The Predictive Validity of the Components of the Process of Selection of Candidates for Higher Education in Israel

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Abstract

The predictive validity of the components of the process of selection of candidates for higher education in Israel was examined with respect to the criterion of cumulative grade point average (CGPA) upon completion of undergraduate studies. The validity coefficients obtained were higher than the validities obtained with respect to the criterion of freshman grade point average (FGPA). In addition to examining the predictive validity of each of the components of the selection process separately, multiple-regression analyses, with several combinations of the components of the selection process, were conducted. Applying differential weights for the components by area of study slightly improved the predictive validity of the process of selection. As for the alternative policy of applying uniform weights by area of study, the results obtained support the current weighting scheme.

1. Introduction

The predictive validity of the process of selection of candidates for higher education in Israel is examined in this study. The predictors are the components of the process of selection: the total score on the Psychometric Entrance Test (PET), the scores on each of the three subtests of PET (Verbal Reasonong, Quantitative Reasoning and English), the average of grades on the high-school matriculation certificate (HSM) and a composite score consisting of equally weighted scores on PET and HSM. The main criterion is cumulative grade point average (CGPA) upon completion of undergraduate studies. A secondary criterion is freshman grade point average (FGPA). Typically, studies of the predictive validity of preadmissions measures at the undergraduate level rely - both at NITE and elsewhere (Linn, 1990) - on FGPA as the criterion measure. In the present study the predictive validity with respect to CGPA will be compared to the predictive validity with respect to FGPA.

Predictive validity results will be reported by: (1) correlation coefficients between each of the predictors and the criteria, and (2) regression coefficients and multiple correlations obtained from multiple regression analyses of each of the criteria on several combinations of the predictors.

Studies of predictive validity are usually conducted on selected samples. It is recognized that the effect of selection on correlation coefficients and regression coefficients varies with the nature of the selection procedures. Knowing the nature of the selection procedures, it is possible to correct for their effect. The problem is that in real-life situations the actual selection procedures are usually complex and, to a great degree, unknown. In such circumstances it is desirable to make the most reasonable guesses possible regarding the selection procedure operative in any particular instance (Gulliksen, 1950). We follow this recommendation in the present study.

The current admissions process at Israeli universities is based mainly on the composite score. Thus, the composite score is subject to explicit selection which results in incidental selection on all the other predictors, as well as on the criteria. The effect of this selection process on the sample statistics (correlation and regression coefficients) will be corrected for, using the correction formula for univariate selection in the three variable case (Gulliksen, 1950).

2. Method

2.1 Subjects

The subjects were first-year students at the six Israeli universities in the school years 1991-92 and 1992-93.

Two samples were defined on the basis of the above group:

(1) all the students (N=24,969) for whom FGPA was reported and (2) the students (N=16,731) for whom CGPA was reported (all the students in this sample have FGPA reported as well).

An observation was recorded for each student studying in a given department (by university and school year). Since some students studied in more than one department, the number of observations is greater than the number of students. Only departments with at least 20 observations with non-missing data in each of the predictors and the relevant criterion were included in the analyses.

2.2 Criteria

1) Freshman grade point average (FGPA) in undergraduate studies.
2) Cumulative grade point average (CGPA) upon completion of undergraduate studies.

(The correlation - averaged across all the departments - between FGPA and CGPA was 0.82.)

2.3 Predictors

1) The scores on PET:
   - (a) The score in Verbal Reasoning (V).
   - (b) The score in Quantitative Reasoning (Q).
   - (c) The score in English (E).
   - (d) The total score (PET). To reach this score, the subsections are weighted as follows: 40% V, 40% Q and 20% E.
2) The average of grades on HSM.

3) A composite score (Comp), consisting of equally weighted PET and HSM scores (these weights were applied at the level of the candidates for each university.)

2.4 Procedure

The unit of analysis was a single department within a university and a school year.

The departments were clustered according to content into eight areas of study (faculties): Humanities, Social Sciences-Verbal (which includes departments that can be characterized as relatively "verbal" – e.g., Sociology, Political Science, International Relations, Psychology, Education), Law, Social Sciences-Quantitative (which includes relatively "quantitative" departments – e.g., Economics, Accounting, Business Administration), Exact and Natural Sciences, Engineering, Medicine and Para-Medical Professions.

The results will be reported as weighted averages across departments by faculties, and across all the departments.

The analyses were conducted in the two samples (described in sub-section 2.1), as follows:

For the sample of students with FGPA, predictive validity with respect to a single criterion – FGPA – was examined. For the sample of students with CGPA, predictive validity with respect to two criteria - FGPA and CGPA - was examined.

The three combinations of sample and criterion are presented in Table 1.

Table 1

Three Combinations of Sample and Criterion Used for the Analyses

Notation	Criterion	Sample of Students with	No. of Students	No. of Observations	No. of Departments
C/C	CGPA	CGPA	16,731	19,587	305
F/C	FGPA	CGPA	16,731	19,578	305
F/F	FGPA	FGPA	24,969	31,285	375

The following results will be reported:

1. Means and standard deviations of the predictors and the criteria (for each of the two samples).

2. Correlations between each of the predictors and the criterion (for each of the three combinations of sample and criterion).

   In order to estimate the correlations in the unselected population, the correlations in the selected sample were corrected, based on the assumption that selection is made on the basis of the composite score. This situation was treated as a standard three-variable situation, and the appropriate formula (Gulliksen, 1950, pp. 145-157) was used (see Appendix A). The correlation of the composite score - as a predictor - with the criterion was corrected by the same formula as the correlations of the other predictors with the criterion. However, since the composite score is the selection variable, the correction formula for the three-variable case simplifies, in this case, to the formula for the bivariate case.

