate the endless subgrouping and subgroup sample size problems. Also, there would be less claims for the ubiquitous moderator in the research literature. Hence, the correlations, slopes, and standard error of estimates should be examined for the following three regression equations:

$$y = a + bx \quad [2]$$

$$y = a + b_1x + b_2z \quad [3]$$

where z is the potential moderator variable but is treated as an independent predictor variable and

$$y = a + b_1x + b_2z + b_3xz \quad [4]$$

(moderated regression equation). If equation 3 and 4 are significantly different from equation 1, but not from each other, then the variable is an independent predictor and not a moderator variable (Zedeck, 1971, p. 304).

A sixth general problem is the identification of moderator variables. Zedeck (1971) found that:

A review of the moderator variable literature indicates that a considerable number of scales and variables function as moderators. The problem of readily and systematically identifying a moderator variable, however still remains unsolved. Banas [1964] ...distinguished between the rational and empirical approach of the identification of moderators. (p. 306)

The rational approach involved intuition, hypothesis-forming, and accident. Zedeck (1971) reported that Saunders (1955), Toops (1959), Frederiksen and Melville (1954), and Conger (1969) used these methods. Unfortunately they are time consuming, inefficient, and costly because of the considerable number of possibilities that exist. The empirical approach involved statistical analysis of the data. Zedeck (1971) reported that Ghiselli (1956, 1960), Berdie (1961), and Hobert and Dunette (1967) used this method though only investigating one variable at a time. This also proves to be time consuming, inefficient and costly. French (1961), Rock, Barone, and Linn (1967), and Zedeck (1969) have attempted to devise statistics and procedures that systematically or mechanically identify moderator variables.

French (1961) developed a program that generated indexes from joint distributions in 3 x 3 contingency tables instead of actual correlation coefficients. The technique was unsuccessful because of the distortion

of the indexes. Zedeck (1969) attempted to use discriminant analysis and analysis of covariance to identify moderators in a multipredictable group validation model. The techniques proved unsuccessful because the findings did not resist cross-validation analysis.

Rock et al. (1967) developed a computer program for a moderated stepwise prediction system (MSPS) where potential moderator variables are examined simultaneously or in a stepwise manner. This stepwise system does not require the impractically large number of groups difficult to obtain in academic settings that factorial designs require. Moreover, it does not lose the information that factorial designs lose by not treating the moderator as a continuous variable. Thus, given a sample of individuals with multiple measures on each individual including a criterion of success, one can utilize this system to isolate groups which consist of individuals characterized by common profiles on background or personality variables, and which also yield optimal within group prediction systems. Besides dealing effectively with the general problem of the identification of moderator variables, the MSPS has the other advantage of also dealing effectively with the general problem of the sample size and the infinite possibilities of subgrouping.

In this section then, the moderator variable approach has been examined in terms of the different conceptualization held by researchers, the categorization of techniques, and the identification of problems in the use of moderator variables. Zedeck (1971) categorized procedures as differential validity techniques, differential predictability techniques, or moderated regression techniques. He also identified the following

problems:

1. Too few investigators have cross-validated their results.
2. The lack of statistical procedures to test differential validities among subgroups.
3. The possibility of infinite subgrouping.
4. Attempts to improve already high validity coefficients.
5. Not reporting the effect of potential moderator variables as independent predictor variables.
6. Difficulty of identifying moderator variables.

They do not however present insurmountable difficulties: the first and fifth problems can be remedied by an appropriate design; the second has been solved by Dayhaw (McInnis, 1972); the third and sixth are dealt with by using the MSPS; and, the fourth does not occur because the Otis-Ottawa has low predictive validity.

The Joint moderator model. Although a joint moderator model could deal effectively enough with the above third and sixth problems, Zedeck, Cranny, Vale, and Smith (1971) reported that this model had largely been ignored in the literature. The joint moderator was defined as "two or more variables, quantitative or qualitative, that interact to influence a validity coefficient" (p. 235) because it is conceivable that two or more potential moderator variables, operating together, could influence the relationship between a predictor and a criterion. Klein, Rock and Evans (1968) reasoned that the major limitation of the usual one-variable-at-a-time moderator approach does not take into consideration the possibility that several moderator variables may be combined.

Klein et al. (1968) used the MSPS as suggested by Rock et al. (1967) to examine the effectiveness of joint moderator variables in the prediction of law school grades. Five items (age, major field of study, degree of preparation by college for law school, father's occupation, and time at which decision was made to attend law school) were used to form multiple moderator variables. The students (n= 402) were assigned randomly to a validation or to a cross-validation sample. The MSPS placed the subjects into homogeneous groups on the basis of the similarity of their profiles on the five items, and computed validity coefficients for each. This grouping technique yielded four homogeneous groups, one of which was significantly different from two of the remaining three at a 0.05 level of confidence; the validity coefficient of this group was also higher than that of the total sample.

The results were cross-validated with the second sample and were replicated in three of the four groups. Thus they concluded: "The dissimilarity in prediction equations between groups also suggests that a given predictor may work better with some types of students than it does with others" (p. 157). The effect of the potential moderator variables as predictors was also investigated and found to be nonexistent. As a result, Klein et al. (1968) believed that they could identify the students for whom accurate predictions could be made, and identify valid predictors for different types of students.

Except for the lack of statistical knowledge, c.f., the second problem (Zedeck, 1971), this study coped adequately with all the other difficulties that has hindered moderator research. Thus, it provides

support for the use of the MSPS in an academic setting.

Zedeck (1971) reported that few investigators used joint moderator variables (Fredericksen & Melville, 1954; Stricker, 1966; Tesser, Starry & Chaney, 1967; Zedeck, 1969). The results of these studies were generally negative, inconclusive, or unclear. However Zedeck (1971) claimed that this lack of results could be attributed to small sample size, the type and quantity of variables used, and/or the correlation between the potential moderator variables.

It seems evident that the use of joint moderator variables has not been frequent. Yet, while two studies out of five reported a joint moderator effect, the MSPS proved successful the only time it was used. As for the other studies, overcoming methodological weaknesses could present a much clearer picture of the situation.

Thus it now appears that the Otis-Ottawa is a potentially good instrument in need of predictive validity analysis. It further appears that the moderator model is a valid alternative to the classical validation model, and that the joint moderator model presents still other advantages in the attempt to validate the predictive ability of the Otis-Ottawa in a university setting.

Statement of the Problem

The main concerns of this study can be summarized with the following questions:

1. What is the predictive validity coefficient of the Otis-Ottawa using the classical validation model?

2. Can the above results be replicated?
3. Can the above results be cross-validated?
4. What are the predictive validity coefficients of the Otis-Ottawa using the joint moderator model?
5. Can some of the above coefficients present an increment over that found with the classical validation model?
6. Can the above results be cross-validated?
7. Can the potential moderator variables function better as predictor variables rather than moderator variables?

It is expected that the predictive validity coefficient of the Otis-Ottawa obtained with the classical validation model will be significantly different from zero in the samples studied. It is also expected that at least one of the predictive validity coefficients obtained with the joint moderator model will be significantly larger than the previous coefficient obtained with the classical validation model. Finally it is expected that the potential moderator variables will function best as moderator variables, and not as predictor variables.

Thus the present research will provide information as to (a) the extent of the correlation between the Otis-Ottawa and college academic performance with the classical validation model and the joint moderator model, and (b) whether or not the Otis-Ottawa is an efficient tool in college academic performance prediction.

Method

This chapter presents the setting, the participants, the moderated stepwise prediction system, the selection procedure, the statement of specific hypotheses, and the statistical analysis that were of use in this study.

Setting

In September of each year (1966-1973), the University of Ottawa Counselling Service (UOCS) carried out an Orientation Testing Program intended to gather information regarding the student population entering the University of Ottawa on a full time basis. Standardized psychological tests (aptitude and personality measures) and custom made Questionnaires collecting sociological, demographical, and attitudinal data were administered in English or in French to participating students. The UOCS has kept computerized records of this information gathered over the years through the University of Ottawa Computing Center.

Although attendance was not compulsory, some 3,726 students (see Table 4) participated in the French administration of the Orientation Testing Program (OTP-F).

Participants

The participants in this study were 658 University of Ottawa undergraduate students who:

1. participated in OTP-F at any time between September 1967 and September 1972 inclusively;
2. reported, on the Questionnaire, that they belonged to the

Table 4

Number of students participating in the French
administrations of the Orientation Testing Program by year^a

Year of administration	Academic Year	Number of students
September 1966	1966-67	265
September 1967	1967-68	381
September 1968	1968-69	401
September 1969	1969-70	479
September 1970	1970-71	620
September 1971	1971-72	544
September 1972	1972-73	640
September 1973	1973-74	396
Total		3,726

^a University of Ottawa Counselling Service. Summary sheets of Orientation Testing Number for 1966-67, 1967-68, 1968-69, 1969-70, 1970-71, 1971-72, 1972-73, and 1973-74.

female sex;

3. reported, on the Questionnaire, that their mother tongue was French;

4. indicated their University of Ottawa Student Identification Number (UOSN)

5. reported, on the Questionnaire, that they were registered in the first year of a program;

6. reported, on the Questionnaire, that they were registered in the Faculty of Social Sciences, the Faculty of Arts, the School of Physical Education and Recreation, the School of Nursing, or the Faculty of Pure and Applied Sciences;

7. reported, on the Questionnaire, their age;

8. reported, on the Questionnaire, the total income of their family;

9. completed the Examen Otis-Ottawa d'habileté mentale, Examen supérieur formule A (Otis-Ottawa);

10. remained registered as full time students for the duration of that academic year; and,

11. obtained credits and alphanumerical marks, for their coursework in their respective programs.

Students participating in the September 1966 OTP-F were disregarded because they were administered the Otis-Ottawa in 30 minutes while all subsequent administrations were 20 minutes. Students participating in the September 1973 OTP-F were disregarded because it was not possible,

at that time, to retrieve from the UOCS computerized records the required information,

Female students were selected because there has been no extensive study of the predictive validity of the Otis-Ottawa with a female population in a university setting.

Students who came to OTP-F but whose mother tongue was other than French were disregarded to reduce error variance. Given that there are differing verbal abilities across individuals, it was deemed unnecessary to introduce a second factor (ability to learn a second language) over which there was even less control.

As it will become evident in a following section, the UOSN was necessary to retrieve some portion of the data for the study. Those students who at the time of testing did not indicate it, for whatever reason, had to be omitted.

To reduce criterion error variance still more, it was also deemed necessary to study one particular group of students at a time. First year students were chosen because they were a large body of students who were beginning a career in the university setting and consequently were more in need of accurate and adequate prediction than other groups. For the purpose of this study, "first year" was further defined as meaning enrolment by a student in at least four full courses, or the equivalent, of first year level; a full course was defined as a course of four credits or more.

The students registering in faculties or schools other than those mentioned above were disregarded because their faculty or school did not

appear consistently in the Questionnaires from year to year.

In order to obtain an adequate estimate of academic performance, it was deemed necessary to use only those students who remained registered as full time students throughout that academic year. For the purpose of this study "full time" was defined as meaning maintaining enrolment and completing course requirements in at least four full first year level courses or the equivalent in that particular academic year. It is evident that not all first year students enrolling at the University of Ottawa on a full time basis maintained their enrolment for the complete academic year. However, those who became part time students or who withdrew completely from the institution constituted two other and different groups of individuals. Granted that the study of the characteristics and predictability of these two other groups is both necessary and urgent, such research was considered beyond the scope of the present study.

Moderated Stepwise Prediction System

The moderated stepwise prediction system (MSPS) proposed by Rock et al. (1967) is described in greater details in Appendix A. Briefly, the essence of this system is to place individuals into groups on the basis of the similarity of their profiles on a given potential moderator variable or combination of potential moderator variables, and then build a separate prediction equation for each group. The program allows for a maximum number of 550 subjects, 5 predictor variables, 5 moderator variables, and 1 criterion variable per run. Klein et al. (1968) state that there are no a priori clusters of groups as they are determined

solely by the characteristics of the data. When more than one predictor variable is used, the prediction system also provides a regression equation and a validity coefficient for each homogeneous group. Rock (1969) suggested a minimum number of 400 subjects because many parameters are being estimated.

Predictor variable. The predictor variable was the IQ score obtained on the Examen Otis-Ottawa d'habileté mentale, Examen supérieur formule A (Otis-Ottawa), by each subject in the OTP-F. The reliability and construct validity of the instrument were acceptable enough to warrant its use.

Potential moderator variables. Klein et al. (1968) examined age, major field of study, degree of preparation by college for law school, father's occupation, and time at which decision to attend law school was made as potential moderator variables. They found that the first (age), fourth (father's occupation), and fifth (time at which decision to attend law school was made) potential moderator variables had the most influence in the formation of the groups while the second (major field of study), and the third (degree of preparation by college for law school) had less.

