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ABSTRACT

It was hypothesized that a student's major-field area interacts with the text content in determining performance on the Test of English as a Foreign Language (TOEFL) reading passages. Results with 32,467 graduate school applicants, all nonnative English speakers, supported the study's hypothesis, as students in two major-field groups, the humanities and social sciences and the biological and physical sciences, performed significantly better on passages related to their own groups than on other passages for three of the four test forms examined. Although the hypothesized interaction was statistically significant for most of the test forms, the effect was relatively small, as expressed in terms of points on the TOEFL scale. As a practical matter, the effect seems to be relatively small with typical TOEFL reading passages. Statistically, however, the results showed the effect to be a reliable phenomenon, even if relatively small in magnitude, supporting the theoretical view that a student's major-field interrelates with the text content in determining reading performance. Appendix A contains 7 supplemental tables, appendix B lists the major fields in the four categories; appendix C presents sample reading passages used in the study; and appendix D gives TOEFL subject matter classifications. (Contains 7 tables, 10 figures, and 13 references.) (SLD)

TOEFL

TEST OF ENGLISH AS A FOREIGN LANGUAGE

Research Reports

REPORT 25
JANUARY 1988

The Interaction of Student Major-Field Group and Text Content in TOEFL Reading Comprehension

Gordon A. Hale

ETS
EDUCATIONAL TESTING SERVICE

The Test of English as a Foreign Language (TOEFL) was developed in 1963 by a National Council on the Testing of English as a Foreign Language, which was formed through the cooperative effort of over thirty organizations, public and private, that were concerned with testing the English proficiency of nonnative speakers of the language applying for admission to institutions in the United States. In 1965, Educational Testing Service (ETS) and the College Board assumed joint responsibility for the program and in 1973 a cooperative arrangement for the operation of the program was entered into by ETS, the College Board, and the Graduate Record Examinations (GRE) Board. The membership of the College Board is composed of schools, colleges, school systems, and educational associations; GRE Board members are associated with graduate education.

ETS administers the TOEFL program under the general direction of a Policy Council that was established by, and is affiliated with, the sponsoring organizations. Members of the Policy Council represent the College Board and the GRE Board and such institutions and agencies as graduate schools of business, junior and community colleges, nonprofit educational exchange agencies, and agencies of the United States government.

A continuing program of research related to TOEFL is carried out under the direction of the TOEFL Research Committee. Its six members include representatives of the Policy Council, the TOEFL Committee of Examiners, and distinguished English-as-a-second-language specialists from the academic community. Currently the committee meets twice yearly to review and approve proposals for test-related research and to set guidelines for the entire scope of the TOEFL research program. Members of the Research Committee serve three-year terms at the invitation of the Policy Council; the chair of the committee serves on the Policy Council.

Because the studies are specific to the test and the testing program, most of the actual research is conducted by ETS staff rather than by outside researchers. However, many projects require the cooperation of other institutions, particularly those with programs in the teaching of English as a foreign or second language. Representatives of such programs who are interested in participating in or conducting TOEFL-related research are invited to contact the TOEFL program office. Local research may sometimes require access to TOEFL data. In such cases, the program may provide this data following approval by the Research Committee. All TOEFL research projects must undergo appropriate ETS review to ascertain that the confidentiality of data will be protected.

Current (1987-88) members of the TOEFL Research Committee include the following:

Paul J. Angelis (chair)	Southern Illinois University
Patricia L. Carrell	Southern Illinois University
Lily Wong Fillmore	University of California at Berkeley
Russell G. Hamilton	Vanderbilt University
Frederick L. Jenks	Florida State University
Harold S. Madsen	Brigham Young University

The Interaction of Student Major-Field Group and Text Content in TOEFL Reading Comprehension

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Princeton, New Jersey

RR 88-1

ABSTRACT

In light of the current emphasis on English for specific purposes, it was hypothesized that a student's major-field area interacts with the text content in determining performance on TOEFL reading passages. To assess this possibility, the present study examined performance on the reading passages in TOEFL® forms used in four operational test administrations.

The results supported the study's hypothesis, as students in the two key major-field groups, the humanities/social sciences and the biological/physical sciences, performed significantly better on passages related to their own groups than on other passages, for three of the four test forms examined.

Although the hypothesized interaction was statistically significant for most of the test forms, however, the effect was relatively small, as expressed in terms of points on the TOEFL scale. Thus, a distinction must be drawn between the practical significance and the statistical significance of the interaction effect. Practically, the effect appears to be relatively small with typical TOEFL reading passages, perhaps because they are drawn from general readings rather than specialized textbooks. Statistically, however, the present results showed the effect to be a reliable phenomenon, even if relatively small in magnitude, thus supporting the theoretical view that a student's major-field area interrelates with the text content in determining reading performance.

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INTRODUCTION

With the increasing interest in the topic of English for specific purposes (ESP) comes a recognition that students' major fields may play a role in their reading performance on general English proficiency tests such as the Test of English as a Foreign Language (TOEFL). It is a reasonable hypothesis that a student's major-field area interacts with the text content in determining performance. Such a hypothesis would be consistent with schema theory, which holds that students who have studied a particular topic develop "schemata" regarding that topic--a base of knowledge, in essence--that facilitates acquisition of further information on that topic (cf. Rumelhart, 1980). Students of the natural sciences, for example, should be more accustomed to reading materials with natural science content than are students of other areas, having developed schemata relating to the natural sciences. The former students, therefore, should perform well on a reading test containing natural science materials in comparison with the latter students, taking account of the students' relative levels of general reading ability.

Previous Studies

Although not much research has been done on the hypothesized interaction of student major field and test content, it is of value to review the few completed studies that are relevant to this issue. Brown (1982) experimentally administered a test of engineering reading containing three passages with accompanying multiple-choice questions. A total of 116 students at UCLA were included, representing two populations, American and Chinese graduate students. He found that engineers outperformed nonengineers on the test and that this was true for both the American and Chinese students.

Brown further classified the test items into two groups, those involving specific engineering content (i.e., engineering facts, vocabulary, inference, rhetorical function) and those termed "linguistic items" (i.e., items testing knowledge of such things as cohesive devices, general vocabulary, and other nontechnical aspects of the text). Engineers outperformed nonengineers on the latter items as well as the former, indicating that the higher performance of engineers applies to all aspects of engineering text, regardless of the degree to which it draws on specific knowledge of engineering facts.

Erickson and Molloy (1983) studied the reading performance of engineering and nonengineering majors at UCLA who were either native English speakers or nonnative English speakers (a total of 83 students). The test, administered experimentally, consisted of a passage with engineering content followed by 38 multiple-choice questions. As did Brown, these authors found that engineers (both

native and nonnative English speakers) significantly outperformed nonengineers. They also found that the effect applied both to engineering content (i.e., engineering facts, inference, and technical vocabulary) and to "language items" (i.e., nontechnical vocabulary, and concepts derived from Halliday and Hasan [1976], such as reference, substitution, ellipsis, and lexical cohesion).

The two studies just cited focused on students in only one specific major-field area (engineering), as the objective was to look at effects for reading materials in that specific area. These studies did not ascertain whether there is an interaction between a student's major-field area and the content of the reading materials--that is, whether the relative performance of students in various major-field areas would depend on the content of the materials to be read.[1]

To address this question requires a comparison of students in selected major-field areas, using reading materials representing differing areas of subject matter. Three studies by Alderson and Urquhart (1983, 1984, 1985) included such comparisons. Students in several major-field areas were tested, all given text materials relevant to the various major-field areas. The students were drawn from the Universities of Aston and Lancaster, England, specializing in (a) development administration and finance (plus economics, in some cases), (b) engineering, (c) liberal arts, and (d) science and mathematics. The students were enrolled in special study-skills courses, and the majority of students were studying in English in an English speaking country for the first time.

The students were experimentally administered a "gap-filling" test (presumably a cloze-type test) in Studies 1 and 2, plus a short-question test in Study 2 based on five passages: two related to development administration, two related to engineering, and one "general" text. Students in Study 3 were administered three modules of the ELTS test (British Council and University of Cambridge Local Examinations Syndicate, 1980): social studies, general academic, and technology, the first administered as a class placement test, the second given as an exit test, and the third administered during the interim for purposes of the experiment. The numbers of students per group ranged from 5 to 15 in Study 1, from 22 to 38 in Study 2, and from 35 to 41 (with related groups combined) in Study 3.

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[1]Granted, both of these studies classified the text into technical aspects and linguistic aspects, in order to determine whether the superiority of technically oriented students would be observed for the former aspects and not the latter. Such an effect was not observed, but this result may simply reflect the fact that, in reading text in the area of one's major field, one grasps all aspects of the text relatively easily.

In Study 1, the low sample size prevented performance of significance tests, although the results were in the direction of an interaction between major-field area and text content. In Study 2, development administration students significantly outperformed engineering students on content related to the former area, while the two groups performed about equally well on content related to the latter area (with students in science and mathematics generally performing similarly to those in engineering, and students in the liberal arts performing similarly to those in development administration). Among the findings of Study 3, the combined group of science, mathematics, and engineering students significantly outperformed development administration students on the technology module (which relates to the former areas), while the two groups performed about equally well on the social studies module (which relates to the latter area).

Taken as a whole, the data from these studies by Alderson and Urquhart are consistent with the hypothesis of an interaction between student major-field area and text content in determining performance. However, the significance tests consisted only of pairwise t-tests, which the authors acknowledge to have certain limitations in this type of situation. Thus, direct evidence of the interaction effect, such as that provided by an analysis of variance, was not available. The authors also note that other aspects of the design and results call for additional research before firm conclusions can be drawn.

Moy (1975), used a cloze test with 312 students at the Chinese University of Hong Kong, with three major-field areas represented: arts, sciences, and social sciences. Although Moy obtained a significant interaction between major-field area and text content, the effect was not exactly as had been expected. For example, social science majors had the highest mean scores on the passage that was expected to favor arts majors. Also, science majors outperformed nonscience majors on both science and nonscience materials. Moy concluded that the study failed to support the hypothesis that students would do better on materials dealing with their own academic fields.

Peretz (1986) studied 185 students of English as a foreign language at Ben Gurion University of the Negev, Israel: 107 students in science and technology classes, 29 in a biology class, and 49 in three humanities and social science classes. Peretz administered a test consisting of questions following each of three passages, which represented each of these three major-field areas. She observed a significant interaction between major-field area and text content, with students in a given area of specialization performing best on the passage relating to that area. She also found that science and technology students performed better than the other groups overall, so that these students scored higher than the other groups on the humanities and social science passage as well as the science and

technology passage. She concluded, "The question whether students would perform better ... if the content of the reading passage were related to their general field of study than if the reading passage were related to another subject was not answered conclusively" (pp. 11-12).