   In order to apply the formula, the variance of both the selected sample and the unselected population had to be known for either the explicit selection variable, or for one of the incidental selection variables. In our application, the information regarding the variance of the explicit selection variable – the composite score – was used. The variance of the unselected population for the composite score was estimated by a weighted average of the variance in the composite score of applicants to a department (by university and school year). These estimates were based on data for applicants to the six Israeli universities during the school years 1991-92 and 1992-93. Such an estimate of the variance of the unselected population should be regarded as conservative.
3. Multiple-regression analyses of the criterion on the predictors (for each of the three combinations of sample and criterion).

   Two sets of predictors were considered:

   1) HSM and PET.

   2) HSM, V, Q and E.

   The following statistics will be reported for each of the multiple-regression analyses:

   1) Standardized regression coefficients (β 's).

   2) Multiple correlation coefficient (R).

   3) The correlation coefficient (r_fac) between a synthetic predictor and the criterion. This synthetic predictor is constructed as a linear combination of the predictors. The weights of the predictors in this combination differ among

faculties: they are the averages of the regression coefficients (β’s) in the faculty.

All the statistics are estimates of the corresponding parameters in the unselected population. They were computed as follows for each department:

1) A matrix of correlations among seven variables (the six predictors and the criterion) was computed in the selected sample.
2) All these (21) correlations were corrected for selection, yielding a matrix of correlations for the unselected population.
3) A multiple regression analysis was conducted, using as its input the matrix of corrected correlations. This analysis yielded estimates of regression parameters (β’s and R) for the unselected population.
4) Constructing the synthetic predictor:
   For each faculty, the average of the β’s were used as weights in constructing a linear combination of the predictors which were included in the regression analysis.
5) The correlation coefficient (r_fac) between the predictor computed in step 4 and the criterion was computed and corrected for the effect of selection, using, as with all the other predictors, the correction formula for the three-variable case.

3. Results

3.1 Means and Standard Deviations

The means and standard deviations of the predictors and the criteria within departments are presented in Table 2.

<u>Table 2</u>

Means (and Standard Deviations) of the Predictors and the Criteria

Faculty	Sample of Students With	No. of Obs. (Dept.)	V	Q	E	PET	HSM	Comp	FGPA	CGPA
Humanities	CGPA	3336 (81)	108 (13)	103 (14)	110 (15)	538 (63)	87.1 (7.4)	45.1 (7.7)	80.2 (6.7)	82.2 (5.3)
	FGPA	7303 (123)	109 (14)	103 (15)	111 (16)	541 (66)	86.6 (7.6)	44.5 (8.0)	79.1 (8.1)	
Social Sciences - Verbal	CGPA	6105 (73)	114 (12)	111 (13)	112 (15)	571 (52)	89.3 (6.2)	49.3 (5.8)	82.5 (5.4)	84.9 (4.2)
	FGPA	8776 (79)	114 (12)	111 (13)	112 (15)	571 (53)	89.0 (6.4)	49.0 (5.9)	81.5 (6.6)	
Law	CGPA	1193 (8)	131 (10)	133 (9)	131 (11)	680 (39)	102.2 (4.8)	63.9 (3.5)	78.4 (5.6)	80.5 (4.7)
	FGPA	1808 (8)	131 (10)	133 (9)	132 (11)	684 (39)	101.6 (5.2)	63.2 (3.9)	78.3 (6.0)	
Social Sciences - Quantitative	CGPA	2473 (20)	124 (11)	130 (9)	121 (14)	645 (43)	94.8 (6.1)	56.6 (5.1)	80.2 (6.6)	82.1 (4.9)
	FGPA	3822 (22)	123 (11)	129 (10)	121 (14)	644 (45)	94.7 (6.3)	56.5 (5.2)	77.3 (9.6)	
Exact & Natural Sciences	CGPA	2491 (51)	119 (13)	124 (10)	117 (15)	617 (54)	94.0 (6.5)	53.9 (6.2)	79.1 (8.4)	82.4 (6.0)
	FGPA	4685 (66)	119 (13)	124 (11)	118 (16)	618 (57)	93.4 (6.6)	53.5 (6.5)	73.6 (13.8)	
Engineering	CGPA	2745 (45)	121 (12)	130 (9)	120 (14)	640 (45)	96.6 (5.9)	55.2 (5.5)	78.5 (6.9)	81.6 (5.1)
	FGPA	3338 (47)	121 (12)	130 (9)	121 (14)	639 (46)	96.3 (5.9)	55.0 (5.4)	77.1 (8.4)	
Medicine	CGPA	600 (11)	130 (9)	135 (8)	132 (11)	686 (33)	102.8 (5.2)	62.3 (4.0)	84.9 (5.6)	84.7 (4.7)
	FGPA	708	131	135	132	685	102.1	62.1	83.9	

		(12)	(9)	(8)	(11)	(34)	(5.3)	(4.1)	(6.7)	
Para- Medical Professions	CGPA	644 (16)	114 (11)	112 (11)	113 (13)	574 (43)	90.0 (5.9)	48.0 (5.2)	84.1 (4.4)	85.7 (3.3)
	FGPA	845 (18)	114 (11)	112 (11)	113 (13)	575 (42)	89.9 (5.9)	48.1 (5.2)	83.4 (4.9)	
All Departmen ts	CGPA	19587 (305)	118 (12)	118 (11)	116 (14)	601 (51)	92.5 (6.3)	52.2 (5.9)	80.7 (6.4)	83.1 (4.9)
	FGPA	31285 (375)	117 (12)	117 (12)	116 (15)	596 (54)	91.6 (6.6)	51.3 (6.3)	78.7 (8.9)	

The following aspects of the data presented in table 2 are notable:

The average of FGPA scores is higher in the sample of students with CGPA than in the sample of students with FGPA. A weaker tendency in the same direction is evident with respect to the predictors.