They found additional support for the joint moderator model and for these five moderator variables in particular in an investigation of the efficiency of these variables as predictor or moderator variables. They developed on the total validation sample a prediction equation that included all moderator and predictor variables, and then applied this equation to the total cross-validation sample. The resulting validity

coefficient was essentially the same as that achieved when the five moderator variables were not included in the equation. Thus they concluded that the value of background variables may lie in their effectiveness as moderator variables rather than in their utility as predictors.

On that basis, the potential moderator variables chosen for this study were age, major field of study, and socio-economic status as determined by total family income. The age variable had the following range:

1. 16 years old or less;
2. 17 years old;
3. 18 years old;
4. 19 years old;
5. 20 years old;
6. 21 years old; and,
7. 22 years old or more.

Following Klein et al. (1968), the major field of study variable was designed to provide a continuum from Liberal Arts to Sciences programs. Thus, in this study this variable was called the faculty variable and had the following range:

1. Faculty of Social Sciences (Social Sciences);
2. Faculty of Arts (Arts);
3. School of Physical Education and Recreation (Ph.Ed);
4. School of Nursing (Nursing);and,
5. Faculty of Pure and Applied Sciences (Sciences).

Finally the socio-economic status variable was called the income variable and had the following range:

1. \$0,000 - 4,999;
2. \$5,000 - 9,999;
3. \$10,000 - 14,999; and,
4. \$15,000 or more.

This variable was determined by total family income rather than by father's occupation because income is a quantitative variable continuous in nature that allows for better statistical manipulations.

The above categories were chosen because they were included in all the Questionnaires over the years and because they provided some kind of interval measurement. For the purpose of data processing, the categories of each variables were recoded to the numerical digits that appear before each. All of the above information was retrieved from the Questionnaire data kept by the UOCS on computerized records.

Criterion variable. The criterion variable was each student's average grade as determined from the marks retrieved from the University of Ottawa Registrar's Office by means of the transcripts. The average grade was the sum of the marks of the first year level courses weighted by each course's credit worth, divided by the sum of the credits. It can be shown by

$$M_y = \frac{\sum cY}{\sum c} \quad [5]$$

where M_y is the grade average

c is each course's credit worth

Y is the mark in each course.

Although one must agree with Guilford (1965) that "marks as ordinarily assigned by teachers are rather poor as measurements" (p. 473), it must be emphasized that this criterion still remains the measure of success in our educational system in general, and in this institution in particular. This study did in fact examine the predictive validity of the Otis-Ottawa using the grade average of first year full time female students.

Selection Procedure

As shown in Table 5, some 3,045 students of both sexes participated in OTP-F from September 1967 to September 1972. The 658 students participating in this study were students from this population who met all the requirements outlined in a preceding section (see Participants). In view of the fact that the necessary data was not all available from the same source, several steps were necessary to gather all the required information.

The sex, mother tongue, UOSN, faculty, age, income, and Otis-Ottawa IQ scores were stored on UOCS computerized records; the year of a program in which the student was registered was also stored on UOCS computerized records but only for the September 1967, 1968, 1969, and 1972 OTP-F's. The year of a program in which a student was registered for the September 1970 and 1971 OTP-F's, the academic status of the student after a full year, and the actual numerical marks and credit worth of courses were kept on transcripts in the University of Ottawa Registrar's Office. The

Table 5

Number of students participating in the French administration of the Orientation Testing Program by year and sex, and number of female students participating in this study by year

Year	No. of participants in OTP-F ^a			No. of females in study
	Total	Male	Female	
1967-68	381	N.A. ^b	N.A.	31
1968-69	401	N.A.	N.A.	67
1969-70	479	N.A.	N.A.	95
1970-71	620	363	257	143
1971-72	544	311	233	139
1972-73	640	320	320	183
Total	3,045	N.A.	N.A.	658

^a University of Ottawa Counselling Service. Summary sheets of Orientation Testing Numbers for 1967-68, 1968-69, 1969-70, 1970-71, 1971-72, and 1972-73.

^b Breakdown by sex was not available.

information stored on UOCS computerized records was readily available while the information kept in the Registrar's Office had to be retrieved manually, transcript by transcript, provided the students' names were available. The selection procedure involved the following steps:

Step one. The information regarding faculty, age, income, and IQ scores was retrieved from the UOCS computerized records and kept on a special file for those female first year students whose mother tongue was French and who had a UOSN. Any student for whom the above information was missing, was omitted from the study. However, in the case of the "year of registration", an exception was made for the 1970 and 1971 participants since this information was not available from the records.

Step two. The list of UOSN now in the special file was matched with the Registrar's Office "Student numbers-Student names" computerized cross-reference index to obtain the names of the students in the special file.

Step three. The transcripts were retrieved from the files of the Registrar's Office for the students whose names were available, and photocopied. This step also involved a verification of both name and UOSN on the list and on the photocopied transcript.

Step four. The photocopies were examined one by one to determine if the students met the definitions of "first year" and of "full time". When this process was completed, the UOSN and each first year level course's mark and credit worth of the students who met the above-mentioned requirements were coded on optical scanning sheets available from the

University of Ottawa Computing Center.

Step five. The optical scanning sheets were fed into the computer via an optical scanner and the grade averages were computed. Using the UOSN the grade average for each student was merged with the other data pertaining to that student in the special file. Subsequently, a card with all the information for each participant was punched on computer cards.

Step six. Using the "Recode" card of the Statistical Package for the Social Sciences (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975, p. 89-96) the variables were recoded so that they became usable with the MSPS. Age and income were recoded to obtain identical categories across the years; faculty was recoded according to the Liberal Arts - Science continuum used. Using the "Write cases" card (Nie et al., 1975, p. 139-144) the variables were also relocated on the cards because they had to be submitted in a particular order to the MSPS, i.e., potential moderator variables first, criterion variable second, and predictor variable last. These six steps resulted in 658 students eligible for the analysis.

Step seven. These students were numbered from 1 to 658; small pieces of paper were also numbered from 1 to 658, folded, and put in a large bowl. They were then randomly picked, one at a time, to determine whether they were assigned to Sample A (the first 329 chosen) or to Sample B (the remaining 329). This procedure also insured a random ordering of the students within each sample. The samples served as cross-validation

samples to each other.

Statement of Specific Hypotheses

With regards to the Statement of the problem presented in the preceding chapter, the following null hypotheses were formulated for each of the two samples:

1. The predictive validity coefficient of the Otis-Ottawa for the total sample obtained with the classical validation model will not be significantly different from zero.

2. The predictive validity coefficients of the Otis-Ottawa for subgroups of the sample obtained with the joint moderator model will not be significantly different from zero.

3. The predictive validity coefficients of the Otis-Ottawa for subgroups of the sample obtained with the joint moderator model will not be significantly different from each other.

4. The predictive validity coefficients of the Otis-Ottawa for subgroups of the sample obtained with the joint moderator model will not be significantly different from the predictive validity coefficient of the Otis-Ottawa for the total sample obtained with the classical validation model.

5. The predictive validity coefficient of the Otis-Ottawa for the total sample obtained with the classical validation model will not be significantly different from the coefficient of multiple correlation for the total sample obtained by using the potential moderator variables as predictor variables along with the original predictor variable.

6. The cross-validated predictive validity coefficient of the Otis-Ottawa for the total sample will not be significantly different from zero.

7. The cross-validated predictive validity coefficients of the Otis-Ottawa for the cross-validation subgroups of the sample will not be significantly different from zero.

8. The cross-validated predictive validity coefficients of the Otis-Ottawa for the subgroups of the sample will not be significantly different from each other.

9. The cross-validated predictive validity coefficients of the Otis-Ottawa for the subgroups of the sample will not be significantly different from the cross-validated predictive validity coefficient of the Otis-Ottawa for the total sample.

Again with regards to the statement of the problem, the following null hypothesis was formulated for both samples taken together.

10. The predictive validity coefficient of the Otis-Ottawa for Sample A obtained with the classical validation model will not be significantly different from the predictive validity coefficient of the Otis-Ottawa for Sample B obtained with the classical validation model.

Statistical Analysis

The following is the description of the statistical procedures used with each sample, namely Sample A and Sample B.

Preliminary analysis. Using the Statistical Package for the Social Sciences (SPSS), subprogram Frequencies (Nie et al., 1975, p. 194-202), each sample was examined in terms of the mean, standard deviation,

skewness, and kurtosis of each variable. The intercorrelations between the variables were also examined in terms of their respective magnitudes and significance. The intercorrelations and Student's t tests of significance with $N-2$ degrees of freedom were computed using the SPSS, subprogram Pearson Corr (Nie et al., 1975, p. 280-288).

Following McInnis (1972, p. 53) it was assumed that the regression of achievement on aptitude was linear. It was further assumed that Samples A and B were equivalent, given the fact that the students were randomly assigned to either one.

Predictive validity analysis. Using the MSPS a Pearson product-moment coefficient of correlation between IQ and Average grade was computed for the total sample and for each subgroup found with each grouping stage for each grouping procedure. As Flaughner and Rock (1969) have explained, as each subgroup is defined, a within group coefficient of correlation is computed; this is the predictive objective function. The grouping objective function on the other hand allows for the selection of the moderator variable or subset of moderator variables which leads to groupings or set of subgroups "that are most different in predictability thus isolating both groups that are predictable and those that are relatively unpredictable"(p. 224). However, Klein et al. (1968) suggest that, given a large sample, the moderator group solution (i.e., T_{bar} , Rock et al., 1967, p. 712) could be used as it yields the highest overall level of validity for the greatest number of subjects. Consequently, in this study, that set of subgroups yielding the largest T_{bar} coefficient

was retained for further analysis.

To test the soundness of these differing coefficients of validity, the three methods that Zedeck (1971) found investigators using were also used. They are listed below:

1. There are significantly different coefficients between subgroups: following McInnis (1972, p. 63), the coefficients of correlation of the subgroups were compared using the X^2 Test of Homogeneity of k values of r (Edwards, 1960, p. 83). The formula was:

$$X^2 = \sum (\underline{n}_i - 3) (\underline{z}_i')^2 - \frac{[\sum (\underline{n}_i - 3) (\underline{z}_i')]^2}{\sum (\underline{n}_i' - 3)} \quad [6]$$

where \underline{n}_i was the size of each subgroup

\underline{z}_i' was the Fisher z transformation of a Pearson r .

The significance was then reported for a one tail test with $k-1$ degrees of freedom.

2. Some subgroup coefficients are significantly different from zero: the coefficients of correlation of the subgroups were examined using the F ratio for significance provided by the MSPS itself. The significance was then reported.

3. Some subgroup coefficients of correlation are significantly different from the total sample coefficient of correlation: the coefficient of correlation of each subgroup was compared to the coefficient of correlation of the total sample using a z Test of Significance as suggested by Dr. McInnis (private conversation August 8, 1975). The formula was:

$$\underline{z} = \frac{R_s - R_t}{\sigma_R} \quad [7]$$

where \underline{R}_s was the coefficient of correlation of the subgroup

\underline{R}_t was the coefficient of correlation of the total sample

σ_R was the standard error of the difference for a coefficient of correlation of a sample and the coefficient of correlation of a subgroup part of that sample.

The significance was then reported for a one tail test. The formula for this standard error of the difference, developed by Dayhaw (McInnis, 1972, p. 58), follows:

$$\sigma_R = \frac{1 - \underline{R}_t^2}{\sqrt{\underline{N}_s - 1}} \sqrt{\frac{\underline{N}_t - \underline{N}_s}{\underline{N}_t - 1}} \quad [8]$$

where σ_R was the standard error of the difference between a coefficient of correlation of a sample and a coefficient of correlation of a subgroup part of that sample.

\underline{R}_t^2 was the coefficient of correlation of the sample squared

\underline{N}_t was the size of the sample

\underline{N}_s was the size of the subgroup.

As also suggested by Zedeck (1971), the effect of the potential moderator variables as independent predictor variables was examined by comparing the coefficient of multiple correlation of the sample (using the predictor and potential moderator variables as the four independent variables) with the Pearson product-moment coefficient of correlation of that same sample. The multiple \underline{R} was computed using the SPSS, sub-program Regression (Nie et al., 1975, p. 342-367) and compared to the \underline{r} by means of the \underline{F} ratio suggested by Guilford (1965, p.403) to test the significance of a difference between coefficients of multiple correlation

having different numbers of independent variables. The formula is

$$F = \frac{(R_1^2 - R_2^2) (N - m_1 - 1)}{(1 - R_1^2) (m_1 - m_2)} \quad [9]$$

where R_1 is the multiple R with the larger number of independent variables

R_2 is the multiple R with one or more independent variables omitted

m_1 is the larger number of independent variables

m_2 is the smaller number of independent variables.

In the use of the F tables, the df_1 degree of freedom are given by

$(m_1 - m_2)$ and the df_2 degrees of freedom by $(N - m_1 - 1)$. The significance was reported for a one tail test.