The results of these various studies appear to provide tentative evidence in favor of the hypothesized interaction between students' major-field area and text content in determining reading performance. Yet there appears to be enough uncertainty in these authors' conclusions about their results--in some cases due to recognized limitations in methodology--that the issue has remained open to further examination.

The Present Study

The present study sought to provide a more comprehensive test of the hypothesized interaction between student major-field area and text content. The study examined the reading comprehension performance of students taking the TOEFL at four operational test administrations, each of which employed a different TOEFL form. These four test forms contained a total of 21 reading passages representing four key major-field areas--humanities (including the arts), social sciences, biological sciences, and physical sciences.

By examining effects for the entire population of TOEFL takers at these four test administrations, the study contained a large sample of students. With samples per test form ranging from 6,000 to almost 10,000, the study provided a greater opportunity to detect statistically significant effects, even if small in magnitude, than the studies cited above, in which the samples ranged from 100 to just over 300. Further, since all regions of the world were represented in the sample, the study was relatively comprehensive in scope because it could help show the degree to which the results could be generalized across cultures. Additionally, by using operational administrations of a test commonly used in admissions decisions, it ensured that students would be more motivated to do well than is sometimes the case with experimental tests. Finally, by using several test administrations, and thus sampling several reading passages per major-field area, the study could provide results with greater generalizability than would be the case if each major-field area were represented by only a single passage or two.

In the study's principal analyses, a distinction was made between two major-field groups: (a) humanities and social sciences and (b) biological and physical sciences. (Division of groups in this manner was based on test development practices discussed below.) Reading materials in the biological and physical sciences--the "natural sciences"--are often suffused with reference to technical terminology and concepts pertaining to natural-science inquiry. Humanities and

social science materials, on the other hand, contain their own terminology and concepts, and they do not contain the kind of technical information common only to the natural sciences. Thus, in the initial analyses of the study, the interaction between student group and text content was examined, where each of these two factors was defined by the distinction between humanities/social sciences and biological/physical sciences.

In addition to analyzing the data at the level of the major-field groupings just described, the study examined student and text differences at the level of the four separate major-field categories: humanities, social sciences, biological sciences, and physical sciences. Further, where there were enough students to permit such an analysis, the study examined effects of student and text differences at the level of the student's specific major field. Thus, the study provided various tests of the notion that student major-field area interacts with text content, each at a different level of specificity in definition of the major-field area.

As indicated above, the study's main objective was to provide a relatively comprehensive test of a hypothesis of theoretical interest in ESL reading assessment. At the same time, the study furnished information of a practical nature concerning TOEFL test development procedures. When reading passages are selected for inclusion in the TOEFL, a balance is sought with regard to the two major-field groupings indicated above--(a) humanities and social sciences and (b) biological and physical sciences--in an effort to construct a suitable test of reading ability for all students. In effect, then, current TOEFL test development practice presumes the truth of the hypothesis addressed by this study. However, the validity of this hypothesis, particularly as it pertains to reading passages used on the TOEFL, has not yet been subjected to a comprehensive test. By testing this hypothesis with actual TOEFL reading passages, the present study would help show whether, and to what extent, it is important to continue seeking a balance of passage content in constructing TOEFL forms.

METHOD

Subjects

The subjects were 32,467 graduate school applicants, all non-native English speakers, who were administered the TOEFL in May 1984, November 1984, May 1985, or November 1985. Because a different test form was used at each administration, the study contained four different subsamples, each associated with a different form. These forms will be labeled Form 1, Form 2. Form 3, and Form 4, respectively. These four test forms were among those that had been disclosed--that is, made public after their administration. The May and November administrations were selected because they are the largest volume administrations of the TOEFL each year.

The native countries represented in the sample were grouped into major regions according to the scheme presented in Open Doors (Adams & Julian, 1983-84), with the following modifications. First, North Africa (Algeria, Egypt, Libya, Morocco, Sudan, and Tunisia) was grouped with the Middle Eastern countries, as its cultures and educational systems are more similar to those of the Middle East than to those of other parts of Africa. Second, Asia was separated into two regions: (a) South Central Asia (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka) and (b) East and Southeast Asia, again because of differences between these two subgroups in their cultures and educational systems.

Also, for analyses in which region was a factor, students from the following groups were excluded, primarily because of the small numbers in each: (a) United States and possessions (8/10 of 1% of the total sample), (b) the remainder of North America except Latin American areas (1/4 of 1% of the sample), (c) Oceania (1/5 of 1% of the sample), and (d) students who failed to indicate their native countries (2.3% of the sample). In all, then, analyses including region as a factor were based on 96.4% of the total sample.

In the data analyses to be presented, wherever region was not a factor in the analyses, the full sample was used. Wherever region was involved, however--specifically in analyses of variance including region as an independent variable--the slightly reduced sample was used. The regions represented were (a) Africa, (b) East and Southeast Asia, (c) Europe, (d) Latin America, (e) Middle East (including North Africa), and (f) South Central Asia.

The students were classified into four different categories of major fields: (a) humanities (including the arts), (b) social sciences, (c) biological sciences, and (d) physical sciences, according to the intended graduate major fields they specified when

they took the TOEFL.[2] The specific fields in the four categories are listed in Appendix B. This is the scheme used by the TOEFL program and by the Graduate Record Examinations program to classify examinees, and it is a method of classifying major fields commonly used by colleges and graduate schools.

The total number of students and the mean TOEFL scores per major-field group for each test form are presented in Table 1. Scores in Table 1 are presented on the TOEFL scale because this provides a familiar frame of reference. In all of the data analyses to be reported, however, percent-correct scores were used, as conversion to the TOEFL scale was not necessary for addressing the issues under study. The numbers of students in each major-field category broken down by region and sex for each test form are presented in Table A1, Appendix A.

Materials

The four different test forms used in the study contained a total of 21 reading comprehension passages--six passages in Form 1, and five in each of Forms 2, 3, and 4. The passages are presented in Appendix C.

Reading passages on the TOEFL are classified by subject matter according to the classification scheme shown in Appendix D. In this scheme, passages fall into the following general classes: (a) humanities (including the arts), (b) philosophy, (c) social sciences, (d) physical sciences, (e) life sciences, (f) applied science and technology, and (g) mathematics and statistics. Only a very rare passage falls into either category b or g, however, so that the other five categories form the essential classification scheme.

Each of the first four categories in this five-part scheme had a direct counterpart among the student major-field categories listed earlier, and all but one of the 21 passages were classified as belonging in one of those four categories (see "Method of Classifying

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[2]Although undergraduate major field ideally would be used, this information was not available. However, it was assumed that students generally plan to study in a major-field area similar to that in which they studied as undergraduates. Data from Smith (1986) show that the intended graduate major-field category was the same as the undergraduate major-field category for 86% of GRE General Test takers planning doctoral study (and 82% of GRE General Test takers planning less than doctoral study). The percentages of students remaining within the combined groups humanities/social sciences vs. biological/physical sciences should be even higher.

Table 1

Mean TOEFL Section and Total Scores (with Ns and SDs)
for Student Major-Field Categories for Each Test Form

	Humanities Students		Social Science Students		Biological Science Students		Physical Science Students	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Test Form 1	(N=570)		(N=2344)		(N=783)		(N=2462)	
Section 1[a]	52.38	8.03	53.49	7.70	52.05	7.50	52.17	7.65
Section 2	53.47	8.47	54.19	7.72	53.54	6.99	54.79	7.62
Section 3	53.47	7.44	54.80	6.88	54.80	6.20	54.94	6.78
Total	531.09	73.41	541.59	67.60	534.62	61.83	539.68	66.77
Test Form 2	(N=643)		(N=2720)		(N=805)		(N=2911)	
Section 1	53.10	7.63	53.79	7.50	52.67	7.69	52.21	7.41
Section 2	54.49	7.26	55.80	7.21	54.69	7.57	55.44	7.06
Section 3	54.31	7.00	55.63	6.72	55.54	6.72	55.60	6.55
Total	539.65	66.76	550.74	65.29	543.01	66.75	544.19	63.78
Test Form 3	(N=752)		(N=3015)		(N=1402)		(N=4739)	
Section 1	53.01	6.89	53.24	6.71	50.92	6.37	51.19	6.19
Section 2	55.53	8.24	55.54	7.28	54.16	7.04	54.69	6.75
Section 3	54.70	7.70	55.17	6.80	54.24	6.56	54.28	6.64
Total	544.14	70.09	546.49	62.98	531.05	59.81	533.85	58.98
Test Form 4	(N=651)		(N=2749)		(N=1128)		(N=4793)	
Section 1	55.07	6.69	55.30	6.58	53.04	6.37	53.23	6.21
Section 2	57.06	7.42	57.69	7.00	55.72	6.73	56.67	6.39
Section 3	55.35	6.94	56.47	6.37	55.04	6.26	55.37	6.09
Total	558.28	64.18	564.82	60.54	546.00	58.10	550.93	55.77

[a]TOEFL sections are: (1) Listening Comprehension, (2) Structure and Written Expression, and (3) Vocabulary and Reading Comprehension.

the Passages," below). The remaining passage (#6)--classified under applied science and technology--involved concepts closely related to engineering, a field in the physical sciences. Therefore, Passage 6 was grouped with the physical science passages to simplify the analyses. Thus, all passages and all students were classified for analysis according to a four-part scheme: (a) humanities (including the arts), (b) social sciences, (c) biological sciences, and (d) physical sciences.

In addition, for reasons outlined in the Introduction, key analyses called for combining the humanities and social sciences categories into one group, and biological and physical sciences into a second group. Hereafter, the terms "student category" (or "student major-field category") and "passage category" will refer to the four categories listed in the previous paragraph. The terms "student group" and "passage group" will refer to the combination just mentioned--(a) humanities and social sciences (abbreviated "H/S" where necessary) and (b) biological and physical sciences (abbreviated "B/P").