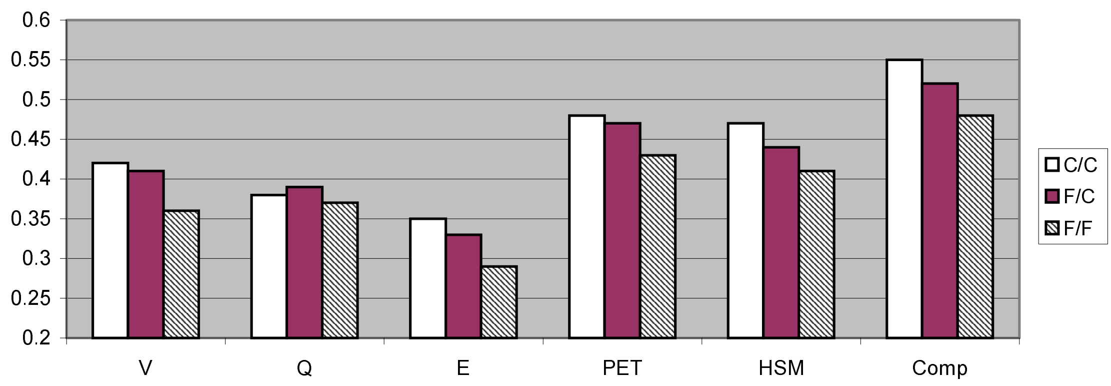
The average of the CGPA scores is higher than the average of the FGPA scores. In addition, CGPA scores have a lower standard deviation.

3.2 Validity Coefficients of the Predictors

The correlation coefficients between the predictors and the criterion are presented in Appendix B (Table 1 for the correlations observed in the selected sample; Table 2 for the correlations corrected for the effect of selection). In the following section only corrected correlations will be considered.

First, we are interested in comparing the validity coefficients of the predictors in the three combinations of sample and criterion. These validity coefficients (across all departments) are presented in Figure 1.

Figure 1: Validity Coefficients of the Predictors in Three Combinations of Criterion and Sample



Across all predictors, the validity for combination F/C is higher than the validity for combination F/F (i.e., the predictive validity - with respect to FGPA - is higher in the sample of students with CGPA than in the sample of students with FGPA).

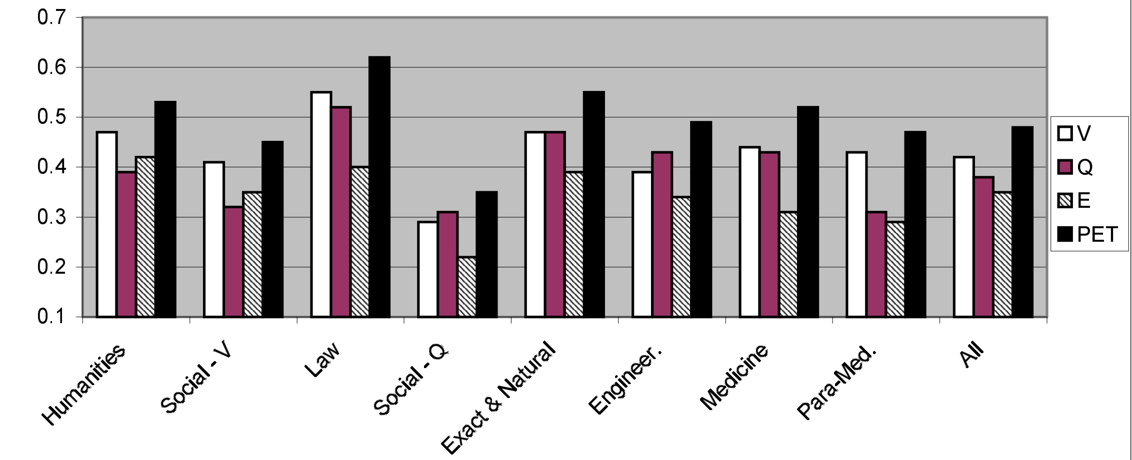
For most of the predictors the validity for combination C/C is higher than the validity for combination F/C (i.e., the predictive validity - in the sample of students with CGPA - is higher for CGPA than for FGPA). An exception to this finding is noted for predictor Q: its validity for combination F/C is slightly higher than its validity for combination C/C.

For all predictors, including Q, the validity for combination C/C (with respect to CGPA) is higher than the validity for combination F/F (with respect to FGPA in the sample of students with FGPA), which has been routinely reported in our predictive validity studies (c.f., Kennet-Cohen, Bronner, & Oren, 1998).

The remaining discussion in this section will be devoted to a closer inspection of the validities of the predictors for combination C/C within areas of study.

We start with the validities of the three sub-tests of PET. These, along with the validity of the total score on PET, are presented in Figure 2.