Cross-validation analysis. In order to verify if the results found in the preceding section were legitimate phenomena rather than spurious capitalizations on chance, a cross-validation analysis was conducted in each sample and their respective subgroups. All the computations were done with the "Compute" and "* Select if" cards (Nie et al., 1975, p. 96-101, 128-129) of the SPSS.

The cross-validation analysis of a sample involved the following:

1. finding the statement of linear regression equation of \underline{Y} from \underline{X} (Guilford, 1965, p. 368) of a sample (validation sample);

2. substituting the predictor values of the students in the other sample (cross-validation sample) in the statement of linear regression equation;

3. correlating the predicted criterion values with the actual criterion values of the students in the cross-validation sample.

The formula used was:

$$\underline{Y}' = r_{\underline{y}\underline{x}} \left(\frac{\sigma_{\underline{y}}}{\sigma_{\underline{x}}} \right) (\underline{X} - \underline{M}_{\underline{x}}) + \underline{M}_{\underline{y}} \quad [10]$$

where \underline{Y}' was the predicted criterion value

$r_{\underline{y}\underline{x}}$ was the coefficient of correlation of the validation sample

$\sigma_{\underline{y}}$ was the standard deviation of the criterion values in the validation sample

$\sigma_{\underline{x}}$ was the standard deviation of the predictor values in the validation sample

\underline{X} was the predictor value of each student in the cross validation sample

$\underline{M}_{\underline{x}}$ was the mean of the predictor values in the validation sample

$\underline{M}_{\underline{y}}$ was the mean of the criterion values in the validation sample

One tail tests of significance were reported using Student's t with $\underline{N}-2$ degrees of freedom for the computed quantity.

However, the cross-validation analysis of the subgroups could be carried out only after the following was done. Since the subgroups, formed from the total sample, were mutually exclusive, any student could belong to only one subgroup; the subgroups could then be very different as their variables could have differing means, standard deviations, inter-correlations, and statements of linear regression equations. Therefore the predictor value of any student could not be substituted in any statement of linear regression equation. Instead the students of the cross-validation sample had to be placed in subgroups similar in terms of

characteristics to the subgroups originally formed in the validation sample.

This assignment was done on the basis of the similarity of a student's profile with the mean profile of each subgroup in the validation sample. Thus a student from the cross-validation sample was assumed to belong to a particular subgroup when the sum of the squared deviations of his scores on the moderator variables from the mean of these moderator variables in that subgroup of the validation sample was less than the sum of the squared deviations of these same scores from the mean of these moderator variables in the other subgroups of the validation sample. Cronbach and Glesser (1953) termed this sum of squared deviations as D^2 ; it assesses the distance between an individual and other individuals on the basis of scores on particular variables. Mathematically this sum of squared deviations can be shown as:

$$D_{12}^2 = \sum_{j=1}^k (x_{j1} - x_{j2})^2 \quad [11]$$

where j is a particular variable

1, 2 are particular individuals or groups of individuals.

In other words, as many D^2 's were computed for each student in the cross-validation sample as there were subgroups formed in the validation sample. Each subject was then assigned to the subgroup from which he was the least distant. When this was completed the students in each cross-validation subgroup were treated in a manner similar to that described for the total sample. That is:

1. finding the statement of linear regression equation of \underline{Y} from

\bar{X} (Guilford, 1965, p. 368) of the validation sample;

2. substituting the predictor values of the students in the cross-validation sample in the statement of linear regression equation;

3. correlating the predicted criterion values with the actual criterion values of the students in the cross-validation sample.

The formula used was:

$$\bar{Y}' = r_{\bar{Y}\bar{X}} \left(\frac{\sigma_{\bar{Y}}}{\sigma_{\bar{X}}} \right) (\bar{X} - \frac{M_{\bar{X}}}{\bar{X}}) + \frac{M_{\bar{Y}}}{\bar{Y}} \quad [10]$$

where \bar{Y}' was the predicted criterion value

$r_{\bar{Y}\bar{X}}$ was the coefficient of correlation of a particular subgroup of the validation sample

$\sigma_{\bar{Y}}$ was the standard deviation of the criterion values of that particular subgroup of the validation sample

$\sigma_{\bar{X}}$ was the standard deviation of the predictor values of that particular subgroup of the validation sample

\bar{X} was the predictor value of each student in the corresponding subgroup of the cross-validation sample

$\frac{M_{\bar{X}}}{\bar{X}}$ was the mean of the predictor variable of that particular subgroup of the validation sample

$\frac{M_{\bar{Y}}}{\bar{Y}}$ was the mean of the criterion variable of that particular subgroup of the validation sample.

Again the three methods Zedeck (1971) found that investigators used to demonstrate differential validities were utilized.

1. There are significantly different coefficients between subgroups: the cross-validated coefficients of correlation of the cross-validation

subgroups were compared using the X^2 Test of Homogeneity for k values of \underline{r} (Edwards, 1960, p. 83). The formula was:

$$X^2 = \frac{\sum(n_i-3)(z_i')^2 - [\sum(n_i-3)(z_i')]^2}{\sum(n_i-3)} \quad [6]$$

where n_i was the size of each subgroup

z_i' was the Fisher z transformation of a Pearson \underline{r} . The significance was then reported for a one tail test with $k-1$ degrees of freedom.

2. Some subgroup coefficients are significantly different from zero: the cross-validated coefficients of correlation of the cross-validation subgroups were examined using Student's t with $N-2$ degrees of freedom for the computed quantity (SPSS, subprogram Pearson Corr, Nie et al., 1975, p. 280-288). The significance was then reported for a one tail test.

3. Some subgroups coefficients of correlation are significantly different from the total sample coefficient of correlation: the cross-validated coefficient of correlation of each cross-validation subgroup was compared to the cross-validated coefficient of correlation of the total cross-validation sample using a z Test of Significance. The formula was:

$$\underline{z} = \frac{R_s - R_t}{\sigma_R} \quad [7]$$

where R_s was the cross-validated coefficient of correlation of the cross-validation subgroup

R_t was the cross-validated coefficient of correlation of the total cross-validation sample

σ_R was the standard error of the difference for a coefficient of correlation of a sample and the coefficient of correlation of a

of a subgroup part of that sample.

The significance was then reported for a one-tail test. The formula for this standard error of the difference, developed by Daylaw (McInnis, 1972, p. 58), follows:

$$\sigma_{\underline{R}} = \frac{1 - \underline{R}_{\underline{t}}^2}{\sqrt{\underline{N}_{\underline{s}} - 1}} \sqrt{\frac{\underline{N}_{\underline{t}} - \underline{N}_{\underline{s}}}{\underline{N}_{\underline{t}} - 1}} \quad [8]$$

where $\sigma_{\underline{R}}$ was the standard error of the difference for a coefficient of correlation of a sample and the coefficient of correlation of a subgroup part of that sample

$\underline{R}_{\underline{t}}^2$ was the cross-validation coefficient of correlation of the cross-validation sample squared

$\underline{N}_{\underline{t}}$ was the size of the cross-validation sample

$\underline{N}_{\underline{s}}$ was the size of the cross-validation subgroup.

Replication. Using the standard error of a difference between Fisher's \underline{z} 's, a \underline{z} Test of Significance (Guilford, 1965, p. 189-190) was made to determine whether or not the coefficients of correlation found in Sample A and in Sample B were significantly different. The formula used for the standard error was:

$$\sigma_{\underline{dz}} = \sqrt{\frac{1}{\underline{N}_1 - 3} + \frac{1}{\underline{N}_2 - 3}} \quad [12]$$

where $\sigma_{\underline{dz}}$ was the standard error of a difference between two independent \underline{z} coefficients

\underline{N}_1 was the size of a sample

\underline{N}_2 was the size of the other sample.

The formula for the test of significance was:

$$\bar{z} = \frac{z_2 - z_1}{\sigma_{dz}} \quad [13]$$

where z_1 was the z coefficient for the Pearson coefficient of correlation of the first sample

z_2 was the z coefficient for the Pearson coefficient of correlation of the second sample.

The significance was then reported for a one-tail test.

Results

This chapter presents the results of the statistical analyses in Sample A and Sample B; the comparison of the two samples is also presented.

Sample A

The predictive validity coefficient of the Otis-Ottawa as a predictor of first year average grade was .13 ($p < .01$) for Sample A ($N = 329$). The frequency distributions of the Faculty, Age, Income, Average, and IQ variables are shown in Tables 6, 7, 8, 9, and 10 respectively. Table 11 presents the intercorrelations among all variables (potential moderator, criterion, and predictor variables); Table 12 presents the Tbar coefficients at each Grouping Stage in each Grouping Procedure of the MSPS for Sample A. Inspection reveals that, given the combination of Faculty and Age, a set of three subgroups differing in predictability yielded the highest overall level of validity for the greatest number of subjects; Table 13 displays the means in each subgroup of the Faculty and Age variables.

Hypothesis 1 was concerned with the magnitude of the coefficient of correlation between IQ and Average found with the classical validation model.

Hypothesis 1. The predictive validity coefficient of the Otis-Ottawa for Sample A obtained with the classical validation model will not be significantly different from zero. As shown in Table 11, the coefficient of correlation between IQ and Average was .13 ($p < .01$).

Table 6
 Frequency Distribution of the Faculty variable in
 Sample A

Faculty	Coding	<u>n</u>	Percentage
Social Science	1	12	4
Arts	2	258	78
Ph. Ed.	3	4	1
Nursing	4	9	3
Sciences	5	46	14

Note. The sample mean is 2.450; the sample standard deviation is 1.104; the sample skewness is 1.672; and, the sample kurtosis is 1.238.

Table 7
 Frequency Distribution of the Age variable in
 Sample A

Age in Years	Coding	<u>n</u>	Percentage
16 or less	1	24	7
17	2	94	29
18	3	122	37
19	4	52	16
20	5	14	4
21	6	2	1
22 or more	7	21	6

Note. The sample mean is 3.085; the sample standard deviation is 1.407; the sample skewness is 1.214; and, the sample kurtosis is 1.575.

Table 8
 Frequency Distribution of the Income variable in
 Sample A

Income in \$	Coding	<u>n</u>	Percentage
0,000-4,999	1	57	17
5,000-9,999	2	115	35
10,000-14,999	3	77	23
15,000 and more	4	80	24

Note. The sample mean is 2.547; the sample standard deviation is 1.041; the sample skewness is 0.061; and, the sample kurtosis is -1.192.

Table 9

Frequency Distribution of the Average variable in
Sample A

Average grade on 100	<u>n</u>	Percentage
36-45	7	2
46-55	15	5
56-65	54	17
66-75	170	51
76-85	77	24
86-95	6	2

Note. The sample mean is 70.219; the sample standard deviation is 8.848; the sample skewness is -0.984; and, the sample kurtosis is 2.231.

Table 10

Frequency Distribution of the IQ variable in
Sample A

Raw Score on the Otis-Ottawa	<u>n</u>	Percentage
31-35	3	1
36-40	13	4
41-45	22	7
46-50	37	11
51-55	61	18
56-60	60	18
61-65	73	22
66-70	42	13
71-75	18	6

Note. The sample mean is 57.286; the sample standard deviation is 9.000; the sample skewness is -0.386; and, the sample kurtosis is -0.448.

Table 11
 Intercorrelations between all the variables in
 Sample A

Variables	Age	Income	Average	IQ
Faculty	-.1347**	.0823	-.2412**	.2707**
Age		-.2441**	.0161	-.1632**
Income			.0780	.0939*
Average				.1336**

* $p < .05$ (Student t , one tail test).

** $p < .01$ (Student t , one tail test).

Table 12
 Grouping objective function Tbar coefficients in
 Sample A

Moderator variable(s) considered in each Grouping procedure	Grouping Stage	Number of Subgroups	Tbar co- efficient
Level 1			
Faculty	1	3	97,799
	2	2	73,438
	3	1	29,409
Age	1	3	64,123
	2	2	67,082
	3	1	29,409
Income	1	3	62,090
	2	2	49,291
	3	1	29,409
Level 2			
Faculty, Age	1	3	102,357 ^a
	2	2	56,363
	3	1	29,409
Faculty, Income	1	3	91,509
	2	2	80,783
	3	1	29,409
Level 3			
Faculty, Age, Income	1	3	77,820
	2	2	80,723
	3	1	29,409

^a this combination of moderator variables proved the most effective and was retained for further analysis. Detailed information concerning the three subgroups formed on this combination is shown in Table 13.

Note. Hypotheses 2, 3, and 4 were concerned with these three selected subgroups only. Tables 13, 14, and 15 present the results of the hypothesis testing.

Table 13

Coefficients of correlation between IQ and Average,
F ratio of significance, and means of the effective moderator
 variables for the subgroups of Sample A retained for the study.