Method of Classifying the Passages

For purposes of this study, a special procedure was used to classify the 21 passages. Two ETS staff members who specialize in TOEFL test development examined each passage and independently indicated the subject-matter category in which it belonged. The two judges agreed with respect to category assignment in 17 of the 21 cases--all but Passages 4, 7, 8, and 17. In the latter four cases, a third judge independently classified the passages, and each passage was assigned to the category that was selected by two of the three judges. In the classification process the judges were asked to indicate not only the passage category (e.g., humanities), but also its subcategory (e.g., architecture), for purposes of certain analyses to be presented below.

Question Types

It was not intended that the data be analyzed at the level of the individual test questions associated with the passages. However, it was useful to classify the questions according to the scheme by which TOEFL reading comprehension questions are described, in order to determine whether there were substantial differences among categories of passages with regard to the types of questions asked. Employing the kind of procedure outlined above, in which two judges were asked to classify the questions and a third judge resolved disagreements, it was determined that 61% of all questions involved supporting ideas (i.e., supporting ideas and details explicitly given in the passage); 13% involved main ideas (i.e., the main subject or idea of the passage); and 12% involved inference based on information strongly

implied by the author. These three categories thus defined the vast majority of questions in the passages, while the remaining questions were spread among the six other categories, with no more than 4% in each: (a) extrapolation from the information given; (b) analogy to the information presented; (c) recognizing the meanings of words in the passage context, (d) recognizing the author's internal logic, (e) understanding the tone of the passage, and (f) identifying the location in the passage of specific information.

Focusing on the three main question types, the breakdown by major-field categories was as follows: (a) for supporting idea questions--humanities 65%, social sciences 51%, biological sciences 70%, and physical sciences 67%; (b) for main idea questions--15%, 12%, 11% and 11%, respectively; and (c) for inference questions--8%, 16%, 7% and 11%, respectively. The amount of variation in these percentages is relatively small. Thus, if performance differences were to be observed among major-field categories, these differences could not be attributed to variation in the proportions of different question types for the different major-field categories.

RESULTS

TOEFL Scores for the Four Major-Field Categories

As shown in Table 1, total TOEFL scores tended to be higher for students in the social sciences than the other groups. This pattern generally held true for Section 3, Vocabulary and Reading Comprehension, the section most pertinent to the present study as well as for the other sections. Nevertheless, for two of the four forms the students in the biological and physical sciences had mean Section 3 scores that were just as high as those for the social science students; only the humanities students scored consistently, but not substantially, lower.

The data in Table 1 are presented merely to provide background information about the sample. While no further analysis of these data is intended, the scores serve to point up the importance of considering major-field differences in proficiency when comparing these groups. Analyses to be reported below are designed to adjust for major-field differences in reading performance.

The Role of Major-Field Group

A principal hypothesis was that students would perform better, in a relative sense, when reading material related to their own major-field group (i.e., humanities/social sciences; biological/physical sciences) than when reading other types of material. Data relevant to this hypothesis are presented in Table 2. Each mean score in the table is the average percent correct on all passages of the type indicated, for the student group listed. For example, in deriving the first mean in the table (.760), the average of the percent-correct scores for the humanities and social science passages in Test Form 1 (Passages 1, 3, and 4) was computed for each student; the mean of these averages across students in the humanities and social sciences was then computed, weighted by the number of students in each of these two categories. (Note that the passages contributed equally in computing this mean.)

Figure 1 is a visual display of the means from Table 2. Pertinent to the study's hypothesis, attention should be directed to the difference between the two bars in each pair of bars. For the humanities/social science passages, the left-hand bar (humanities and social science students) is higher than the right-hand bar (biological and physical science students) for each test form, whereas the reverse is true in each case for the biological/physical science passages. Hence, the data appeared to support the hypotheses of an interaction

Table 2

Mean Scores (and SDs) for Each Student Group and Each Passage Group[a]

	N	Humanities/ Social Science Passages Mean	SD	Biological/ Physical Science Passages Mean	SD
Test Form 1					
Humanities/ Social Science Students	2914	.760	.185	.676	.225
Biological/ Physical Science Students	3245	.747	.175	.689	.221
Test Form 2					
Humanities/ Social Science Students	3363	.698	.216	.817	.177
Biological/ Physical Science Students	3716	.687	.213	.821	.168
Test Form 3					
Humanities/ Social Science Students	3767	.652	.216	.865	.145
Biological/ Physical Science Students	6141	.620	.209	.880	.130
Test Form 4					
Humanities/ Social Science Students	3400	.799	.173	.740	.204
Biological/ Physical Science Students	5921	.769	.166	.753	.189

[a]Data shown are means and SDs of raw scores.

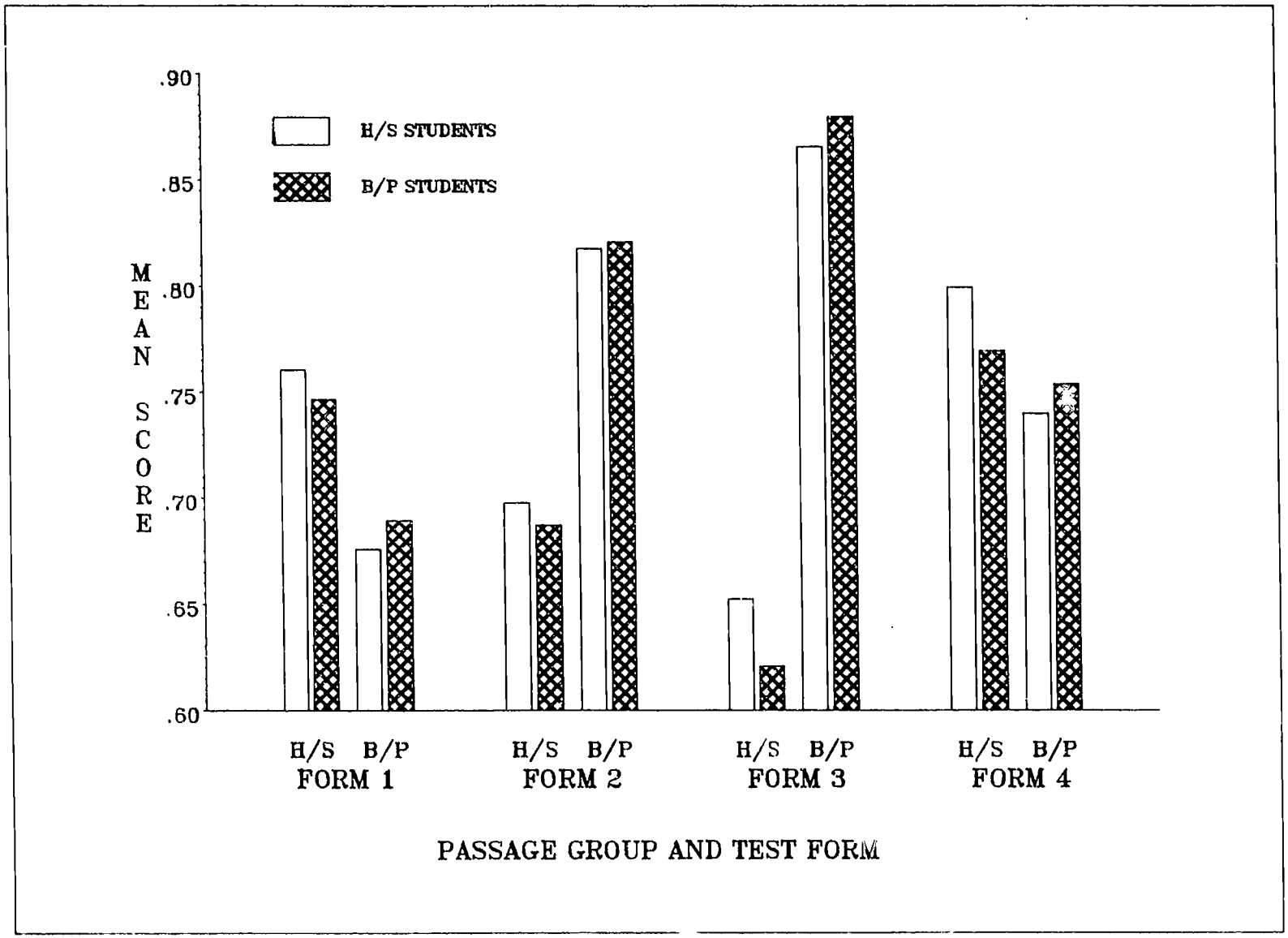

Fig. 1--Mean scores of humanities/social science (H/S) students and biological/physical science (B/P) students for H/S and B/P passages for each test form.

between student group and passage group, and this interaction was consistently in the expected direction.

The strength of the interaction between student group and passage group is even more apparent if the data are depicted in a way that permits comparison with score variability. Toward this end, the data were subjected to an arcsin transformation,[3] and a difference score was computed for each passage group that represented the difference between the H/S and B/P student groups. Figure 2 presents the results of these computations. The difference score in each case appears in the center of the vertical line, with the ends of the vertical line representing the 95% confidence interval around the difference score. For each test form, a line connects the difference score for the H/S passages and the difference score for the B/P passages, to emphasize the comparison between the two. It can be seen that the first difference score exceeds the second in each case. Also, the confidence intervals of the connected data points do not overlap for Test Forms 1, 3, and 4, indicating that the interaction effect was not only consistent but in most cases was quite large in relation to the variance in scores.

Returning to Figure 1, one other aspect of the data requires comment. Substantial differences in heights of the pairs of bars are apparent, reflecting differences due to passage difficulty. The H/S passage group was more difficult than the B/P passage group for two test forms, while the reverse was true for the other two test forms. It must be borne in mind that these differences do not reflect inherent differences among major-field groups with regard to difficulty of reading matter. For every test form, passages are chosen that represent a range of difficulty. In some test forms, the humanities/social science passages happen to be the easier ones, whereas in other test forms the biological/physical science passages are the easier ones. Thus, these data should not be interpreted as providing information about the inherent difficulty of reading material in each of these two domains.

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[3]Here, and in all of the analyses of variance to be conducted, the scores were subjected to an arcsin transformation. This transformation is designed to achieve variance stabilization, as it takes into account the fact that scores near the extremes of the scale tend to be less variable than scores near the middle of the scale. Thus, for a group of relatively easy passages, which produce a mean score near the ceiling level, the variability about the mean is less than for a group of passages of intermediate difficulty. The arcsin transformation tends to reduce the discrepancy in score variability among such groups of passages, thus permitting more meaningful comparison of these groups.