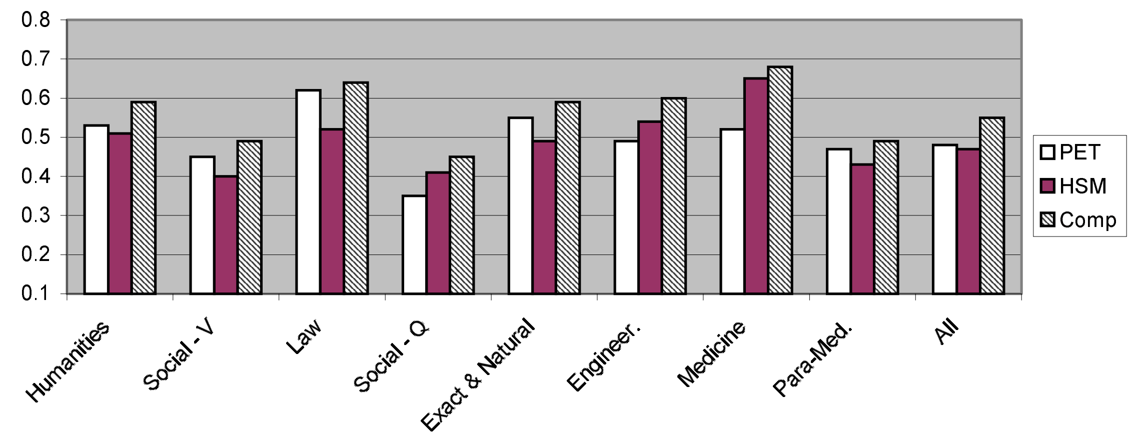
Figure 2: Validity Coefficients of the Components of PET for CGPA



We find that the predictive validity of V is higher than the predictive validity of Q across all the departments and in all the faculties except in the quantitative ones. In the quantitative faculties, Q tends to have a greater predictive validity than V. The validity of E is the lowest, across all the departments and in most of the faculties.
The validity of PET is always higher than the validity of each of the three sub-tests.

We next turn to the validities of the three major components of the admissions system. The validities of PET, HSM and the composite score are presented in Figure 3.

Figure 3: Validity Coefficients of PET, HSM and the Composite Score for CGPA



The average predictive validity of the composite score is 0.55. It is interesting to note that its predictive validity is especially high in the two most selective faculties:

Medicine (0.68) and Law (0.64). In all the faculties we find its predictive validity to be higher than the predictive validity of each of its major components, PET and HSM. The validities of PET and HSM are roughly equal (0.48 and 0.47, respectively, across all the departments). The highest validity for PET is found in Law (0.62), while the highest validity for HSM is in Medicine (0.65).

The marginal contribution of PET, beyond that of HSM, to the predictive validity of the current admissions procedure can be expressed in terms of the difference between the predictive validity of the composite score and that of HSM. This contribution amounts, across all departments, to 0.08 points on the correlation coefficient scale, which means an increase of 17% in the predictive validity of the admissions procedure. PET’s contribution is relatively high in the verbal faculties and in the Exact and Natural Sciences.

3.3 Predictive Validity when Combining PET and HSM: Multiple Regression Analyses

Table 3 below presents the results of multiple regression analyses of the criterion on the predictors PET and HSM across all the departments. (The results of the multiple regression analyses by faculties are presented in Table 3 in Appendix B.)

<u>Table 3</u>

Multiple Regression Analyses of the Criterion on the Predictors PET and HSM: Results Across all Departments

Combination of Sample & Criterion	No. of Obs.	No. of Dept.	β		R	r_fac	r_comp
			PET	HSM			
C/C	19587	305	0.32	0.31	0.57	0.55	0.55
F/C	19587	305	0.32	0.28	0.55	0.53	0.52
F/F	31285	375	0.29	0.27	0.51	0.49	0.48

We first consider the three correlation coefficients presented in the last three columns of Table 3. Multiple R was calculated using weights specifically tailored to each department. The difference between multiple R and the validity coefficient of the composite score (r_comp) represents the upper limit of the gain in validity which can be obtained in the present data by departing from the weights used in the composite score. It can be discerned that the potential gain is very small; in addition, both from a theoretical and practical point of view, using such a weighting scheme is not highly feasible.

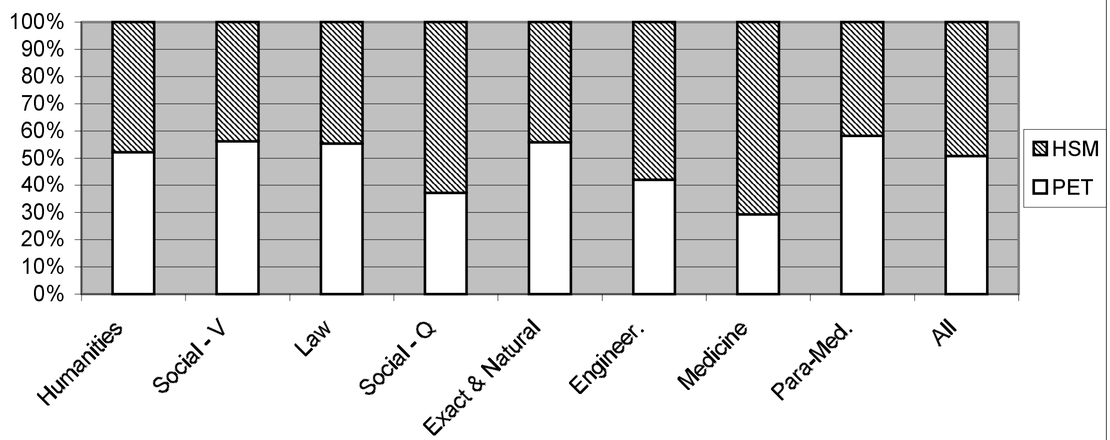
Another alternative is to use differential weights for each faculty (and identical weights for all the departments within a given faculty). The validity of this weighting scheme is presented by r_fac. Clearly, the difference between r_fac and r_comp is negligible. It can be concluded that, given the alternative proposed here, there is nothing to be gained from changing the weighting scheme used in creating the composite score.

Inspection of the regression coefficients of the two predictors reveals that their weights are practically equal. If one chooses to use a uniform weighting scheme (for all departments and faculties), then the weights for PET and HSM should be equal, a condition which is indeed met in the current definition of the composite score.