Subgroup	<u>n</u>	<u>r</u>	<u>F</u> ratio	Faculty	Age
1	245	.1209	3.6019	1.9633	2.7959
2	30	.5092	9.8023*	2.1333	6.4667
3	54	.4268	11.5809*	4.8333	2.5185

* p < .01.

As a result, the null hypothesis was rejected: the predictive validity coefficient of the Otis-Ottawa for Sample A obtained with the classical validation model was significantly greater than zero.

Hypotheses 2, 3, and 4 were concerned with the three methods used to demonstrate differential validity in the three subgroups (in Sample A) selected for the study. A description of these methods was made in the section on "Predictive validity analysis" of the preceding chapter.

Hypothesis 2. The predictive validity coefficients of the Otis-Ottawa for subgroups of Sample A obtained with the joint moderator model will not be significantly different from zero. As shown in Table 13, the coefficient of correlation between the IQ and Average for Subgroup 1 was .12 and not significant, that for Subgroup 2 was .51 ($\underline{p} < .01$), and that for Subgroup 3 was .43 ($\underline{p} < .01$). As a result, the null hypothesis failed to be rejected in the case of Subgroup 1 but was rejected in the case of Subgroups 2 and 3. In other words, only the predictive validity coefficients of the Otis-Ottawa for Subgroups 2 and 3 of Sample A obtained with the joint moderator model were significantly greater than zero.

Hypothesis 3. The predictive validity coefficients of the Otis-Ottawa for subgroups of Sample A obtained with the joint moderator model will not be significantly different from each other. As shown in Table 14, the computed X^2 value was significant ($\underline{p} < .01$) for the X^2 Test of Homogeneity of three values of \underline{r} . As a result, the null hypothesis is

rejected: the predictive validity coefficients of the Otis-Ottawa for subgroups of Sample A obtained with the joint moderator model were significantly different from each other.

Hypothesis 4. The predictive validity coefficients of the Otis-Ottawa for subgroups of Sample A obtained with the joint moderator model will not be significantly different from the predictive validity coefficient of the Otis-Ottawa for Sample A obtained with the classical validation model. As shown in Table 15, the z coefficient for Subgroup 1 was not significant, while that for Subgroup 2 was significant ($p < .05$) and that for Subgroup 3 was significant ($p < .01$). As a result, the null hypothesis failed to be rejected in the case of Subgroup 1 but was rejected in the case of Subgroups 2 and 3. In other words, only the predictive validity coefficients of the Otis-Ottawa for Subgroups 2 and 3 of Sample A obtained with the joint moderator model were significantly greater than the predictive validity coefficient of the Otis-Ottawa for Sample A obtained with the classical validation model.

Hypothesis 5 was concerned with the importance of the potential moderator variables if they were used as predictor variables.

Hypothesis 5. The predictive validity coefficient of the Otis-Ottawa for Sample A obtained with the classical validation model will not be significantly different from the coefficient of multiple correlation for Sample A obtained by using the potential moderator variables as predictor variables along with the original predictor variable. As shown in Table 16, the coefficient of multiple correlation was .33 and significantly larger than the coefficient of correlation ($p < .01$). As a result,

Table 14

Calculations for the X^2 Test of Homogeneity of the coefficients of correlation of the three subgroups of Sample A

Subgroup	\underline{n}	\underline{r}	$(\underline{n}-3)$	\underline{z}'	$(\underline{z}')^2$	$(\underline{n}-3)(\underline{z}')$	$(\underline{n}-3)(\underline{z}')^2$
1	245	.121	242	.121	.014	29.282	3.388
2	30	.509	27	.563	.316	15.201	8.532
3	54	.427	51	.464	.206	23.154	10.506

$$\begin{aligned}
 X^2 &= \sum(\underline{n}-3)(\underline{z}')^2 - \frac{[\sum(\underline{n}-3)(\underline{z}')]^2}{\sum(\underline{n}-3)} \\
 &= 22.426 - \frac{(67.637)^2}{320} \\
 &= 8.130^a
 \end{aligned}$$

^a $X^2(2) = 7.824, p < .01$ (one tail test).

Table 15

Coefficients for the standard error of the difference and for the z Test of Significance between the coefficients of correlation of Sample A and each subgroup of Sample A in turn

Comparison	<u>n</u>	<u>r</u>	σ_R	<u>z</u>
Subgroup 1	245	.1209	.0317	-.4006
Total sample	329	.1336		
Subgroup 2	30	.5092	.1740	2.1586*
Total sample	329	.1336		
Subgroup 3	54	.4268	.1235	2.3740**
Total sample	329	.1336		

Note. $\sigma_R = \frac{1 - R_t^2}{\sqrt{N_s - 1}} \sqrt{\frac{N_t - N_s}{N_t - 1}}$ and

$$z = \frac{R_s - R_t}{\sigma_R}$$

* $p < .05$ (one tail test)

** $p < .01$ (one tail test).

Table 16

Calculations for the F ratio of the significance of the difference between the coefficient of multiple correlation and the coefficient of correlation of Sample A

Type of coefficient ^a	Size of coefficient	Number of independent variables	F ratio
multiple R	.32966	4	11.00562*
total r	.13359	1	

$$\begin{aligned}
 F &= \frac{(\underline{R}_1^2 - \underline{R}_2^2) (\underline{N} - \underline{m}_1 - 1)}{(1 - \underline{R}_1^2) (\underline{m}_1 - \underline{m}_2)} \\
 &= \frac{(.32966^2 - .13359^2) (329-4-1)}{(1 - .32966^2) (4-1)} \\
 &= 11.00562
 \end{aligned}$$

^a sample size = 329.

* $p < .01$, $F(3,324) = 3.83$ (one tail test).

the null hypothesis was rejected: the coefficient of multiple correlation for Sample A obtained by using the potential moderator variables as predictor variables along with the original predictor variable was significantly greater than the predictive validity coefficient of the Otis-Ottawa for Sample A obtained with the classical validation model.

Hypothesis 6 was concerned with the magnitude of the cross-validated coefficient of correlation between the predicted criterion values and the actual criterion values of the students in the cross-validation sample.

Hypothesis 6. The cross-validated predictive validity coefficient of the Otis-Ottawa for Sample A will not be significantly different from zero. Table 17 presents the data used in the calculations of the cross-validated coefficients while Table 18 shows that the cross-validated coefficient of correlation of the Otis-Ottawa was .20 ($p < .01$). As a result, the null hypothesis was rejected: the cross-validated predictive validity coefficient of the Otis-Ottawa for Sample A was significantly greater than zero.

Hypotheses 7, 8, and 9 were concerned with the three methods used and to demonstrate differential validity in the three cross-validation subgroups. A description of these methods was made in the section on "Cross-validation analysis" of the preceding chapter.

Hypothesis 7. The cross-validated predictive validity coefficients of the Otis-Ottawa for the cross-validation subgroups of Sample A will not be significantly different from zero. As shown in Table 18, the cross-validated predictive validity coefficients of the Otis-Ottawa for

Subgroups 1 and 2 were .21 and .42 ($\underline{p} < .01$), and that of Subgroup 3 was .27 ($\underline{p} < .05$). As a result, the null hypothesis was rejected in all cases: the cross-validated predictive validity coefficients of the Otis-Ottawa for all cross-validation subgroups of Sample A were significantly greater than zero.

Hypothesis 8. The cross-validated predictive validity coefficients of the Otis-Ottawa for the cross-validation subgroups of Sample A will not be significantly different from each other. As shown in Table 19, the computed X^2 value was not significant for the X^2 Test of Homogeneity of 3 values of \underline{r} . As a result, the null hypothesis failed to be rejected: the cross-validated predictive validity coefficients of the Otis-Ottawa for the cross-validation subgroups of Sample A were not significantly different from each other.

Hypothesis 9. The cross-validated predictive validity coefficients of the Otis-Ottawa for the cross-validation subgroups of Sample A will not be significantly different from the cross-validated predictive validity coefficient of the Otis-Ottawa for Sample A. As shown in Table 20, none of the \underline{z} coefficients reached significance. As a result, the null hypothesis failed to be rejected in all three cases: in other words, the cross-validated predictive validity coefficients of the Otis-Ottawa for the cross-validation subgroups of Sample A were not significantly different from the cross-validated predictive validity coefficient of the Otis-Ottawa for Sample A.

Table 17

Data for the calculations of the cross-validated coefficient of correlation for Sample A and the cross-validated coefficients of correlation for the subgroups of Sample A

Subgroup	<u>n</u>	Variable	Mean	Standard deviation	<u>r</u>
1	245	I.Q	56.2735	8.7688	.1209
		Average	71.1551	6.8309	
2	30	I.Q.	55.3333	9.3464	.5092
		Average	71.4333	7.5617	
3	54	I.Q.	62.9630	7.4560	.4268
		Average	65.2963	14.2499	
Total sample	329	I.Q.	57.2857	8.9862	.1336
		Average	70.2188	8.8349	

Note.
$$\underline{Y}' = \frac{r_{yx}}{\frac{\sigma_y}{\sigma_x}} \left(\underline{X} - \frac{M_x}{\sigma_x} \right) + \left(\frac{M_y}{\sigma_y} \right)$$

Table 18

Cross-validated coefficients of correlation for Sample A and
for the subgroups of Sample A

Subgroup	<u>n</u>	<u>r</u>
1	246	.2122**
2	38	.4192**
3	45	.2657*
Total sample	329	.2012**

* $p < .05$ (Student t , one tail test).

** $p < .01$ (Student t , one tail test).

Table 19
 Calculations for the X^2 Test of Homogeneity
 of three cross-validated coefficients of correlation for
 Subgroups of Sample A

Subgroup	<u>n</u>	<u>r</u>	(<u>n-3</u>)	<u>z'</u>	(<u>z'</u>) ²	(<u>n-3</u>)(<u>z'</u>)	(<u>n-3</u>)(<u>z'</u>) ²
1	246	.212	243	.213	.045	51.759	10.935
2	38	.419	35	.448	.200	15.680	7.000
3	45	.266	42	.271	.073	11.382	3.066

$$\begin{aligned}
 X^2 &= \frac{\sum(\underline{n-3}) (\underline{z}')^2 - [\sum(\underline{n-3}) (\underline{z}')]^2}{\sum(\underline{n-3})} \\
 &= 21.001 - \frac{(78.821)^2}{320} \\
 &= 1.587^a
 \end{aligned}$$

^a $X^2(2) = 4.605, p < .05$ (one tail test).

Table 20

Coefficients for the Standard error of the difference
and for the \underline{z} Test of Significance between the cross-validated
coefficients of correlation of the total sample and each subgroup
of Sample A in turn

Comparison	\underline{n}	\underline{r}	$\underline{\sigma}_R$	\underline{z}
Subgroup 1	246	.2122		
			.0308	.3571
Total Sample	329	.2012		
Subgroup 2	38	.4192		
			.1485	1.4680
Total Sample	329	.2012		
Subgroup 3	45	.2657		
			.1345	.4795
Total Sample	329	.2012		

Note. $\underline{\sigma}_R = \frac{1 - R_t^2}{\sqrt{N_s - 1}} \sqrt{\frac{N_t - N_s}{N_t - 1}}$ and

$$\underline{z} = \frac{R_s - R_t}{\underline{\sigma}_R}$$

Sample B

The predictive validity coefficient of the Otis-Ottawa as a predictor of first year average grade was .20 ($p < .01$) for Sample B ($N = 329$). The frequency distributions of the Faculty, Age, Income, Average, and IQ variables are shown in Tables 21, 22, 23, 24, and 25 respectively. Table 26 presents the intercorrelations among all variables (potential moderator, criterion, and predictor variables); Table 27 presents the Tbar coefficients at each Grouping Stage in each Grouping Procedure of the MSPS for Sample B. Inspection reveals that, given Faculty alone, a set of three subgroups differing in predictability yielded the highest overall level of validity for the greatest number of subjects; Table 28 displays the mean in each subgroup of the Faculty variable.

Hypothesis 10 was concerned with the magnitude of the coefficient of correlation between IQ and Average found with the classical validation model.

Hypothesis 10. The predictive validity coefficient of the Otis-Ottawa for Sample B obtained with the classical validation model will not be significantly different from zero. As shown in Table 26, the coefficient of correlation between the IQ and the Average was .20 and significantly different from zero ($p < .01$). As a result, the null hypothesis was rejected: the predictive validity coefficient of the Otis-Ottawa for Sample B obtained with the classical validation model was significantly greater than zero.

Table 21
 Frequency Distribution of the Faculty variable in
 Sample B

Faculty	Coding	<u>n</u>	Percentage
Social Sciences	1	16	5
Arts	2	256	78
Ph. Ed.	3	9	3
Nursing	4	13	4
Sciences	5	35	11

Note. The sample mean is 2.377; the sample standard deviation is 1.026; the sample skewness is 1.790; and, the sample kurtosis is 1.984.