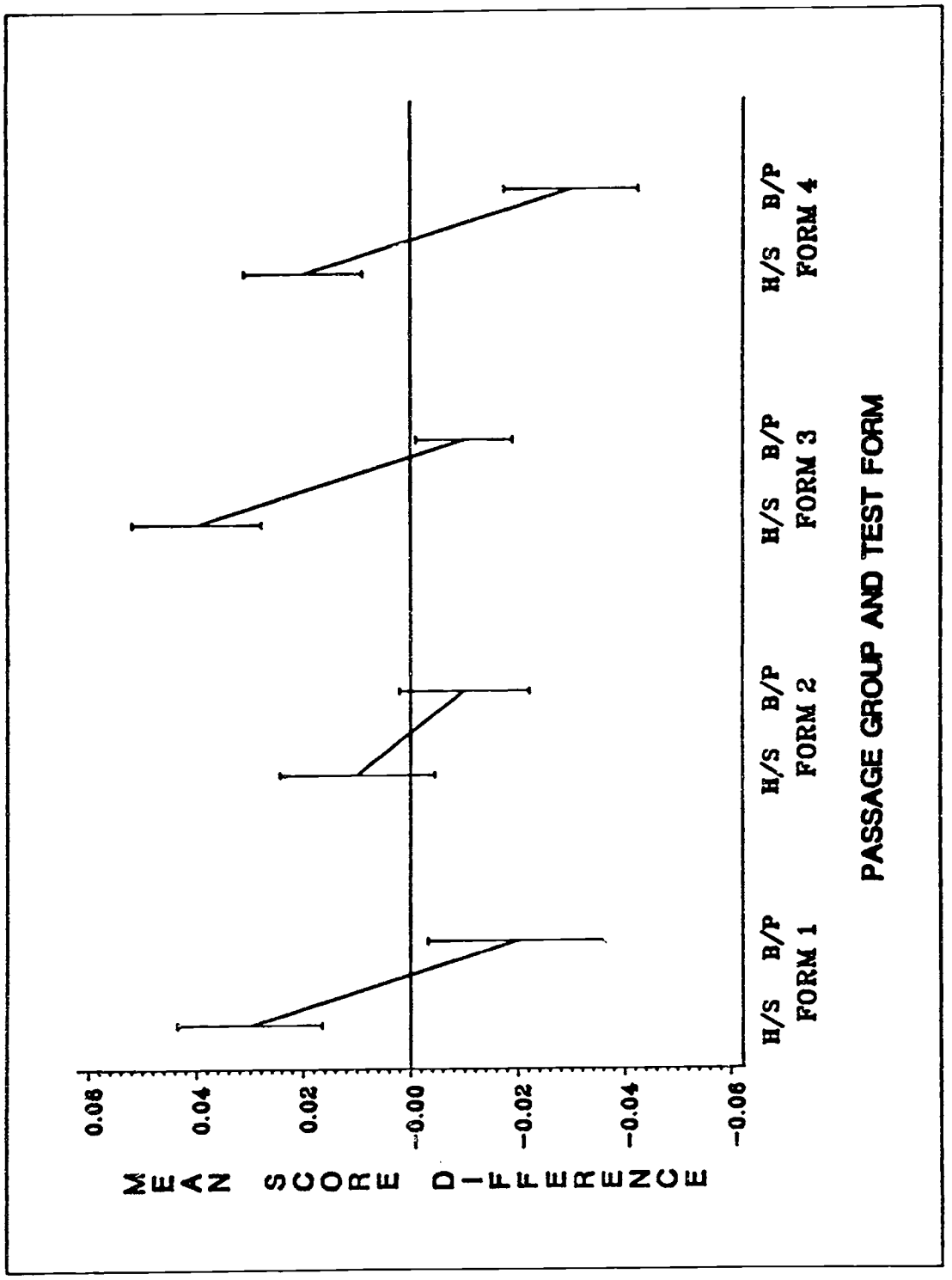

Fig. 2--Mean difference between humanities/social science (H/S) and biological/physical science (B/P) students, plotted for H/S and B/P passages for each test form. (Scores were first subjected to arcsin transformation.) Vertical line through each data point represents 95% confidence interval.

Analyses to be reported below deal primarily with the statistical significance of the interaction between student major-field group and passage group. As will be seen, the interaction effects for all but one test form meet a standard criterion of statistical significance, indicating that these effects can be expected to recur with reasonable reliability across different samples of students.

It is also of value, however, to assess the practical importance of the effects observed. Although there are no hard and fast rules for determining whether an effect has practical significance, a useful way of approaching this issue is to estimate the impact of the observed interactions in terms of the TOEFL scale. Toward this end, an effort was made to estimate the difference in scaled score between H/S and B/P students that would occur in two situations: (a) if the entire reading comprehension subsection were to contain all H/S passages, and (b) if this subsection were to contain all B/P passages.

The analysis focused on Test Form 3, the form for which the largest interaction effect was observed. The percent-correct scores in Table 2 translate into number-correct scores, out of the 29 reading comprehension items, of 18.91 and 17.98 for H/S and B/P student groups on the humanities/social science passages. These are the estimated scores on the reading comprehension subsection that would have been produced if the entire subsection had contained humanities/social science passages. Similarly, estimated scores were 25.09 and 25.52 for the two groups if all passages had contained biological/physical science material. The difference between the first two scores is .93, and between the second two scores, -.43; thus, the difference between differences (which reflects the interaction effect) was 1.36 raw score points.

Assuming that mean scores on the vocabulary subsection would not differ for the two situations posed above, the difference between differences for the entire Vocabulary and Reading Comprehension section (Section 3) should also be 1.36 raw score points. A difference of 10 points in raw score on TOEFL Section 3 translates into a difference of about 7 to 9 points in scaled score for that section (depending on whether scores are near the extremes or in the middle of the scale; raw scores ranging from 0 to 58 translate into scaled scores ranging from 20 to 67). Thus, the difference between differences, which was 1.36 in raw scores, would be approximately 1 in scaled scores. Given that the score for each TOEFL section is multiplied by 10/3 and added to the others to yield the total TOEFL score, a difference of 1 scaled score point on the Vocabulary and Reading Comprehension section contributes 10/3 x 1 or about 3 TOEFL score points.

Therefore, the consequences of using only one or the other type of reading passage (of the kind found on Form 3) are that there would be a reversal in relative standing of H/S and B/P student groups of approximately 3 points. For example, given mean scores for the two

groups of about 547 and 532, respectively, if only humanities/social science passages were used, the mean scores might be about 545-1/2 and 533-1/2, respectively, if only biological/physical science passages were used. Similar calculations for Test Forms 1, 2, and 4 indicate effects of about 2, 1, and 3 scaled-score points, respectively.

It must be noted that this is a very crude method of estimation, designed to give only a rough idea of the magnitude of the differences observed here. It does suffice to show, however, that the interaction between student major-field group and text content, expressed in terms of points on the TOEFL scale, was relatively small. (Note that this effect was a very small fraction of the standard deviation in total TOEFL scores, which is typically about 65 points--cf. Educational Testing Service, 1987.) Thus, it is important to draw a distinction between the statistical significance of this effect and its practical importance. Statistically, analyses presented below show the effect to be a replicable one; the use of an extremely large sample size in this study helped make it possible to detect an effect that, while small, is a reliable phenomenon. Practically, however, the advantage that would accrue to students in a major-field group if given reading passages all related to that major-field group apparently translates into only a few points in overall TOEFL scaled score. This is the case, at least, with reading passages appearing in the typical TOEFL, which are drawn from general reading materials rather than from highly specialized textbooks.

Through the remainder of this report, the focus is primarily upon the statistical significance of effects, as the objective is to determine whether the hypotheses stated in the Introduction are supported with statistical reliability. However, as will be reiterated in the Discussion section, it is also necessary to pay attention to the absolute magnitude of the effects, particularly where practical inferences might be drawn from the data.

Statistical Analyses of Major-Field Group Effects

Description of analyses. Statistical tests were performed to determine the significance of effects involving the student and passage groups (i.e., the effects depicted in Figures 1 and 2). Two sets of analyses, differing in the dependent variable employed, were performed for each test form. In the analyses most pertinent to the hypothesis under study, the dependent variable was the difference between humanities/social science passages and biological/physical science passages (with the scores first subjected to arcsin transformation). Analyses were also performed in which the dependent

variable was the average percent correct across all passages (after arcsin transformation).[4]

The principal independent factor in each analysis was the comparison between student groups--i.e., humanities/social science students vs. biological/physical science students. Two additional factors were sex of student and student's region of origin. These last two factors were included to ensure a test of effects involving major-field groups that would control for the roles of sex and region.

Analyses with H/S vs. B/P passages as dependent variable. Table 3 indicates the significant effects in the analyses in which the dependent variable was humanities/social science vs. biological/physical science passages. Table A2 in Appendix A shows the means corresponding to each significant effect in Table 3. (Error terms from Table 3 allow the interested reader to determine the variability of the scores.)

The result of greatest relevance to the study was the effect of student group. For three of the four test forms this effect was significant (at the .001 level); only for Form 2 did the effect not reach significance, although it was in the same direction as those for the other forms. Thus, the hypothesis regarding an interaction between student group and passage group--depicted in Figures 1 and 2--received relatively strong support.

The other significant effects are more difficult to interpret, as they do not relate to any specific expectations or hypotheses under study. Nevertheless, these effects deserve brief mention, as they may lead to useful hypotheses for further research.

The sex effects were inconsistent, as the H/S vs. B/P difference was greater for males on Form 1 but greater for females on Form 4; hence no general conclusion regarding the role of sex seems warranted.

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[4]It was decided to conduct two such analyses rather than to perform a single analysis with passage group as a repeated measures factor. Either method would serve the same purpose. That is, testing the effect of a given factor on the difference between passage groups is statistically equivalent to testing the interaction between that factor and passage group, with the latter defined as a repeated measures variable. But an advantage of not including all factors in a single analysis of variance is that it avoids the problem of testing an effect that, for reasons discussed above, is essentially meaningless in this context--the difference between humanities/social science passages and biological/physical science passages.

Table 3

Significant Effects in Analyses of Variance in which Dependent Variable is Contrast between Humanities/Social Science Passages and Biological/Physical Science Passages[a]

Effect (and df)	Form 1	Form 2	Form 3	Form 4
Student group (G) (1)[b]	15.79**	--	30.92**	31.50**
Sex (S) (1)	7.87*	--	--	4.97
G x S (1)	--	--	--	--
Region (R) (5)	7.63**	55.35**	52.22**	9.03**
G x R (5)	--	--	2.99	--
S x R (5)	--	3.40*	--	--
G x S x R (5)	--	--	--	--
MS error	.65	2.29	2.28	2.06
df error	5795	6763	9473	9178

[a]Entries are F values for effects.