All the above applies equally to the three combinations of sample and criterion. The main difference between the three combinations is that the three correlation coefficients (R, r_fac and r_comp) are the highest in the combination C/C and the lowest in the combination F/F.

Although empirical considerations show no apparent advantage to using differential weights for PET and HSM in different faculties, there is still some interest in observing the weights of the two predictors within faculties. These will be presented (for the combination C/C) in Figure 4.

Figure 4: The Relative Weights of PET and HSM in Multiple Regression Analyses Predicting CGPA



As was mentioned with regard to Table 3, the weights of PET and HSM, averaged across all the departments, are equal. Inspection of Figure 4 reveals that this pattern holds approximately for most of the faculties, with the exception of Social - Q and, especially, Medicine.[1]

3.4 Predictive Validity when Combining V, Q, E and HSM: Multiple Regression Analyses

Table 4 presents the results of multiple regression analyses of the criterion on the predictors V, Q, E and HSM across all the departments. (The results of the multiple regression analyses by faculty are presented in Table 4 in Appendix B.)

[1]It should be noted, that for Medicine, the weight of PET in the actual admissions measure is usually higher than that of HSM (70% and 30%, respectively). Thus, the correction formula, based on the assumption of direct selection on the composite score (with equal weights for PET and HSM) tends to underestimate the regression weight (and the correlation coefficient) of PET.

Table 4

Multiple Regression Analyses of the Criterion on the Predictors HSM, V, Q and E: Results across all Departments

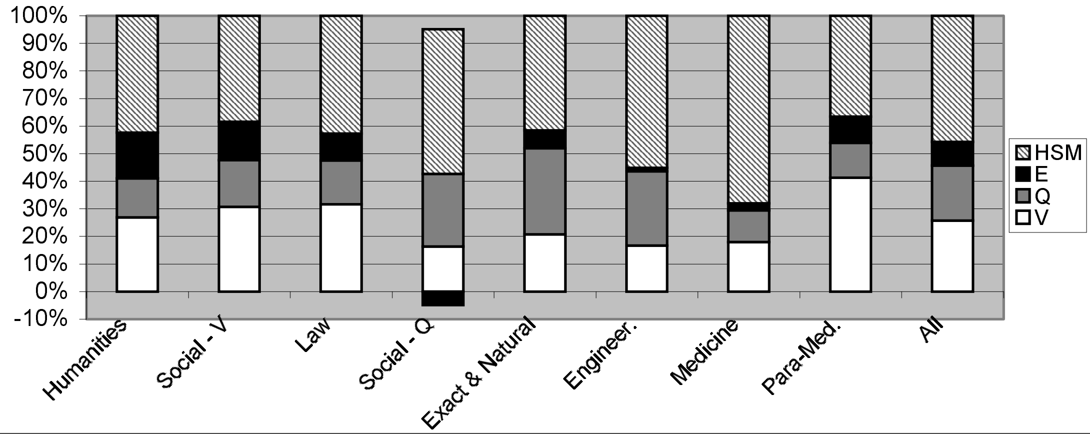
Combination of Sample & Criterion	No. of Obs.	No. of Dept.	β				R	r_fac	r_comp
			V	Q	E	HSM			
C/C	19587	305	0.18	0.14	0.06	0.32	0.60	0.55	0.55
F/C	19587	305	0.17	0.17	0.05	0.29	0.59	0.53	0.52
F/F	31285	375	0.15	0.17	0.03	0.28	0.54	0.50	0.48

We first consider the three correlation coefficients presented in the last three columns of Table 4. The difference between multiple R and the validity coefficient of the composite score (r_comp) is somewhat higher than was observed with respect to PET and HSM as predictors (see Table 3). This can be expected since in the current multiple regression analysis we allow the relative weights of the sub-sections of PET to change, while in the former analysis these weights were fixed. However, as stated above, the interest in this difference is mainly theoretical. Practically speaking, the focus should be on comparing r_fac to r_comp. As was observed with the previous regression analysis (see Table 3) the gain obtained by switching from the composite score to a differential weighting of the predictors for different faculties is very small.
All the above applies equally to the three combinations of sample and criterion. Similar to what was found in the previous regression analysis (see Table 3), the three correlations (R, r_fac and r_comp) are highest for the combination C/C and lowest for the combination F/F.

Inspection of the regression coefficients appearing in Table 4 reveals, in general, that the greatest weight is given to HSM; the next largest weights are given to the predictors V and Q; and the smallest weight is given to E. These weights are relatively stable across the three combinations of sample and criterion, except for a decline in the relative weight of Q in the combination C/C compared to its weight in the combinations F/F and F/C.

Although there is no clear advantage – from the standpoint of predictive validity – to giving differential weights to the predictors for different faculties, there is some interest in observing what these weights are. They are presented in Figure 5 for the combination C/C.

Figure 5: The Relative Weights of V, Q, E and HSM in Multiple Regression Analyses Predicting CGPA



The relative weights of the components of the Psychometric Entrance Test differ by areas of study in the following way: the relative weight of V is highest (30%) in verbal faculties (and in Para-Medical professions). The relative weight of Q is highest (30%) in the quantitative areas of study. E has some weight (more than 10%) in the verbal areas of study. In the quantitative areas of study (and in Medicine) E has, at best, a minor unique contribution and in Social - Q its relative weight is even slightly negative. In general, across all faculties, the relative weights were 46% for HSM, 26% for V, 20% for Q and 8% for E.

4. Summary and Discussion

4.1 The Purpose of the study

The aim of the present study was to examine the predictive validity of the process of selection of candidates for higher education in Israel with respect to the criterion of cumulative grade point average (CGPA) upon completion of undergraduate studies.