Table 22
 Frequency Distribution of the Age variable in
 Sample B

Age in Years	Coding	<u>n</u>	Percentage
16 or less	1	18	5
17	2	81	25
18	3	131	40
19	4	61	19
20	5	12	4
21	6	3	1
22 or more	7	23	7

Note. The sample mean is 3.210; the sample standard deviation is 1.400; the sample skewness is 1.198; and, the sample kurtosis is 1.512.

Table 23
 Frequency Distribution of the Income variable in
 Sample B

Income in \$	Coding	<u>n</u>	Percentage
0,000-4,999	1	64	19
5,000-9,999	2	104	32
10,000-14,999	3	68	21
15,000 or more	4	93	28

Note. The sample mean is 2.578; the sample standard deviation is 1.096; the sample skewness is 0.004; and, the sample kurtosis is -1.331.

Table 24
 Frequency Distribution of the Average variable in
 Sample B

Average grade on 100	<u>n</u>	Percentage
26-35	1	0
36-45	1	0
46-55	21	7
56-65	77	24
66-75	150	45
76-85	73	22
86-95	6	2

Note. The sample mean is 69.100; the sample standard deviation is 9.178; the sample skewness is -0.495; and, the sample kurtosis is 0.581.

Table 25
Frequency Distribution of the IQ variable in
Sample B

Raw Score on the Otis-Ottawa	<u>n</u>	Percentage
31-35	1	0
36-40	14	4
41-45	30	10
46-50	51	16
51-55	48	14
56-60	45	13
61-65	71	22
66-70	53	16
71-75	16	5

Note. The sample mean is 57,100; the sample standard deviation is 9.469; the sample skewness is -0.273; and, the sample kurtosis is -0.859.

Table 26
 Intercorrelations between all the variables in
 Sample B

Variables	Age	Income	Average	IQ
Faculty	-.1380**	.0634	-.1808**	.1850**
Age		.2818**	.0382	-.1543**
Income			.0930*	.1533**
Average				.2013**

* $p < .05$ (Student t , one tail test).

** $p < .01$ (Student t , one tail test).

Table 27
 Grouping objective function Tbar coefficient in
 Sample B

Moderator variable(s) considered in each Grouping procedure	Grouping Stage	Number of Subgroups	Tbar coefficient
Level 1			
Faculty	1	3	106,548 ^a
	2	2	93,738
	3	1	64,764
Age	1	3	81,789
	2	2	69,714
	3	1	64,764
Income	1	3	68,638
	2	2	62,277
	3	1	64,764
Level 2			
Faculty, Age	1	3	99,878
	2	2	93,313
	3	1	64,764
Faculty, Income	1	3	88,363
	2	2	91,547
	3	1	64,764
Level 3			
Faculty, Age, Income	1	3	86,289
	2	2	87,991
	3	1	64,764

^a this single moderator variable, faculty, proved the most effective and was retained for further analysis. Detailed information regarding the three subgroups formed on this moderator variable is shown in Table 28.

Note. Hypotheses 11, 12, and 13 were concerned with these three selected subgroups only. Table 28, 29, and 30 present the results of the hypothesis testing.

Hypotheses 11, 12, and 13 were concerned with the three methods used to demonstrate differential validity in the three subgroups in Sample B selected for the study. A description of these methods was made in the section on "Predictive validity analysis" of the preceding chapter.

Hypothesis 11. The predictive validity coefficients of the Otis-Ottawa for subgroups of Sample B obtained with the joint moderator model will not be significantly different from zero. As shown in Table 28, the coefficient of correlation between IQ and Average for Subgroup 1 was .24 ($p < .01$), for Subgroup 2 was .38 ($p < .05$), and for Subgroup 3 was .26 (N.S.). As a result, the null hypothesis was rejected in the case of Subgroups 1 and 2 but failed to be rejected in the case of Subgroup 3. In other words, only the predictive validity coefficients of the Otis-Ottawa for Subgroups 1 and 2 of Sample B obtained with the joint moderator model were significantly greater than zero.

Hypothesis 12. The predictive validity coefficients of the Otis-Ottawa for subgroups of Sample B obtained with the joint moderator model will not be significantly different from each other. As shown in Table 29, the computed X^2 value was not significant for the X^2 Test of Homogeneity of three values of r . As a result, the null hypothesis failed to be rejected: the predictive validity coefficients of the Otis-Ottawa for subgroups of Sample B obtained with the joint moderator model were not significantly different from each other.

Table 28

Coefficients of correlation between IQ and Average, \bar{F} ratio of significance, and means of the effective moderator variable for the subgroups of Sample B retained for the study.

Subgroup	<u>n</u>	<u>r</u>	<u>F</u> ratio	Faculty
1	272	.2427	16.8941**	1.9412
2	35	.3752	5.4071*	5.0000
3	22	.2559	1.4019	3.5909

* $p < .05$.

** $p < .01$.

Table 29

Calculations for the X^2 Test of Homogeneity of the coefficients
of correlation of the three subgroups of
Sample B

Subgroup	\underline{n}	\underline{r}	$(\underline{n}-3)$	\underline{z}'	$(\underline{z}')^2$	$(\underline{n}-3)(\underline{z}')$	$(\underline{n}-3)(\underline{z}')^2$
1	272	.243	269	.250	.062	67.250	16.678
2	35	.375	32	.394	.155	12.608	4.960
3	22	.256	19	.261	.068	4.959	1.292

$$\begin{aligned}
 X^2 &= \sum(\underline{n}-3)(\underline{z}')^2 - \frac{[\sum(\underline{n}-3)(\underline{z}')]^2}{\sum(\underline{n}-3)} \\
 &= 22.930 - \frac{(84.817)^2}{320} \\
 &= .449^a
 \end{aligned}$$

^a $X^2(2) = 4.605$, $p < .05$ (one tail test).

Hypothesis 13. The predictive validity coefficients of the Otis-Ottawa for subgroups of Sample B obtained with the joint moderator model will not be significantly different from the predictive validity coefficient of the Otis-Ottawa for Sample B obtained with the classical validation model. As shown in Table 30, the z coefficient for Subgroup 1 was significant ($p < .05$) while that for Subgroups 2 and 3 were not significant. As a result, the null hypothesis was rejected in the case of Subgroup 1 but failed to be rejected in the case of Subgroups 2 and 3. In other words, only the predictive validity coefficient of the Otis-Ottawa for Subgroup 1 of Sample B obtained with the joint moderator model was significantly greater than the predictive validity coefficient of the Otis-Ottawa for Sample B obtained with the classical validation model.

Hypothesis 14 was concerned with the importance of the potential moderator variables if they were used as predictor variables.

Hypothesis 14. The predictive validity coefficient of the Otis-Ottawa for Sample B obtained with the classical validation model will not be significantly different from the coefficient of multiple correlation for Sample B obtained by using the potential moderator variables as predictor variables along with the original predictor variable. As shown in Table 31, the coefficient of multiple correlation was .31 and significantly larger than the coefficient of correlation ($p < .01$). As a result, the null hypothesis was rejected: the coefficient of multiple correlation for Sample B obtained by using the potential

Table 30

Coefficients for the standard error of the difference and for the \underline{z} Test of Significance between the coefficients of correlation of Sample B and each subgroup of Sample B in turn.

Comparison	\underline{n}	\underline{r}	$\underline{\sigma}_R$	\underline{z}
Subgroup 1	272	.2427	.0242	1.7107*
Total sample	329	.2013		
Subgroup 2	35	.3752	.1557	1.1168
Total sample	329	.2013		
Subgroup 3	22	.2559	.2024	.2697
Total sample	329	.2013		

Note. $\underline{\sigma}_R = \frac{1 - \underline{r}_t^2}{\sqrt{\underline{N}_s - 1}} \sqrt{\frac{\underline{N}_t - \underline{N}_s}{\underline{N}_t - 1}}$ and

$$\underline{z} = \frac{\underline{R}_s - \underline{R}_t}{\underline{\sigma}_R}$$

* $p < .05$ (one tail test).

Table 31

Calculations for the F ratio of the significance of the difference between the coefficient of multiple correlation and the coefficient of correlation in Sample B.

Type of coefficient ^a	Size of coefficient	Number of independent variables	F ratio
multiple R	.31492	4	7.03271*
Total r	.20128	1	

$$\begin{aligned}
 F &= \frac{(R_1^2 - R_2^2) (N - m_1 - 1)}{(1 - R_1^2) (m_1 - m_2)} \\
 &= \frac{(.31492^2 - .20128^2) (329 - 4 - 1)}{(1 - .31492^2) (4-1)} \\
 &= 7.03271
 \end{aligned}$$

^a sample size = 329.

* $p < .01$, $F(3,324) = 3.83$ (one tail test).

moderator variables as predictor variables along with the original predictor variable was significantly greater than the predictive validity coefficient of the Otis-Ottawa for Sample B obtained with the classical validation model.

Hypothesis 15 was concerned with the magnitude of the cross-validated coefficient of correlation between the predicted criterion values and the actual criterion values of the students in the cross-validation sample.

Hypothesis 15. The cross-validated predictive validity coefficient of the Otis-Ottawa for Sample B will not be significantly different from zero. Table 32 presents the data used in the calculations of the cross-validated coefficients while Table 33 shows that the cross-validated coefficient of correlation of the Otis-Ottawa was .13 ($p < .01$). As a result, the null hypothesis was rejected: the cross-validated predictive validity coefficient of the Otis-Ottawa for Sample B was significantly greater than zero.

Hypotheses 16, 17, and 18 were concerned with the three methods used to demonstrate differential validity in the three cross-validation subgroups. A description of these methods was made in the section on "Cross-validation analysis" of the preceding chapter.

Hypothesis 16. The cross-validated predictive validity coefficients of the Otis-Ottawa for the cross-validation subgroups of Sample B will not be significantly different from zero. As shown in Table 33, the cross-validated predictive validity coefficients of the Otis-Ottawa for

Subgroups 1 and 2 were .17 and .54 ($\underline{p} < .01$), and for Subgroup 3 was -.02 (N.S.). As a result, the null hypothesis was rejected in the case of Subgroups 1 and 2 but failed to be rejected in the case of Subgroup 3: in other words, only the cross-validated predictive validity coefficients of the Otis-Ottawa for Subgroups 1 and 2 of Sample B were significantly greater than zero.

Hypothesis 17. The cross-validated predictive validity coefficients of the Otis-Ottawa for the cross-validation subgroups of Sample B will not be significantly different from each other. As shown in Table 34, the computed X^2 value was significant ($\underline{p} < .01$) for the X^2 Test of Homogeneity of 3 values of \underline{r} . As a result, the null hypothesis was rejected: the cross-validated predictive validity coefficients of the Otis-Ottawa for the cross-validation subgroups of Sample B were significantly different from each other.

Hypothesis 18. The cross-validated predictive validity coefficients of the Otis-Ottawa for the cross-validation subgroups of Sample B will not be significantly different from the cross-validated predictive validity coefficient of the Otis-Ottawa for Sample B. As shown in Table 35, the \underline{z} coefficient for Subgroups 1 and 3 were not significant, while that of Subgroup 2 was significant ($\underline{p} < .01$). As a result, the null hypothesis failed to be rejected in the case of Subgroups 1 and 3, but was rejected in the case of Subgroup 2; in other words, only the cross-validated predictive validity coefficient of the Otis-Ottawa for cross-validation Subgroup 2 of Sample B was significantly greater than the cross-validated

Table 32

Data for the calculations of the cross-validated coefficient of correlation for Sample B and the cross-validated coefficients of correlation for the subgroups of Sample B.

Subgroup	<u>n</u>	Variable	Mean	Standard deviation	<u>r</u>
1	272	IQ	56.3382	9.5638	.2427
		Average	69.6949	7.9446	
2	35	IQ	61.6286	7.6198	.3752
		Average	62.0857	14.2916	
3	22	IQ	59.3182	8.2923	.2559
		Average	72.9091	7.3169	
Total sample	329	IQ	57.1003	9.4544	.2013
		Average	69.1003	9.1644	

Note.
$$\underline{Y}' = r_{yx} \left(\frac{\sigma_y}{\sigma_x} \right) (\underline{X} - \underline{M}_x) + (\underline{M}_y)$$

Table 33

Cross-validated coefficients of correlation for Sample B and
for the subgroups of Sample B

Subgroup	<u>n</u>	<u>r</u>
1	270	.1686*
2	46	.5432*
3	13	-.0240
Total sample	329	.1336*

* $p < .01$ (Student t , one tail test).