[b]Student group factor is humanities/social science students vs. biological/physical science students.

*p<.01; **p<001; others p<.05

The region effect simply shows that the difference between H/S and B/P passages varied across regions, and that this was true for every test form. Inspection of the difference scores in Table A2 shows no consistent pattern; while the rank-ordering of regions was roughly the same for Forms 2 and 3, a quite different rank-ordering was observed for Forms 1 and 4.

The group x region effect was observed for only one test form, as was the sex x region effect, and thus was not consistent enough to permit any general conclusions. It is notable, however, that even where a significant group x region effect was observed (Form 3), the results for every region were in the same direction as the overall group effect.

The main reason for including sex and region in these analyses was to determine whether the effect pertaining to the study's principal hypothesis--the interaction of student group and passage group, shown in Figures 1 and 2--could be attributed simply to confounding with either of these factors. The results show that the interaction effect cannot be attributed to such confounding.

Analyses involving overall performance as the dependent variable. Table 4 shows the significant effects in the second set of analyses, in which the dependent variable was the average across all passages. Table A3 in Appendix A shows the means corresponding to each significant effect (error terms in Table 4 indicate the variability of scores.) The sex effect was found for only one test form and thus was not consistent enough to permit general conclusions. The effects of region indicated that students from Europe generally ranked highest, and those from the Middle East, lowest, while the other groups generally rank-ordered similarly for the different test forms. Concerning the group x region effects (Forms 2 and 3), although Europeans generally scored highest and Middle Eastern students lowest, there were some slight shifts in rank-ordering of the other groups.

With regard to the sex x region effects, the relative ranking of Latin American students was higher among men than among women for Forms 1 and 2 (but not 3 and 4); the relative ranking of South Central Asians was higher among men than women for Forms 2 and 4 (but not 1 and 3); and the relative ranking of African and Middle Eastern students was higher among women than men for Forms 2 and 4 (but not 1 and 3). These effects were too inconsistent to permit any general conclusions. It may be notable, however, that the difference in scores between the highest ranking region and the lowest ranking region was consistently greater for men than women, suggesting greater variability among regions for men.

Some of the above-mentioned effects involving sex and region may represent interesting differences that deserve further examination.

Table 4

Significant Effects in Analyses of Variance with Overall Performance as Dependent Variable[a]

Effect (and df)	Form 1	Form 2	Form 3	Form 4
Student group (G)[b] (1)	--	--	--	--
Sex (S) (1)	--	4.07	--	--
G x S (1)	--	--	--	--
Region (R) (5)	69.43**	150.41**	90.87**	235.32**
G x R (5)	--	4.00*	3.30*	--
S x R (5)	3.71*	5.34**	2.74	12.05**
G x S x R (5)	--	--	--	--
MS error	2.43	1.46	1.26	1.25
df error	5795	6763	9473	9178

[a]Entries are F values for effects.

[b]Student group factor is humanities/social science students vs. biological/physical science students.

*$p<.01$; **$p<.001$; other effects, $p<.05$

However, because these effects tended to be inconsistent across test forms, and because no specific hypotheses had been advanced about them, further efforts to interpret these effects would be premature. These results must be regarded only as sources of hypotheses for further study at this point.

Analyses involving language group as a factor. In the main analyses discussed above, world region was included as a factor to determine whether effects involving major-field group were due to confounding with region. Supplementary analyses were also conducted, with language group substituted for region as a third factor along with major-field group and sex. This was done to check on the possibility that language differences might underlie effects involving students' major-field groups. The sample for this analysis, which comprised 60% of the total sample, included students in the six most heavily represented language groups: Arabic, Chinese, Hindi, Japanese, Korean, and Spanish. Two analyses were conducted, one with H/S vs. B/P passage groups as the dependent variable, and the other with overall reading performance as the dependent variable.

As before, the principal effect of interest--the effect of students' major-field group on the contrast between passage groups--was significant in most cases ($p<.01$ or .001 for Forms 2, 3, and 4). Other consistently significant effects paralleled those observed in the analyses involving world region: (a) the effect of language on overall performance for all four forms and (b) the effect of language on the contrast between passage groups for all four forms. One effect (group x language for overall score) was significant for Forms 2 and 3. Other effects were observed for one form only: (a) sex x language for overall score on Form 2, (b) the sex effect for the contrast between passage groups for Form 4, (c) group x sex for the contrast between passage groups for Form 4, and (d) sex x language for the contrast between passage types for Form 2.

These effects closely parallel those obtained in the analyses involving world region. This is not surprising, given that the students in the six language groups represent a sustantial proportion of the students in four of the six regions: East and Southeast Asia (Chinese, Korean, and Japanese languages), Latin America (Spanish), South Central Asia (Hindi), and the Middle East (Arabic). Because of the close parallelism in results observed in the analyses involving region and language, additional analyses in this study include only students' region of origin as a factor.

Analyses of Individual Passage Means

To further understand the basis for the results presented above, it is of value to examine the data for each individual reading passage.

Score adjustment. To permit proper interpretation of the individual passage data, a score adjustment was performed that would help take into account differences among student major-field groups in overall reading proficiency. First, a student's score on each passage was computed and arcsin transformed. Then, the average of the students' transformed scores was computed across all passages within the same test form. Finally, to produce the student's adjusted score for a given passage, the second (average) score was substracted from the first (individual passage) score. The resulting adjusted score reflects the student's performance on a given passage, controlling for overall reading performance on that test form.

The role of the two major-field groups. Figure 3 (i.e., 3a through 3d) presents the adjusted scores on each passage. (For the corresponding raw mean scores, see Table A4 in Appendix A.) The mean adjusted scores are represented by the midpoints of the vertical lines; the height of each vertical line represents the 95% confidence interval around its respective data point; and the line connecting the left- and right-hand data points for each passage represents the comparison between the H/S and B/P student groups. In examining Figure 3, it must be remembered that an adjusted score reflects a group's performance relative to its average performance. Hence, there are necessarily some passages on which the score plotted for the H/S students exceeds that for the B/P students, and others on which the reverse is true. The advantage of depicting the data in this manner is that it shows which passages favor each group, apart from the effects of overall reading ability. More important, it shows those cases in which the superiority of one student group over the other is especially pronounced, thus indicating those passages on which performance is most sensitive to differences in student major-field groups.

One general observation from Figure 3 is that there was a highly consistent tendency for the two major-field groups to differ in the expected direction. That is, for a given passage, a higher mean score was generally obtained for the student major-field group to which the passage relates. In only one case (Passage 8) were the results in the opposite direction.

A second general observation is that, despite this consistency, the effect was considerably more pronounced for some passages than for others. This latter observation will be considered in more detail

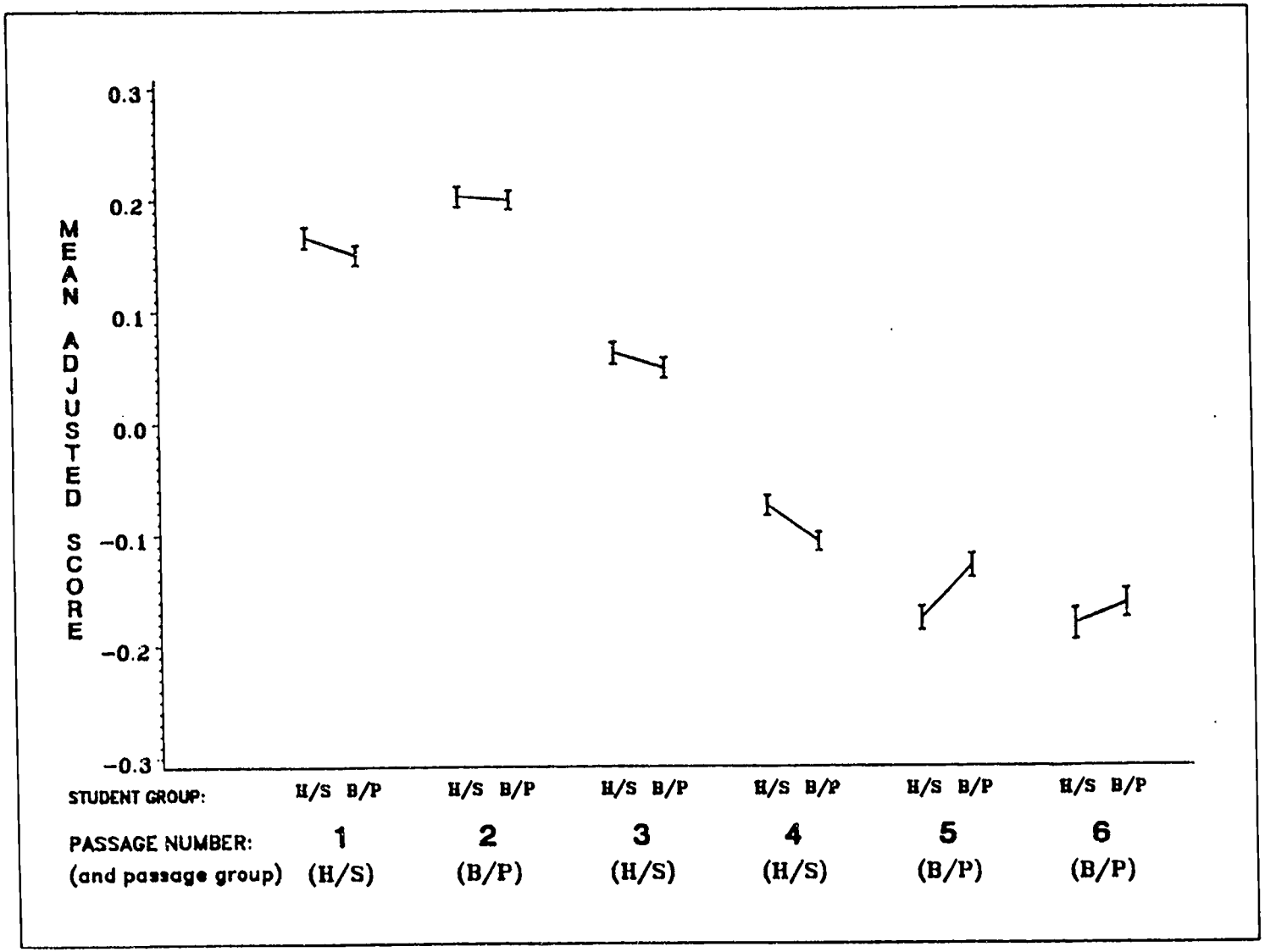

Fig. 3a--Mean adjusted, transformed scores for humanities/social science (H/S) and biological/physical science (B/P) students for each passage in Test Form 1. Vertical line through each data point represents 95% confidence interval.