Predictive validity studies are routinely conducted at NITE with respect to the criterion of freshman grade point average (FGPA). Two potential sources of differences between the results of these two kinds of studies can be hypothesized: (1) the difference in criterion and (2) the difference in sample (predictive validity with respect to CGPA is computed only for students who have both FGPA and CGPA, while predictive validity with respect to FGPA is usually computed for all students with FGPA).

In order to isolate each of these potential sources of difference, predictive validity with respect to FGPA was also computed, for each of two samples: for the sample of all students with FGPA (a combination of sample and criterion denoted F/F) and for the sample of students with CGPA (a combination denoted F/C).

By comparing the predictive validity with respect to CGPA (combination C/C) to the predictive validity for combination F/C, the effect of the criterion on predictive validity results could be assessed. Comparison of the predictive validity for combination F/C to that of combination F/F enabled us to asses the effect of the sample.

4.2 Validity Coefficients of the Predictors

The validity of all the predictors is higher in combination F/C than in the combination F/F. This means that the sample effect leads to higher correlations in the sample of students with (both FGPA and) CGPA than in the sample of students with FGPA. In other words, the students who did not have CGPA had a negative effect on the predictive validity for the group of students with FGPA.

The validity of all the predictors, except for Q, is higher in combination C/C than in combination F/C. This means that the criterion effect leads to higher correlations of the predictors with CGPA than with FGPA. Such a result is not surprising, since CGPA is a more reliable (based on more measurements) criterion than FGPA.

The average correlations (across all the departments) of the predictors with CGPA (combination C/C) were: 0.42, 0.38 and 0.35, for V, Q, and E, respectively, and 0.55, 0.48 and 0.47 for the composite score, PET and HSM, respectively. Overall, with respect to all the predictors, including Q, these values are higher than the values obtained in the combination F/F. Thus, it can be concluded that the predictive validity results which are routinely reported by NITE (based on the combination F/F), present a conservative estimate of the predictive validity of the components of the selection process.

4.3 Validity of Combinations of Predictors: Multiple Regression Analyses

Two multiple regression analyses for predicting the criteria were conducted: the first, with PET and HSM as the predictors, and the second, with V, Q, E and HSM as the predictors.

Their results can be summarized as follows:

1) Applying differential regression weights by faculties does not contribute much to the overall predictive validity: when PET and HSM were the predictors, no difference was found between r_fac and r_comp (their respective values, across all the departments, were 0.548 and 0.546). A greater difference between the two correlations was found with respect to the combination of V, Q, E and HSM as predictors (0.553 and 0.546 for r_fac and r_comp, respectively). It can be concluded that, from the perspective of predictive validity, there is no advantage in applying different weights to the predictors in different faculties. This conclusion, however, does not preclude other considerations (such as face validity) which may play a role in the decision-making process. This last statement pertains mainly to the relative weights of V, Q and E. Specifically, adapting the relative weights of V and Q according to area of study, supported by their differential relative regression weights, deserves some consideration. In addition, attention should be paid to the negligible weight of E in the quantitative areas of study.

2) With regard to the existing policy of applying a uniform combination of weights across all departments, it appears that the specific weights currently used are compatible with the evidence obtained in this study. Specifically, the relative weights obtained in the regression analyses (for combination C/C) were: 51% and 49% for PET and HSM, respectively, in the multiple regression with PET and HSM as predictors; and 26% for V, 20% for Q, 8% for E and 46% for HSM, in the multiple regression with V, Q, E and HSM as predictors.

4.4 A Technical Note: Correction for Restriction of Range Caused by an Explicit Selection on the Composite Score

The approach adopted in the present study for correcting the sample statistics (the correlation coefficients and regression coefficients in the multiple regression analyses) departs from the method which has been applied in previous predictive validity studies (c.f., Kennet-Cohen, Bronner, & Oren, 1998). Specifically, a change has been introduced in the assumption made regarding the selection process. In the past, an implicit assumption was made that each predictor had undergone an explicit selection. Thus, the formula for the bivariate case (Gulliksen, 1950, pp. 128-143) was applied in order to correct the validity coefficient (and no adjustment was made for the regression coefficients). The present study makes the more realistic assumption that selection is carried out on the basis of the composite score. Accordingly, the appropriate formula for univariate selection in a three-variable case (Gulliksen, 1950, pp. 145-156) is used to correct the validity coefficients of each of the predictors (followed by a corresponding adjustment of the multiple-regression coefficients).

The adoption of this new approach introduced some changes in the predictive validity indices. Therefore, any comparison of the results obtained in this study with previously reported results should take this into consideration.

When considering the effect of the present approach to correction-for-selection, two aspects of the results deserve some attention:

1. The effect of the correction on the validity coefficients varied for the different predictors. In principle, the higher the correlation of the predictor with the composite score and the lower its correlation with the criterion, the greater the effect of (explicit) selection (on the composite score) on the validity coefficient of that predictor (Ghiselli, Campbell, & Zedeck, 1981).
2. Given the assumption of explicit selection on the composite score, the correction-for-selection had no pronounced effect on the regression coefficients in the multiple regression analyses conducted here. This result follows from the fact that each of the two combinations of predictors included in the regression analyses was based on all the components of the composite score. Each combination had, therefore, undergone an explicit selection, which left the regression coefficients unchanged.

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Appendix A

Correction for Univariate Selection in the Three-Variable Case

The standard three variable situation is as follows:
Selection is known to be made on the basis of one variable, U (in the present context it is the composite score). The standard deviation for this variable is available in both the selected and unselected groups. The other two variables of interest, X (in our case, each of the predictors) and Y (the criterion), are subject to incidental selection. Statistics (e.g., variances and correlations) involving X and Y are available only for the selected group.