Table 34

Calculations for the X^2 Test of Homogeneity of three cross-validated coefficients of correlation for subgroups of Sample B

Subgroup	<u>n</u>	<u>r</u>	(n-3)	<u>z'</u>	(<u>z'</u>) ²	(n-3)(z')	(n-3)(z') ²
1	270	.169	267	.172	.029	45.924	7.743
2	46	.543	43	.695	.483	29.885	20.769
3	13	-.024	10	-.025	.001	- 0.250	.010

$$\begin{aligned}
 X^2 &= \frac{\sum(n-3)(z')^2 - \frac{[\sum(n-3)(z')]^2}{\sum(n-3)}}{1} \\
 &= 28.522 - \frac{(75.559)^2}{320} \\
 &= 10.681^a
 \end{aligned}$$

^a $X^2 (2) = 7.824, p < .01$ (one tail test).

Table 35

Coefficients for the Standard error of the difference and for the \underline{z} Test of Significance between the cross-validated coefficient of correlation of the Sample B and each subgroup of Sample B in turn.

Comparison	\underline{n}	\underline{r}	$\underline{\sigma}_R$	\underline{z}
Subgroup 1	270	.1686		
			.0253	1.3833
Total sample	329	.1336		
Subgroup 2	46	.5432		
			.1359	3.0139*
Total sample	329	.1336		
Subgroup 3	13	-.0240		
			.2782	-.5664
Total sample	329	.1336		

Note. $\underline{\sigma}_R = \frac{1 - \underline{R}_t^2}{\sqrt{\underline{N}_s - 1}} \sqrt{\frac{\underline{N}_t - \underline{N}_s}{\underline{N}_t - 1}}$ and

$$\underline{z} = \frac{\underline{R}_s - \underline{R}_t}{\underline{\sigma}_R}$$

* $p < .01$ (one tail test)

predictive validity coefficient of the Otis-Ottawa for Sample B.

Comparison of Both Samples

Hypothesis 19. The predictive validity coefficient of the Otis-Ottawa for Sample A obtained with the classical validation model will not be significantly different from the predictive validity coefficient of the Otis-Ottawa for Sample B obtained with the classical validation model. As shown in Table 36, the z coefficient was not significant. As a result, the null hypothesis failed to be rejected: the predictive validity coefficient of the Otis-Ottawa for Sample A obtained with the classical validation model was not significantly different from the predictive validity coefficient of the Otis-Ottawa for Sample B obtained with the classical validation model.

Table 36

Coefficients for the Standard error of the difference between Fisher's \underline{z} 's and the \underline{z} Test of significance for the predictive validity coefficients of Samples A and B.

Comparison	\underline{n}	\underline{r}	\underline{z}	σ_{dz}	\bar{z}
Sample A	329	.1336	.136		
				.077	.870
Sample B	329	.2013	.203		

Note. $\sigma_{dz} = \sqrt{\frac{1}{N_1-3} + \frac{1}{N_2-3}}$ and

$$\bar{z} = \frac{z_2 - z_1}{\sigma_{dz}}$$

Discussion

This chapter first examines the seven questions that circumscribed the concern of this study, and then summarizes the findings. Subsequent sections deal with the limitations and sources of error in the study, and with applications and suggestions for further research. The conclusions outline the purpose, expectations and contribution of the present study.

Statement of the Problem

This study investigated the predictive validity of the Examen Otis-Ottawa d'habileté mentale, Examen Supérieur formule A, as determined by joint moderator methodology. The main concerns of the study were summarized by seven questions in a preceding section (see Statement of the Problem, Review of the Literature). Each question will now be reviewed in the light of the results of the statistical analyses in Samples A and B.

Questions 1, 2, and 3 were concerned with coefficients of correlation between IQ and Average for the total samples obtained with the classical validation model.

Question 1. What is the predictive validity coefficient of the Otis-Ottawa using the classical validation model? From Tables 11 and 26, the coefficients of correlation between IQ and Average were .13 and .20 for Samples A and B respectively; the rejection of Hypotheses 1 and 10 indicated that these coefficients were significantly greater than zero. It appears that there is a low positive relationship between the two

above mentioned variables in each sample when using the classical validation model.

Question 2. Can the above results be replicated? From Table 36, it is evident that there was no significant difference between the coefficients of Samples A and B. Had Hypothesis 19 been rejected, it would have meant that the quality of the relationship between IQ and Average in each sample would have been different. Since this was not the case it appears that the results presented in Question 1 can be replicated.

Question 3. Can the above results (see Question 1) be cross-validated? In order to cross-validate the results of Sample A, all the students not belonging to Sample A, i.e., Sample B students, were used, and vice-versa to cross-validate the results of Sample B. From Tables 18 and 33, the cross-validated coefficients were .20 and .13 for Samples A and B respectively. The rejection of Hypotheses 6 and 15 indicated that these cross-validated coefficients were significantly greater than zero. It appears that the low positive relationship between IQ and Average in each sample was replicated in a cross-validation analysis and was maintained across other samples of female students.

Questions 4, 5, and 6 were concerned with coefficients of correlation between IQ and Average for the subgroups of the samples obtained with the joint moderator model.

Question 4. What are the predictive validity coefficients of the Otis-Ottawa using the joint moderator model? In Sample A, the coefficients of correlation for Subgroups 1, 2, and 3 were .12, .51, and .43 respectively

(see Table 13). The rejection of Hypothesis 2 in the case of the second (.51) and the third (.43) coefficients indicated that the coefficients for Subgroups 2 and 3 were significantly greater than zero. Hence the requirements of a method demonstrating differential validity were satisfied, i.e., some coefficients are significantly different from zero (Zedeck, 1971, p. 303). Furthermore the rejection of Hypothesis 3 (see Table 14) indicated that the three coefficients were significantly different from each other. Hence the requirements of a second method demonstrating differential validity were satisfied, i.e., the coefficients are significantly different from each other (Zedeck, 1971, p. 303). It appears then that there was a moderate positive relationship between IQ and Average for Subgroups 2 and 3, and that it was stronger than that of Subgroup 1.

In Sample B, the coefficients of correlation for Subgroups 1, 2, and 3 were .24, .38, and .26 respectively (see Table 28). The rejection of Hypothesis 11 in the case of the first (.24) and second (.38) coefficients indicated that these coefficients for Subgroups 1 and 2 were significantly greater than zero. Hence the requirements of a method demonstrating differential validity were satisfied, i.e., some coefficients are significantly different from zero. However, failure to reject Hypothesis 12 (see Table 29), indicated that the three coefficients were not significantly different from each other. Hence the requirements of a second method demonstrating differential validity were not satisfied, i.e., the coefficients were significantly different from each other. Evidence

then that there was a moderate positive relationship between IQ and Average grade is somewhat contradictory; it was deemed advisable to suspend judgement regarding Question 4 for Sample B until further evidence is made available.

Question 5. Can some of the coefficients (obtained with the joint moderator model) above present an increment over that found with the classical validation model? In Sample A, the coefficients of correlation for Subgroups 1, 2, and 3 were .12, .51, and .43 respectively (see Table 15). The rejection of Hypothesis 4 in the case of the second (.51) and third (.43) coefficients indicated that the coefficients for Subgroups 2 and 3 were significantly greater than the coefficient of correlation for the whole of Sample A. Hence the requirements of a third method demonstrating differential validity were satisfied, i.e., some subgroup coefficients are significantly greater than the sample coefficient (Zedeck, 1971, p. 303).

Generally in Sample A, the coefficients of correlation for the three subgroups satisfied the requirements of all three proposed methods of demonstrating differential validity between the coefficients of the subgroups found by fractionation. This was interpreted as follows: moderator variables were operating and the subgroups, found on the basis of these moderator variables, presented evidence of differential validity.

With regards to Sample B, the coefficients of correlation for Subgroups 1, 2, and 3 were .24, .38, and .26 respectively (see Table 30). The rejection of Hypothesis 13 in the case of the first coefficient (.24)

indicated that the coefficient for Subgroup 1 was significantly greater than the coefficient for the whole Sample B. Hence the requirements of a third method demonstrating differential validity were satisfied, i.e., some subgroup coefficients are significantly greater than the sample coefficient.

Generally in Sample B, the coefficients of correlation for the three subgroups satisfied the requirements of two proposed methods of demonstrating differential validity between the coefficients of the Subgroups found by fractionation. This is interpreted as follows: a moderator variable could be operating and the three subgroups could give some indication of differential validity.

Question 6. Can the above results (see Question 5) be cross-validated? Again, in order to cross-validate the results of the subgroups of Sample A, all the students not belonging to any subgroup of Sample A, i.e., Sample B students, were used, and vice-versa to cross-validate the results of the subgroups of Sample B.

In Sample A, the cross-validated coefficients of correlation for Subgroups 1, 2, and 3 were .21, .42, and .27 respectively (see Table 18). The rejection of Hypothesis 7 in the case of all three cross-validated coefficients indicated that the coefficients for all three subgroups were significantly greater than zero. Hence the requirements of a method demonstrating differential validity were not satisfied, i.e., some coefficients are significantly different from zero. The failure to reject Hypothesis 8 (see Table 19) indicated that the cross-validated coefficients for the subgroups were not significantly different from each

other. Hence the requirements of a second method demonstrating differential validity were not satisfied, i.e., the coefficients are significantly different from each other. Finally the failure to reject Hypothesis 9 (see Table 20) in the case of all three cross-validated coefficients for the subgroups indicated that none of the cross-validated coefficients were significantly greater than the cross-validated coefficient of correlation for the whole Sample A. Hence the requirements of a third method demonstrating differential validity were not satisfied, i.e., some subgroup coefficients are significantly greater than the sample coefficient.

Generally, the cross-validated coefficients of correlation for the three subgroups of Sample A did not satisfy the requirements of any of the proposed methods of demonstrating differential validity. This is interpreted as follows: the moderator variables identified as effective in Sample A were not moderator variables but rather idiosyncracies particular to the students in that sample.

In Sample B, the cross-validated coefficients of correlation for Subgroups 1, 2, and 3 were .17, .54, and -.02 respectively (see Table 33). The rejection of Hypothesis 16 in the case of the first (.17) and second (.54) coefficients indicated that the cross-validated coefficients for Subgroups 1 and 2 were significantly greater than zero. Hence the requirements of a method demonstrating differential validity were satisfied, i.e., some coefficients are significantly different from zero. The rejection of Hypothesis 17, (see Table 34) indicated that the cross-validated coefficients for the subgroups were significantly different

from each other. Hence the requirements of a second method demonstrating differential validity were satisfied, i.e., the coefficients are significantly different from each other. Finally, the rejection of Hypothesis 18 (see Table 35) in the case of the second cross-validated coefficient (.54) indicated that the cross-validated coefficient for Subgroup 2 was significantly greater than the cross-validated coefficient of correlation for the whole Sample B. Hence the requirements of a third method demonstrating differential validity were satisfied, i.e., some subgroup coefficients are significantly greater than the sample coefficient.

Generally the cross-validated coefficients of correlation for the three subgroups of Sample B satisfied the requirements of all three proposed methods of demonstrating differential validity. This is interpreted as follows: there is a high probability that the moderator variable, i.e., faculty, identified as effective in Sample B, is indeed operating; it should not be considered as an artifact due to sampling error.

Question 7 was concerned with the importance of the potential moderator variables if they were used as predictor variables.

Question 7. Can the potential moderator variables function better as predictor variables rather than moderator variables? Since there exists no means of testing the significance of a difference between the coefficient of multiple correlation for a group and the coefficient of correlation, e.g., product-moment, for a subgroup part of that group, this question can only be answered indirectly.

In Sample A the coefficient of multiple correlation was .33 while the coefficient of correlation was .13 (see Table 16). The rejection of Hypothesis 5 indicated that the coefficient of multiple correlation was significantly greater than the coefficient of correlation. Since no moderator variables were found to operate in Sample A, this result suggested that Faculty, Age, and/or Income when used with the Otis-Ottawa as multiple predictors, improves the prediction of academic achievement in a linear regression equation. However as multiple prediction was not the concern of this study, it was not investigated further.

In Sample B the coefficient of multiple correlation was .31 while the coefficient of correlation was .20 (see Table 31). The rejection of Hypothesis 14 indicated that the coefficient of multiple correlation was significantly greater than the coefficient of correlation. Since a moderator variable was found to operate in Sample B, this was interpreted as follows: Faculty, Age, and/or Income, when used with the Otis-Ottawa as multiple predictors improves the prediction of academic achievement in a linear regression equation for most female students. This last comment is important because the coefficient of multiple correlation, though larger than the coefficient for the sample, is still smaller than the .54 coefficient found for the subgroup of first year female Science students. However, as multiple prediction was not the concern of this study, it was not investigated further.

Summary of the Findings

The findings revolve around two concerns: (a) the predictive validity of the Otis-Ottawa, and (b) the usefulness of the joint moderator model. In Sample B, the Faculty in which students were registered operated as a moderator variable. Table 37 presents the characteristics of the subgroups formed by fractionation on that moderator variable. Inspection reveals that the joint moderator model provided an increment (up to .54) in the predictive validity of the Otis-Ottawa for first year French speaking female Science students; it also reveals that there was generally a low but definite correlation (up to .20) between IQ and Average for first year female French speaking students of all faculties. However it is evident that the prediction ceiling has not been broken. As for Sample A no moderator variables were found operating.