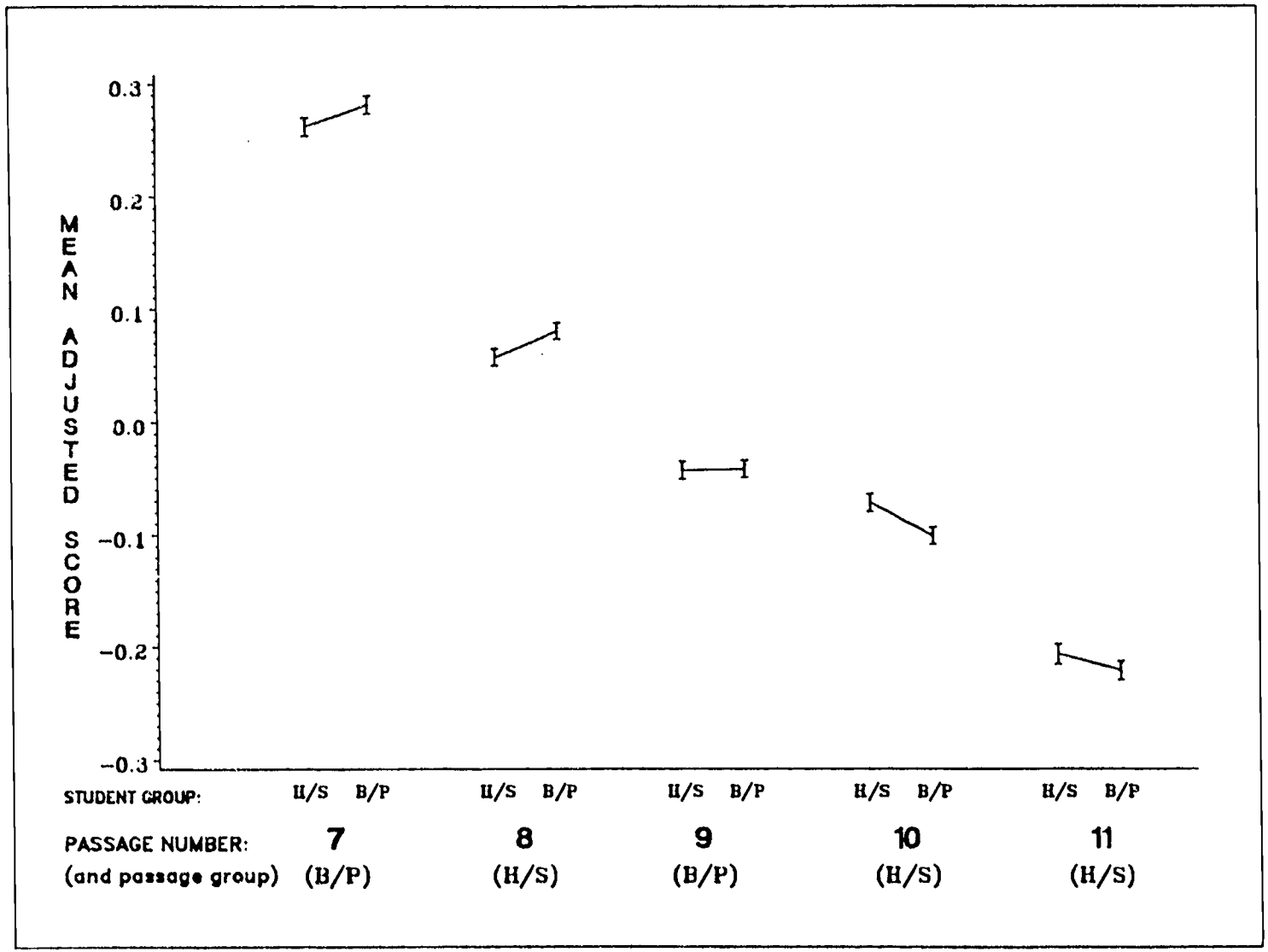

Fig. 3b--Mean adjusted, transformed scores for humanities/social science (H/S) and biological/physical science (B/P) students for each passage in Test Form 2. Vertical line through each data point represents 95% confidence interval.

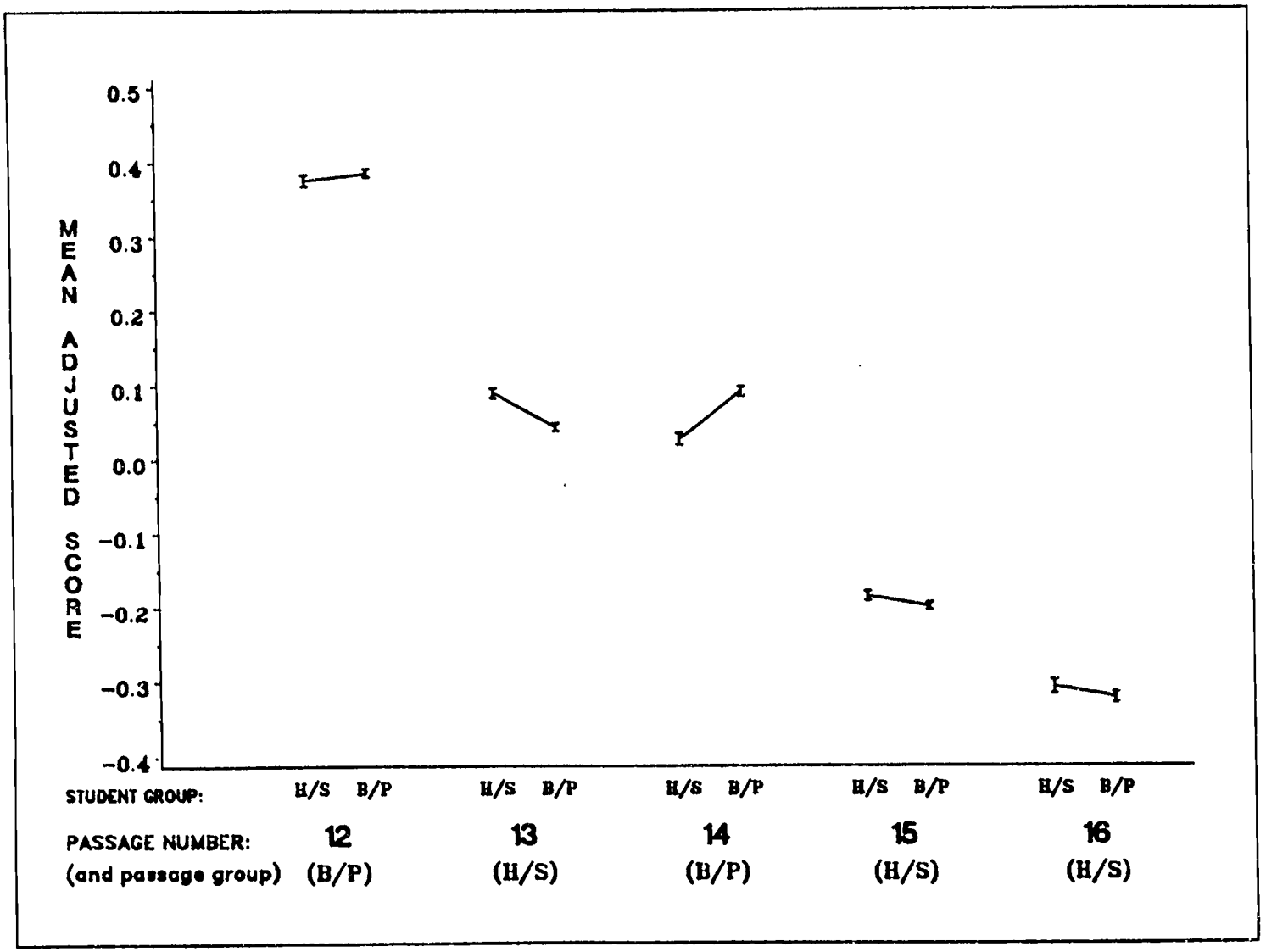

Fig. 3c--Mean adjusted, transformed scores for humanities/social science (H/S) and biological/physical science (B/P) students for each passage in Test Form 3. Vertical line through each data point represents 95% confidence interval.