The solution to estimating the correlation between X and Y for the unselected population depends on the following assumptions:
1) The regressions of X and Y on U are linear.
2) The conditional variances and covariances for X and Y do not depend on U.

The solution is[2]:

$$R_{xy} = \frac{r_{xy} + w_u r_{ux} r_{uy}}{\sqrt{\left(1 + w_u r_{ux}^2\right)\left(1 + w_u r_{uy}^2\right)}}$$

where

$$w_u = \left(\frac{S_u^2}{s_u^2} - 1\right).$$

S and *s* denote standard deviations, *R* and *r* denote correlations, lower case letters refer to statistics in the selected sample, and upper case letters to estimates of the parameters in the unselected population.

[2]The formula presented here is adopted from Linn, 1983.

Appendix B

Table 1

Correlation Coefficients (observed) between the Predictors and the Criterion

Faculty	Combination of Sample & Criterion	No. of Obs.	No. of Dept.	V	Q	E	PET	HSM	Comp
Humanities	C/C	3336	81	0.42	0.34	0.38	0.48	0.46	0.55
	F/C	3336	81	0.39	0.33	0.36	0.45	0.42	0.51
	F/F	7303	123	0.36	0.31	0.31	0.41	0.40	0.47
Social Sciences - Verbal	C/C	6105	73	0.27	0.18	0.22	0.31	0.25	0.36
	F/C	6105	73	0.27	0.20	0.20	0.32	0.22	0.35
	F/F	8776	79	0.23	0.19	0.17	0.28	0.20	0.31
Law	C/C	1193	8	0.29	0.18	0.16	0.31	0.12	0.35
	F/C	1193	8	0.29	0.15	0.15	0.30	0.11	0.32
	F/F	1808	8	0.26	0.15	0.17	0.28	0.17	0.34
Social Sciences - Quantitative	C/C	2473	20	0.12	0.18	0.05	0.18	0.24	0.29
	F/C	2473	20	0.13	0.24	0.05	0.21	0.22	0.30
	F/F	3822	22	0.16	0.27	0.02	0.23	0.20	0.29
Exact & Natural Sciences	C/C	2491	51	0.32	0.36	0.24	0.41	0.34	0.47
	F/C	2491	51	0.30	0.36	0.22	0.39	0.31	0.44
	F/F	4685	66	0.24	0.34	0.16	0.33	0.31	0.40
Engineering	C/C	2745	45	0.19	0.26	0.13	0.27	0.35	0.43
	F/C	2745	45	0.18	0.29	0.10	0.28	0.30	0.40
	F/F	3338	47	0.14	0.29	0.08	0.24	0.30	0.37
Medicine	C/C	600	11	0.12	0.10	0.04	0.14	0.36	0.40
	F/C	600	11	0.12	0.12	0.02	0.14	0.35	0.40
	F/F	708	12	0.11	0.18	0.04	0.18	0.32	0.38
Para-Medical Professions	C/C	644	16	0.27	0.12	0.15	0.28	0.22	0.33
	F/C	644	16	0.26	0.20	0.08	0.30	0.22	0.33
	F/F	845	18	0.21	0.19	0.08	0.26	0.23	0.31
All Departments	C/C	19587	305	0.27	0.24	0.20	0.33	0.30	0.41
	F/C	19587	305	0.26	0.25	0.19	0.32	0.28	0.39
	F/F	31285	375	0.24	0.26	0.17	0.30	0.27	0.37

Table 2

Correlation Coefficients (Corrected for the Effect of Selection) between the Predictors and the Criterion

Faculty	Combination of Sample & Criterion	No. of Obs.	No. of Dept.	V	Q	E	PET	HSM	Comp
Humanities	C/C	3336	81	0.47	0.39	0.42	0.53	0.51	0.59
	F/C	3336	81	0.43	0.37	0.40	0.50	0.47	0.55
	F/F	7303	123	0.39	0.34	0.33	0.44	0.43	0.50
Social Sciences - Verbal	C/C	6105	73	0.41	0.32	0.35	0.45	0.40	0.49
	F/C	6105	73	0.41	0.33	0.33	0.46	0.39	0.48
	F/F	8776	79	0.35	0.31	0.29	0.41	0.34	0.43
Law	C/C	1193	8	0.55	0.52	0.40	0.62	0.52	0.64
	F/C	1193	8	0.54	0.48	0.38	0.59	0.48	0.60
	F/F	1808	8	0.50	0.45	0.40	0.56	0.51	0.61
Social Sciences - Quantitative	C/C	2473	20	0.29	0.31	0.22	0.35	0.41	0.45
	F/C	2473	20	0.29	0.36	0.22	0.38	0.40	0.45
	F/F	3822	22	0.30	0.39	0.17	0.38	0.37	0.43
Exact & Natural Sciences	C/C	2491	51	0.47	0.47	0.39	0.55	0.49	0.59
	F/C	2491	51	0.44	0.46	0.36	0.52	0.46	0.56
	F/F	4685	66	0.36	0.43	0.28	0.44	0.43	0.50
Engineering	C/C	2745	45	0.39	0.43	0.34	0.49	0.54	0.60
	F/C	2745	45	0.37	0.44	0.30	0.47	0.49	0.56
	F/F	3338	47	0.33	0.44	0.28	0.44	0.48	0.54
Medicine	C/C	600	11	0.44	0.43	0.31	0.52	0.65	0.68
	F/C	600	11	0.44	0.43	0.29	0.51	0.63	0.66
	F/F	708	12	0.41	0.47	0.29	0.53	0.61	0.65
Para-Medical Professions	C/C	644	16	0.43	0.31	0.29	0.47	0.43	0.49
	F/C	644	16	0.43	0.37	0.25	0.48	0.45	0.52
	F/F	845	18	0.37	0.34	0.22	0.44	0.42	0.48
All Departments	C/C	19587	305	0.42	0.38	0.35	0.48	0.47	0.55
	F/C	19587	305	0.41	0.39	0.33	0.47	0.44	0.52
	F/F	31285	375	0.36	0.37	0.29	0.43	0.41	0.48