Still the predictive validity of the Otis-Ottawa has been increased by quite a large margin for some portion of the student body with the use of the joint moderator model. The dissimilarity in prediction equations between groups also suggested that a given predictor, viz., the Otis-Ottawa, may work better with some types of students than it does for other types. Yet the disadvantage of enhancing prediction only for a segment of the population remains. It seems then that the joint moderator model can be useful in helping to locate potential moderator variables although only one was found in this case. Perhaps variables of a psychological nature, e.g., responsibility or maturity, could provide more fruitful results.

Table 37

Characteristics of the Subgroups of Sample B formed on the
basis on the moderator variable Faculty

Subgroup	<u>n</u> ^a	Faculty ^a	Coefficient of Correlation ^a	Cross-validated coefficient ^b
1	272	Soc. Sc. and Arts	.24	.17
2	35	Science	.38	.54
3	22	Ph.Ed. and Nursing	.26	-.02
Total	329	all	.20	.13

^a from Table 28

^b from Table 33.

Limitations and Sources of Error

Sampling. Some factors could have had an unknown influence on the outcome of this study. For example, students not completing their first year as full time students were not considered; what could have been their influence? Did the missing students differ significantly from the students in the study on one or more of the variables used? These questions remain unanswered. A second area involves the restriction of range that the Otis-Ottawa suffers from when administered to university students as results are concentrated in the upper portion of the IQ scale. Such a narrow range could result in lowered prediction coefficients. Finally the numerous requirements determining selection for the study may have biased, again in an unknown fashion, the results of the study.

Criterion. In the criterion, there were several potential sources of error. For instance, the type of courses offered to students varied from faculty to faculty, from year to year, and from department to department within faculties. Furthermore, the type of grading varied from courses to courses and from professor to professor even within the framework of similar or same courses. However, it was assumed that all the courses were of the same difficulty level independently of faculty, department, year, and professor. It must be emphasized again that the criterion selected, i.e., average grade, is the measure of success in this institution however imperfect it may be.

Other variables. Still other error variance could have been introduced by the students themselves, the professors themselves and even the

environment in which the students live and study.

However it is evident from the preceding sections that whatever error variance was introduced, it was not considerable enough to mar the results of this study.

Applications and Suggestions for Further Research.

An immediate benefit of this study could be the compilation of Expectancy Tables for female students by faculty. These tables would indicate for any raw score on the Otis-Ottawa what percentage of students was found at each level of academic performance. This would undoubtedly be a useful tool for counselling purposes. Another benefit could be the use of the statement of linear regression equation, found in Subgroup 2 of Sample B, to predict achievement of first year French speaking female Science students.

Since this study involved female students only, a replication using the same variables and the same design could certainly be undertaken with male students. Similarly another study could retain the same design while examining other potential moderator variables both with male and female students. Further investigations could also be undertaken to include drop out students along with successful and unsuccessful full time students; however this type of study would involve modifications in the present design. Other modifications of design could involve the study of the upper and lower thirds in the distribution of students on the IQ variable in any of the above mentioned suggestions.

Research could also be done in a more mathematical framework: this would involve, for example, the comparison of the effectiveness of different

multiple moderator model in an identical setting. Finally, this last suggestion proposes that the Otis-Ottawa could be standardized on a university population as there are few instruments to assess and discriminate intellectual ability in population of high ability. This is even more so in French Canada. Such an instrument, developed with the same rationale used for the other Otis tests, would certainly be more appropriate in a setting like the Counselling Service.

Conclusion.

The purpose of this study was the analysis of the predictive validity of the Examen Otis-Ottawa d'habilité mentale, Examen Supérieur formule A, as determined by joint moderator methodology. Examination of the Otis-Ottawa revealed that generally (a) it is not quite the equivalent of the American instrument, (b) it has acceptable reliability and construct validity, and (c) it has low but definite predictive validity. This study attempted to enhance the predictive validity of the Otis-Ottawa with a recent prediction strategy: the moderator variable. However past research in this area has suffered from a number of methodological lags. Fortunately a joint moderator methodology (Rock et al., 1967) used in conjunction with a double blind cross-validation design could remedy this situation.

The results show that Faculty has a moderator effect; the predictive validity of the Otis-Ottawa rose to the mid .50's when predicting academic achievement from the Otis-Ottawa for first year female students registered in the Faculty of Pure and Applied Science. The results also show that

the predictive validity of the Otis-Ottawa was in the area of .20 when predicting academic achievement for the whole population of first year female students. Moreover these results were replicated in a cross-validation analysis.

Given (a) the possibility of error variance in the sampling, the criterion, and other variables, and (b) the fact that the Otis-Ottawa was used as a sole predictor, these results are indeed surprising but certainly valid. They suggest that the Otis-Ottawa is a valuable instrument in need of reworking, and that the joint moderator model is a useful strategy in the quest to enhance predictive accuracy.

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Appendix A

Moderated Stepwise Prediction System

Rock, Barone, and Linn (1967) describe their program as providing two systematic procedures for grouping individuals on similar background profiles for purposes of developing within group prediction equations. Unlike previous techniques of introducing moderators, the power of their technique lies in the fact that specific moderators may be handled simultaneously or in a stepwise manner. That is, the program will iteratively select that subset of moderators which will yield groupings which have the largest within group multiple correlations.

The program uses an iterative procedure in an attempt to maximize two objective functions. The first is associated with the predictor matrix and is referred to as the predictive objective function; the second is associated with the moderator data matrix and is referred to as the grouping objective function or error sum squares. The grouping objective function yields an indication of the similarity of profiles among individuals within any one group or groups formed on the \underline{M} moderator variables or some subset of the \underline{M} moderators. The grouping objective function may be defined as the sum of squares deviations taken about the group mean which in turn is taken over all groups. The predictive objective function yields an overall indication for the predictive accuracy of the system for each unique set of groupings on the moderator variables.

The computer also has two methods available for maximizing within group multiple correlations as defined by the predictive objective function.

The first and theoretically less optimal model assumes common covariance matrices, but differing intercepts for the groups. In general, this approach should yield lower within group multiple correlations on the primary sample but will also be less susceptible to sampling error and thus shrinkage on the validation sample. The second method is more optimal in the sense that it makes no assumption concerning a common covariance matrix and thus computes separate regression equations for each subgroup.

Ward (1963) has described a procedure for forming hierarchial groups of mutually exclusive subsets on the basis of their similarity with respect to specified characteristics. This computer program computes the hierarchial structure of the group at each stage and also prints out group memberships beginning at the j^{th} stage, j depending in this University, on a parameter submitted by the user. Unfortunately that stage where at least one of the hierarchially formed groups achieves a minimum size N_j cannot be stipulated by the user as yet.

Within any one stage, the grouping objective function is computed independently of the predictive objective function. However, the moderator variable or combination of moderator variables which yields those groups having the highest predictive objective functions will be retained for the next stepwise level. For example, if the research has M moderators, M grouping procedures will be carried out at the first level. The one moderator variable which yields the highest predictive objective function will then be retained for level two. At level two, the remaining moderators will be taken in combination with the moderator

selected at level 1. The "best" (as defined by the predictive objective function) combination of two will then be carried in level three. This stepwise procedure continues in this manner until all M levels are exhausted or if the increase in the predictive objective function does not exceed some predetermined increment when going from one level to the next.

As the groups are defined based on the error sum of squares grouping function, the researcher has two options for computing his predictive objective function. The first makes no assumption concerning homogeneity of the dispersions and means for the G groups at any one stage. That is, at any one stage in the grouping stepwise multiple regression for the matrix of predictor variables, X will be computed within each group. The second, referred to as intercept method, is based on the assumption that the groupings on profiles based on moderator variables will lead to groups having common covariance matrices but differing intercepts.

At each stage, the computer output includes group membership, common stepwise multiple correlation, and regression output including vectors of predictor and moderator means for each group. The predictive objective function as well as the grouping objective function is also printed out at each stage.

Appendix B

Raw data for Predictive Validity of the Otis-Ottawa using First Year Grades of Female Students with Age, Faculty and Socio-Economic Status as moderator variables.

The raw data for the present study have been deposited at the University of Ottawa Counselling Service in the care of Dr. Sergio J. Piccinin, director. The material thus deposited include:

1. a complete deck of computer cards for Samples A and B;
2. a computer print-out of the information retrieved from UOCS computerized files;
3. a computer print-out of the list of student names necessary to retrieve the transcripts;
4. a computer print-out of the computations done with the MSPS and various SPSS subprograms;
5. photocopies of the retrieved transcripts; and
6. the optical scanning sheets of the first year grades and credits.

Appendix C

The Examen Otis-Ottawa d'habileté mentale,
Examen Supérieur formule A

EXAMENS OTIS-OTTAWA D'HABILITÉ MENTALE

Otis Self-Administering Tests of Mental Ability, by Arthur S. Otis

traduits et adaptés par

Rodolphe Gendron, o.m.i., et Raymond Shevenell, o.m.i.

EXAMEN SUPÉRIEUR: FORMULE A Résultat:

20

Pour les Écoles secondaires

A.M. Q.I.

Lisez cette page. Faites ce qui vous y est demandé.

N'ouvrez pas ce feuillet, ne le tournez pas avant qu'on vous le dise. Remplissez les espaces en blanc, indiquant votre nom, votre âge, votre anniversaire de naissance, etc. Écrivez lisiblement.

Nom	Prénom		Nom de famille		Age au dernier anniversaire	ans
Anniversaire	Jour	Mois	Classe	Date	19	
Collège ou école	Ville					
Occupation de mon père	Adresse			Ville	Province	

Cet examen a pour but de déterminer votre facilité de penser. Il contient des questions variées. Voici un exemple de question à laquelle on a bien répondu. Remarquez comment la réponse est donnée.

Lequel des cinq mots suivants indique ce qu'est une pomme?

1 une fleur, 2 un arbre, 3 un légume, 4 un fruit, 5 un animal (4)

La bonne réponse est en effet "fruit"; alors le mot "fruit" est souligné. Le mot "fruit" est le n° 4; on inscrit donc le chiffre 4 dans la parenthèse au bout de la ligne pointillée. C'est ainsi que vous devez répondre à toutes les questions.

Essayez celle-ci. N'écrivez pas la réponse; soulignez-la seulement et inscrivez son numéro dans la parenthèse.

Lequel des cinq mots suivants signifie l'opposé du nord?

1 pôle, 2 équateur, 3 sud, 4 est, 5 ouest ()

La réponse est en effet "sud"; donc vous avez dû souligner le mot "sud" et inscrire le chiffre 3 dans la parenthèse. Essayez celle-ci:

Le pied est à l'homme et la patte au chat ce que le sabot est ?

1 au chien, 2 au cheval, 3 au fer, 4 au forgeron, 5 à la selle ()

La réponse est en effet "cheval"; donc vous avez dû souligner le mot "cheval" et inscrire le chiffre 2 dans la parenthèse. Essayez celle-ci:

A quatre sous chacun, combien coûteront 6 crayons? ()

La réponse est en effet 24, et il n'y a rien à souligner; alors inscrivez simplement 24 dans la parenthèse.

Quand la réponse à une question est un nombre ou une lettre, inscrivez ce nombre ou cette lettre dans la parenthèse, sans rien souligner. Écrivez toutes vos lettres en majuscules d'imprimerie.

Cet examen contient 75 questions, on ne s'attend pas à ce que vous puissiez répondre à toutes, mais faites votre possible. Vous aurez une demi-heure à partir du moment où l'on vous dira de commencer. Essayez d'en réussir autant que possible. Prenez garde d'aller si vite que vous fassiez des fautes. Ne vous attardez pas trop sur une question aux dépens des autres. On ne donnera aucune explication une fois l'examen commencé. Déposez votre crayon.


Ne tournez pas cette page avant qu'on vous dise de commencer.