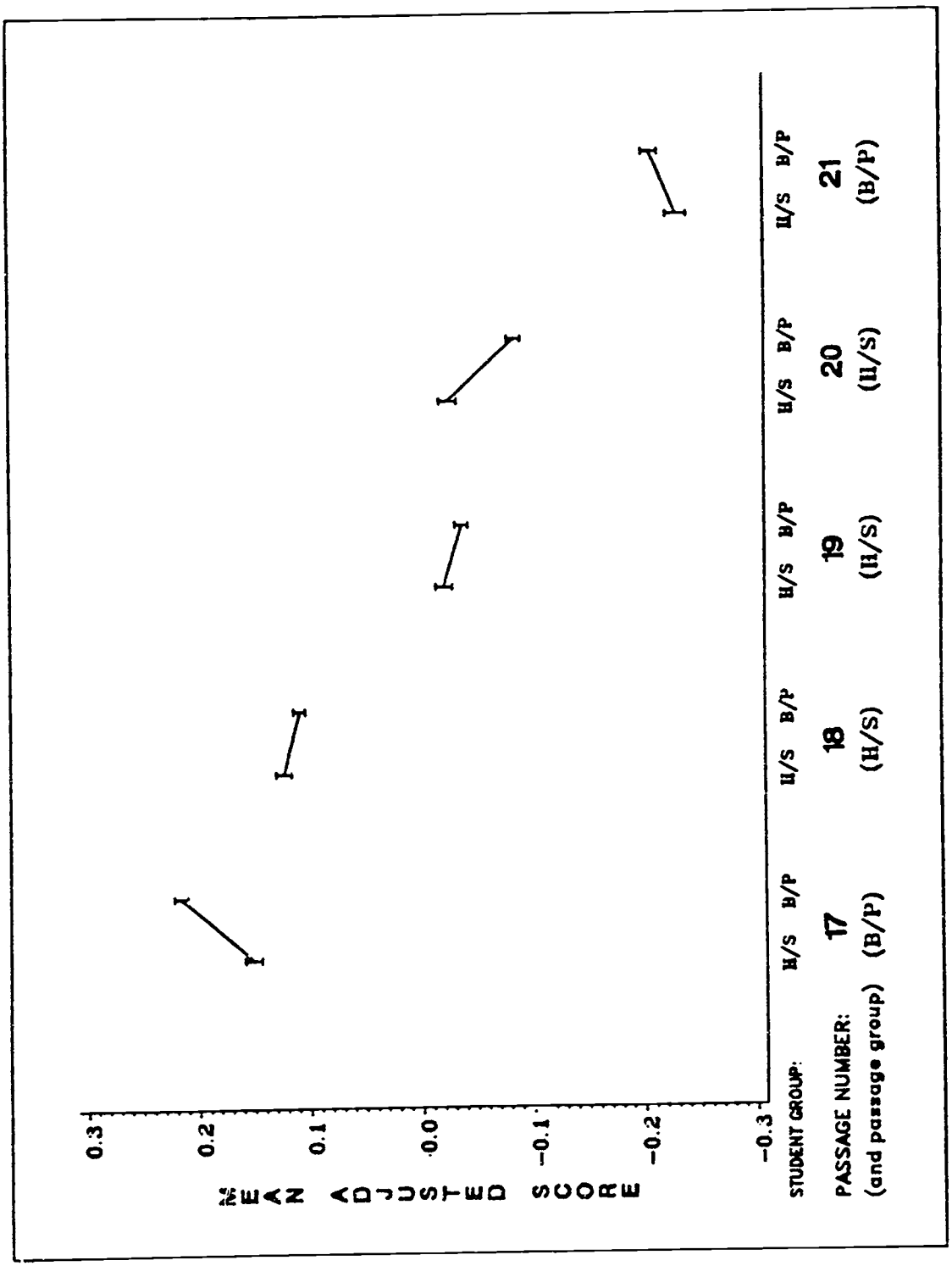

Fig. 3d--Mean adjusted, transformed scores for humanities/social science (H/S) and biological/physical science (B/P) students for each passage in Test Form 4. Vertical line through each data point represents 95% confidence interval.

in the Discussion section, where differences in the nature of the passages will be examined.

The role of the four major-field categories. It was also of value to break down the major-field groups into their constituent categories--humanities, social sciences, biological sciences, and physical sciences. Figure 4 presents the corresponding scores after transformation and adjustment (using the method of adjustment described above). Again, it is the adjusted scores, shown in Figure 4, that are of primary interest. (For the corresponding raw mean scores, see Table A5 in Appendix A.)

Figure 4 shows that, for 13 of the 21 passages, there was a match between the passage category and the student category with the score that was highest or tied for highest. Thus, the expected pattern--superiority of a given student category on passages related to that category--was observed in the majority of cases. Of course, there were instances in which humanities students performed relatively well on social science passages or vice versa (cf. Passages 4, 10, 11, 15, and 16), and cases in which biological science students performed relatively well on physical science passages or vice versa (e.g., Passages 2 and 7). This effect reflects the kinship among categories within each of the two major-field groups. Nevertheless, there were also cases of pronounced superiority of a given student category on a passage related to that category. Perhaps most notable in this regard was the marked superiority of biological science students on two biological science passages, 5 and 21.

Tests of significance for individual passages. Analyses of variance were conducted for each passage in order to determine the significance of differences between major-field groups (as shown in Figure 3) and among major-field categories (as shown in Figure 4), controlling for sex and region.

In these analyses, the dependent variable for a student on a given passage was the adjusted score--that is, the student's score on the passage in question minus the student's average score on all passages in the test form containing that passage (with scores first subjected to arcsin transformation). Independent factors were the student's major-field category (i.e., the four categories listed above), sex, and region; the contrast between humanities/social science group and biological/physical science group was also computed for each passage. Because subdivision by specific categories yielded very low Ns in certain cells for the African group (see Table A1), Africa was excluded from this analysis in order to ensure that the effects would not be disproportionately affected by that particular region. Because Africa represents such a small proportion of the total sample, the results were expected to provide a reasonably

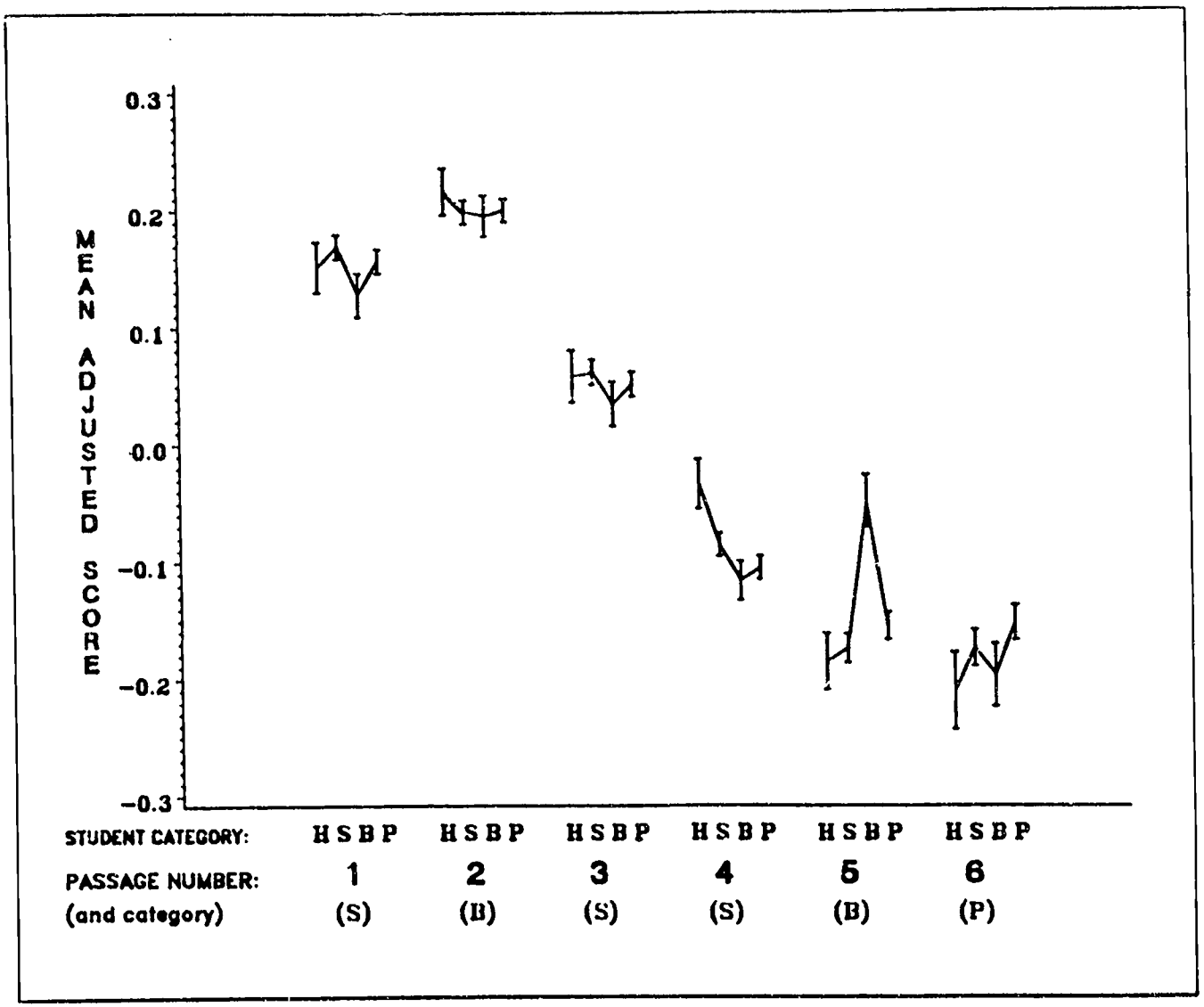

Fig. 4a--Mean adjusted, transformed scores for humanities (H), social science (S), biological science (B), and physical science (P) students for each passage in Test Form 1. Vertical line through each data point represents 95% confidence interval.