Table 3

Results of Multiple Regression Analyses of the Criterion on the Predictors PET and HSM

Faculty	Combination of Sample & Criterion	No. of Obs.	No. of Dept.	β		R	r_fac	r_comp
				PET	HSM			
Humanities	C/C	3336	81	0.36	0.33	0.62	0.59	0.59
	F/C	3336	81	0.34	0.29	0.58	0.55	0.55
	F/F	7303	123	0.29	0.28	0.53	0.50	0.50
Social Sciences - Verbal	C/C	6105	73	0.32	0.25	0.52	0.49	0.49
	F/C	6105	73	0.34	0.22	0.52	0.49	0.48
	F/F	8776	79	0.30	0.20	0.46	0.43	0.43
Law	C/C	1193	8	0.41	0.33	0.68	0.65	0.64
	F/C	1193	8	0.39	0.31	0.65	0.61	0.60
	F/F	1808	8	0.35	0.35	0.64	0.61	0.61
Social Sciences - Quantitative	C/C	2473	20	0.19	0.32	0.47	0.44	0.45
	F/C	2473	20	0.23	0.29	0.48	0.45	0.45
	F/F	3822	22	0.26	0.25	0.46	0.43	0.43
Exact & Natural Sciences	C/C	2491	51	0.38	0.30	0.62	0.59	0.59
	F/C	2491	51	0.38	0.26	0.58	0.57	0.56
	F/F	4685	66	0.30	0.29	0.52	0.50	0.50
Engineering	C/C	2745	45	0.29	0.40	0.62	0.60	0.60
	F/C	2745	45	0.30	0.35	0.57	0.56	0.56
	F/F	3338	47	0.27	0.35	0.56	0.54	0.54
Medicine	C/C	600	11	0.22	0.53	0.70	0.68	0.68
	F/C	600	11	0.23	0.50	0.68	0.66	0.66
	F/F	708	12	0.26	0.46	0.67	0.65	0.65
Para-Medical Professions	C/C	644	16	0.32	0.23	0.54	0.50	0.49
	F/C	644	16	0.33	0.25	0.54	0.52	0.52
	F/F	845	18	0.28	0.25	0.50	0.48	0.48
All Departments	C/C	19587	305	0.32	0.31	0.57	0.55	0.55
	F/C	19587	305	0.32	0.28	0.55	0.53	0.52
	F/F	31285	375	0.29	0.27	0.51	0.49	0.48

Table 4

Results of Multiple Regression Analyses of the Criterion on the Predictors V, Q, E and HSM

Faculty	Combination of Sample & Criterion	No. of Obs.	No. of Dept.	β V	β Q	β E	β HSM	R	r_fac	r_com
Humanities	C/C	3336	81	0.21	0.11	0.13	0.33	0.65	0.60	0.59
	F/C	3336	81	0.18	0.12	0.13	0.29	0.62	0.56	0.55
	F/F	7303	123	0.18	0.11	0.08	0.28	0.56	0.50	0.50
Social Sciences - Verbal	C/C	6105	73	0.20	0.11	0.09	0.25	0.55	0.50	0.49
	F/C	6105	73	0.20	0.13	0.08	0.23	0.55	0.49	0.48
	F/F	8776	79	0.17	0.13	0.06	0.21	0.49	0.43	0.43
Law	C/C	1193	8	0.26	0.13	0.08	0.35	0.70	0.65	0.64
	F/C	1193	8	0.29	0.09	0.06	0.33	0.66	0.61	0.60
	F/F	1808	8	0.24	0.09	0.07	0.37	0.65	0.61	0.61
Social Sciences - Quantitative	C/C	2473	20	0.10	0.16	-0.03	0.32	0.50	0.45	0.45
	F/C	2473	20	0.08	0.22	-0.02	0.30	0.52	0.47	0.45
	F/F	3822	22	0.12	0.24	-0.07	0.26	0.50	0.46	0.43
Exact & Natural Sciences	C/C	2491	51	0.16	0.24	0.05	0.32	0.65	0.60	0.59
	F/C	2491	51	0.15	0.26	0.04	0.29	0.62	0.57	0.56
	F/F	4685	66	0.08	0.26	-0.00	0.30	0.57	0.52	0.50
Engineering	C/C	2745	45	0.13	0.21	0.01	0.43	0.65	0.61	0.60
	F/C	2745	45	0.12	0.26	-0.01	0.3	0.62	0.57	0.56
	F/F	3338	47	0.08	0.27	-0.01	0.37	0.60	0.56	0.54
Medicine	C/C	600	11	0.14	0.09	0.02	0.53	0.71	0.68	0.68
	F/C	600	11	0.14	0.11	0.01	0.49	0.69	0.66	0.66
	F/F	708	12	0.13	0.17	0.03	0.44	0.68	0.65	0.65
Para-Medical Professions	C/C	644	16	0.26	0.08	0.06	0.23	0.59	0.51	0.49
	F/C	644	16	0.24	0.16	0.00	0.26	0.59	0.53	0.52
	F/F	845	18	0.20	0.13	0.02	0.26	0.54	0.48	0.48
All Departments	C/C	19587	305	0.18	0.14	0.06	0.32	0.60	0.55	0.55
	F/C	19587	305	0.17	0.17	0.05	0.29	0.59	0.53	0.52
	F/F	31285	375	0.15	0.17	0.03	0.28	0.54	0.50	0.48