LITHO—CANADA

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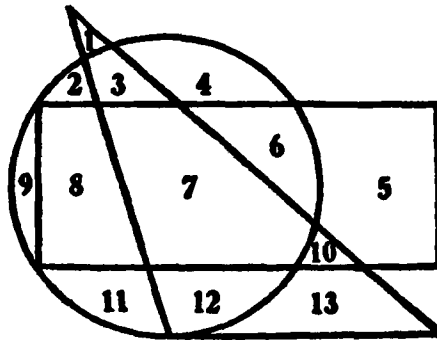
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L'EXAMEN COMMENCE ICI :

1. Quel est le contraire de haine ? ()
1 ennemi, 2 crainte, 3 amour, 4 ami, 5 joie
2. Si 3 crayons coûtent 5 sous, combien de crayons peut-on acheter avec 50 sous ? ()
3. Un oiseau n'a pas toujours (?) ()
1 des ailes, 2 des yeux, 3 des pattes, 4 un nid, 5 un bec
4. Quel est le contraire de courage ? ()
1 gloire, 2 honte, 3 lâcheté, 4 crainte, 5 défaite
5. Un renard ressemble davantage à un (?) ()
1 loup, 2 bouc, 3 porc, 4 tigre, 5 chat
6. Le silence est au son ce que l'obscurité est à (?) ()
1 une cave, 2 la clarté, 3 au bruit, 4 la tranquillité, 5 la sonorité
7. Une réunion comprenait un homme et sa femme, ses deux fils et leur femme, et quatre enfants de chacun des fils. Combien de personnes y avait-il à cette réunion ? ()
8. Un arbre a toujours (?) ()
1 des feuilles, 2 des fruits, 3 des bourgeons, 4 des racines, 5 une ombre
9. Quel est le contraire d'économique ? ()
1 bon marché, 2 chiche, 3 dispendieux, 4 valeur, 5 riche
10. L'argent coûte plus cher que le fer parce qu'il est plus (?) ()
1 pesant, 2 rare, 3 blanc, 4 dur, 5 beau
11. Lequel des six énoncés suivants explique le sens du proverbe: "Aide-toi, le ciel t'aidera" ? ()
 1. On n'est pas tenu à l'impossible.
 2. Les médecines sont souvent mauvaises au goût.
 3. Attendons que viennent les épreuves pour nous tourmenter.
 4. Le monde aux plus fins, le ciel aux plus dignes.
 5. Les travailleurs sont plus favorisés que les fainéants.
 6. Il est inutile de gémir sur ce qu'on ne peut réparer.
12. Lequel des énoncés précédents explique le proverbe: "A chose faite, point de remède" ? ()
13. Lequel des énoncés précédents explique le proverbe: "A chaque jour suffit sa peine" ? ()
14. Une lampe électrique est à une chandelle ce qu'une automobile est à (?) ()
1 une voiture, 2 l'électricité, 3 un pneu, 4 la vitesse, 5 la lueur
15. Un enfant court à raison de 6 pieds en $\frac{1}{4}$ de seconde, combien de pieds courra-t-il en 10 secondes ? ()
16. Un repas comporte toujours (?) ()
1 une table, 2 de la vaisselle, 3 la faim, 4 de la nourriture, 5 de l'eau
17. Des cinq mots ci-dessous, quatre ont entre eux une certaine ressemblance. Lequel n'est pas semblable à ces quatre ? ()
1 plier, 2 raser, 3 hacher, 4 tailler, 5 tondre
18. Quel est le contraire de jamais ? ()
1 souvent, 2 quelquefois, 3 parfois, 4 toujours, 5 fréquemment
19. Une horloge est au temps ce qu'un thermomètre est à (?) ()
1 une montre, 2 au climat, 3 un cadran, 4 au mercure, 5 la température
20. Lequel de ces mots rend cette phrase le plus vraisemblable ? Les hommes sont (?) plus courts que leur femme. ()
1 toujours, 2 habituellement, 3 beaucoup, 4 rarement, 5 jamais
21. Un chiffre est inexact dans la série suivante. Quel devrait être le chiffre exact ? ()
1 4 2 5 3 6 4 7 5 9 6 9
22. Si les deux premiers énoncés suivants sont vrais, le troisième est (?) Tous les membres de ce club sont des libéraux. Gagnon n'est pas un libéral. Gagnon est membre de ce club. ()
1 vrai, 2 faux, 3 incertain
23. Une joute comporte toujours (?) ()
1 un arbitre, 2 des adversaires, 3 des spectateurs, 4 des applaudissements, 5 une victoire
24. Quel chiffre de cette série apparaît une seconde fois le plus près du commencement ? ()
6 4 5 3 7 8 0 9 5 9 8 8 6 5 4 7 3 0 8 9 1
25. La lune est à la terre ce que la terre est (?) ()
1 à Mars, 2 au soleil, 3 aux nuages, 4 aux étoiles, 5 à l'univers
26. Lequel de ces mots rend cette phrase le plus vraisemblable ? Les pères sont (?) plus sages que leur fils. ()
1 toujours, 2 d'ordinaire, 3 beaucoup, 4 rarement, 5 jamais

27. Quel est le contraire de gauche ?
1 fort, 2 joli, 3 court, 4 habile, 5 rapide ()
28. La mère est toujours plus (?) que sa fille.
1 sage, 2 grande, 3 corpulente, 4 âgée, 5 ridée ()
29. Lequel des six énoncés suivants explique le sens du proverbe: "Chat échaudé craint l'eau froide" ?
1. La dissipation règne en l'absence du maître.
2. Une expérience douloureuse enseigne la prudence.
3. Nos actions sont la mesure de notre valeur.
4. On juge d'un ouvrier d'après ses parents.
5. Les petits animaux ne s'amuse jamais en présence des gros.
6. Les chats souffrent moins de la chaleur que du froid. ()
30. Lequel des énoncés précédents explique le proverbe: "Le chat parti, les souris dansent" ? ()
31. Lequel des énoncés précédents explique le proverbe: "A l'oeuvre on connaît l'artisan" ? ()
32. Quand le règlement d'une dispute se fait par une concession mutuelle, on dit que c'est (?)
1 une promesse, 2 un compromis, 3 une injonction, 4 une coercition, 5 une restauration ()
33. Qu'est-ce qui est à la maladie ce que la prudence est à un accident ?
1 médecin, 2 chirurgie, 3 médicament, 4 hôpital, 5 hygiène ()
34. Des cinq choses suivantes, quatre ont entre elles une certaine ressemblance. Laquelle ne ressemble pas à ces quatre ?
1 pirater, 2 voler, 3 frauder, 4 tricher, 5 vendre ()
35. Si 10 caisses de pommes pèsent 400 livres, et que chaque caisse vide pèse 4 livres, combien de livres pèsent toutes les pommes ? ()
36. Quel est le contraire d'espérance ?
1 foi, 2 misère, 3 peine, 4 désespoir, 5 haine ()
37. Si toutes les lettres de nombre impair de l'alphabet étaient rayées, quelle serait la dixième lettre non rayée ? Écrivez-la (majuscule d'imprimerie). Ne marquez pas l'alphabet.
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z ()
38. Quelle lettre du mot MAGNIFIQUE tient dans le mot le même rang (à compter du commencement) qu'elle tient dans l'alphabet ? Écrivez-la (majuscule d'imprimerie) ()
39. Ce que le monde dit de quelqu'un constitue (?)
1 son caractère, 2 du bavardage, 3 sa réputation, 4 ses dispositions, 5 sa personnalité ()
40. Si 2½ verges d'étoffe coûtent 30 sous, combien coûteront 10 verges ? ()
41. Si l'on disposait les mots suivants de façon à former une phrase, par quelle lettre commencerait le second mot de cette phrase ? Écrivez-la en majuscule.
même chose signifie haut élevé la que ()
42. Si les deux premiers énoncés suivants sont vrais, le troisième est (?) Georges est plus vieux que François. Jacques est plus vieux que Georges. François est plus jeune que Jacques.
1 vrai, 2 faux, 3 incertain ()
43. Supposez que la première et la deuxième lettre du mot CONSTITUTIONNEL soient interverties, de même que la 3^e et la 4^e, la 5^e et la 6^e, etc. Écrivez la lettre qui serait alors la douzième lettre à compter de gauche à droite ()
44. Un chiffre est inexact dans la série suivante. Quel devrait être le chiffre exact ?
0 1 3 6 10 15 21 28 34 ()
45. Si 4½ verges d'étoffe coûtent 90 sous, combien coûteront 2½ verges ? ()
46. L'influence d'un homme dans le monde devrait dépendre de (?)
1 sa richesse, 2 sa dignité, 3 sa sagesse, 4 son ambition, 5 son pouvoir politique ()
47. Qu'est-ce qui est à quelques ce qu'ordinaire est à exceptionnel ?
1 aucun, 2 certains, 3 plusieurs, 4 peu, 5 encore ()
48. Quel est le contraire de traître ?
1 bienveillant, 2 brave, 3 sage, 4 lâche, 5 loyal ()
49. Lequel des cinq mots suivants diffère le plus des quatre autres ?
1 bon, 2 large, 3 rouge, 4 rire, 5 épais ()
50. Si les deux premiers énoncés suivants sont vrais, le troisième est (?) Quelques amis de Roy sont anglais. Quelques amis de Roy sont dentistes. Quelques amis de Roy sont dentistes anglais.
1 vrai, 2 faux, 3 incertain ()
51. Combien de mots parmi les suivants peuvent être formés avec les lettres contenues dans le mot ESTIVAL, en répétant la même lettre au besoin ?
Valet, taillis, liasses, svelte, largesse, villas, vieille, vestige ()
52. Soutenir que la lune est un disque d'argent, c'est (?)
1 absurde, 2 trompeur, 3 impossible, 4 injuste, 5 méchant ()

53. Des cinq choses suivantes, quatre ont entre elles une certaine ressemblance. Laquelle ne ressemble pas à ces quatre ?
1 goudron, 2 neige, 3 suie, 4 ébène, 5 charbon ()
54. Qu'est-ce qui est à un cube ce qu'un cercle est à un carré ?
1 circonférence, 2 sphère, 3 coin, 4 solide, 5 épaisseur ()
55. Si les mots suivants étaient vus dans un miroir opposé au mur où ils sont écrits, lequel de ces mots apparaîtrait exactement comme s'il était vu directement ?
1 OHIO, 2 NON, 3 VAL, 4 COTON, 5 OTTO ()
56. Si une bande d'étoffe longue de 24 pouces se contracte à 22 pouces au lavage, quelle longueur aura, après le lavage, une bande de 36 pouces ? ()
57. Lequel des suivants est un trait de caractère ?
1 personnalité, 2 estime, 3 amour, 4 générosité, 5 santé ()
58. Trouvez les deux lettres du mot PIÈGE ayant juste autant de lettres entre elles dans le mot qu'elles en ont dans l'alphabet. Écrivez celle qui est la première dans l'alphabet.
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z ()
59. Révolution est à évolution ce que voler est à (?)
1 oiseau, 2 tourbillonner, 3 marcher, 4 ailes, 5 debout ()
60. Un nombre est inexact dans la série suivante. Quel devrait être le nombre exact ?
1 3 9 27 81 108 ()
61. Si Jean parcourt à bicyclette 30 pieds pendant que Georges en fait 20 à la course, combien de pieds Jean parcourra-t-il pendant que Georges en fera 30 ? ()
62. Comptez dans cette série chaque N immédiatement suivi d'un O à condition que l'O ne soit pas immédiatement suivi d'un T. Combien de ces N y a-t-il ?
N O N T Q M N O T M O N O N Q M N N O Q N O T O N A M O N O M ()
63. On dit de quelqu'un qui est opposé au changement et au progrès qu'il est (?)
1 démocrate, 2 radical, 3 conservateur, 4 anarchiste, 5 libéral ()
64. Écrivez la lettre qui est la quatrième à gauche de la lettre qui tient le milieu entre l'O et le S de l'alphabet ()
65. Quel chiffre occupe l'espace inclus dans le rectangle et le triangle, mais non dans le cercle ? ()



66. Quel chiffre se trouve dans la, ou les mêmes figures géométriques que le chiffre 8 ? ()
67. Combien d'espaces sont communs à deux de ces figures, mais à deux seulement ? ()
68. Une surface est à une ligne ce qu'une ligne est à (?)
1 un solide, 2 un plan, 3 une courbe, 4 un point, 5 une corde ()
69. Si ces deux premiers énoncés sont vrais, le troisième est (?) On ne peut devenir bon violoniste sans pratiquer beaucoup. Guy pratique beaucoup le violon. Guy deviendra bon violoniste.
1 vrai, 2 faux, 3 incertain ()
70. Si l'on disposait les mots ci-dessous de façon à former une phrase, par quelle lettre se terminerait le dernier mot de la phrase ? Écrivez cette lettre (majuscule d'imprimerie).
savoir bonheur vertu la nécessaires Le et sont au ()
71. On dit d'un homme, dont la décision est influencée par des idées préconçues, qu'il est (?)
1 influent, 2 prévenu, 3 hypocrite, 4 décidé, 5 impartial ()
72. Un hôtelier sert un mélange fait de 2 parties de crème et de 3 parties de lait. Combien de pintes de crème faudra-t-il pour obtenir un mélange de 15 pintes ? ()
73. Qu'est-ce qui est au sang ce que la physique est au mouvement ?
1 la température, 2 une veine, 3 le corps, 4 la physiologie, 5 la géographie ()
74. Un énoncé dont le sens est imprécis est (?)
1 erroné, 2 douteux, 3 ambigu, 4 défiguré, 5 hypothétique ()
75. Si un fil long de 20 pouces doit être coupé de telle sorte qu'une partie soit les 2/3 de l'autre, quelle sera, en pouces, la longueur de la plus courte ? ()