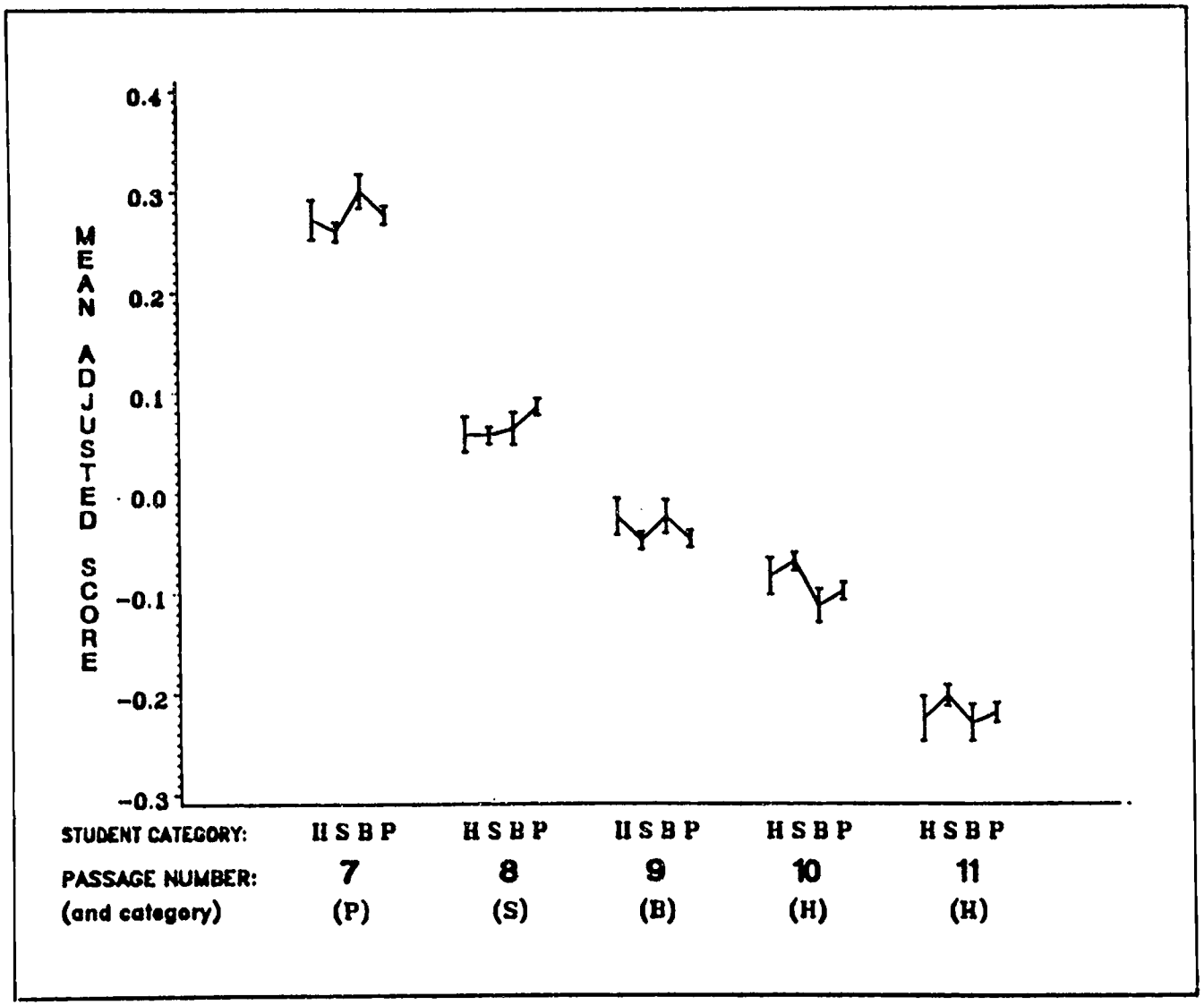

Fig. 4b--Mean adjusted, transformed scores for humanities (H), social science (S), biological science (B), and physical science (P) students for each passage in Test Form 2. Vertical line through each data point represents 95% confidence interval.

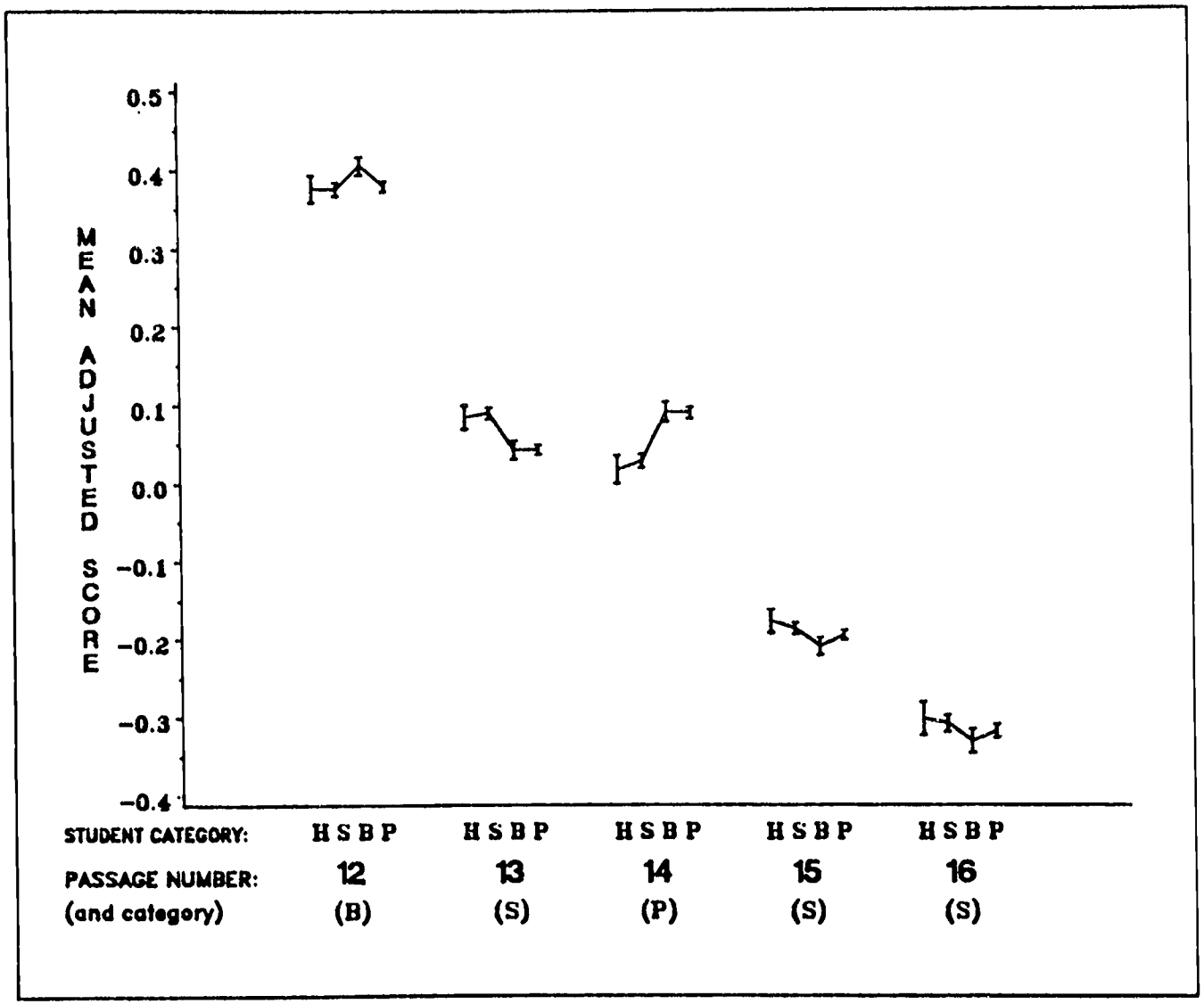

Fig. 4c--Mean adjusted, transformed scores for humanities (H), social science (S), biological science (B), and physical science (P) students for each passage in Test Form 3. Vertical line through each data point represents 95% confidence interval.

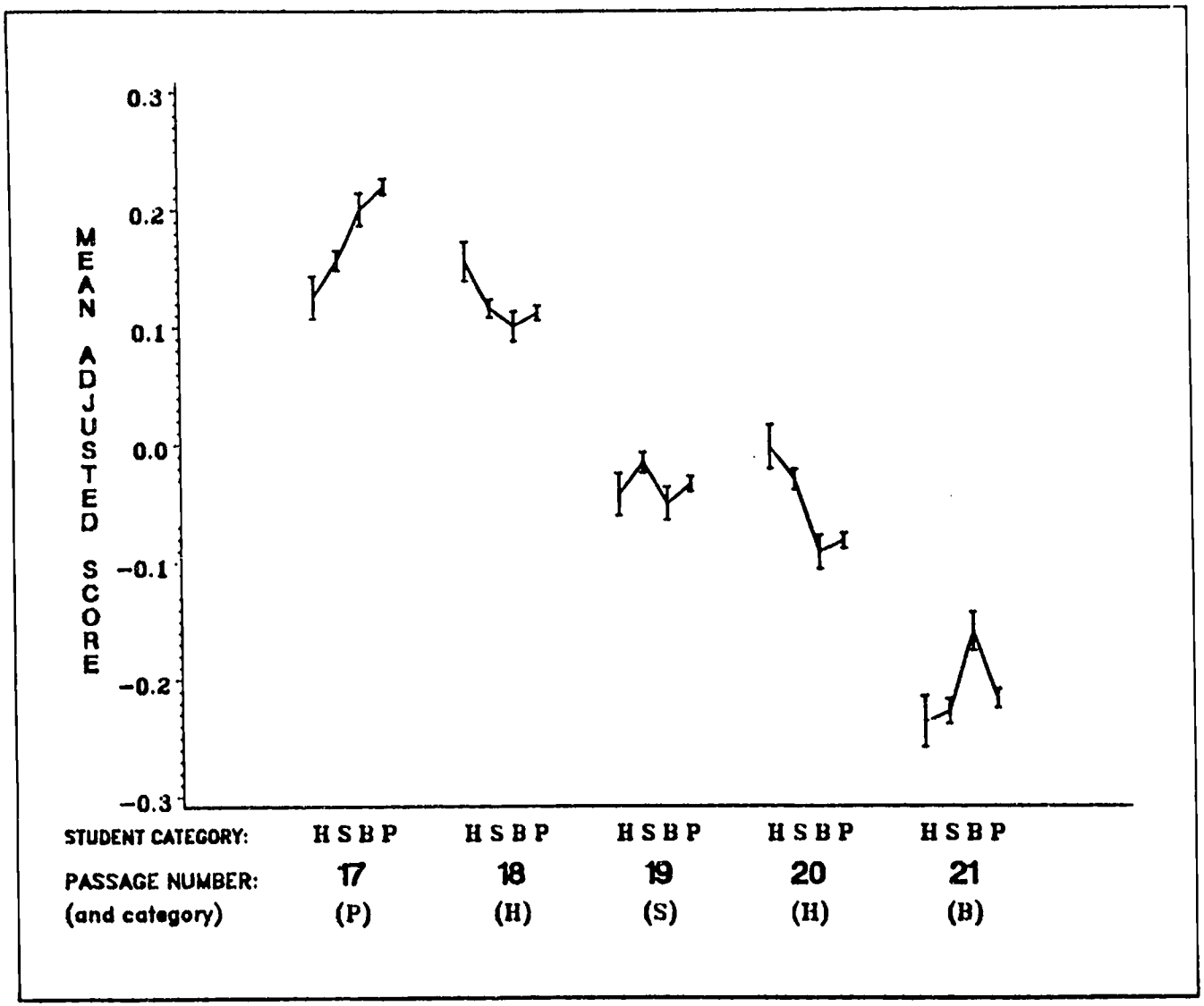

Fig. 4d--Mean adjusted, transformed scores for humanities (H), social science (S), biological science (B), and physical science (P) students for each passage in Test Form 4. Vertical line through each data point represents 95% confidence interval.

accurate indication of the significance of effects for the sample as a whole.

The significant effects are shown in Table 5. The means associated with these effects appear in Table A6, Appendix A (except for the means already shown in Figures 3 and 4).

The effects of primary interest are those depicted in Figures 3 and 4--(a) the contrast between humanities/social science students and biological/physical science students and (b) the main effect of student category. In the contrasts between H/S and B/P students, the 10 significant effects tended to be those that might be expected from inspection of Figure 3--namely, those for which the difference between groups H/S and B/P appeared most pronounced.

The effect of student category was significant in 13 cases. In interpreting these effects, it is useful to examine the results of the Tukey comparisons in Table 6. Generally, the significant comparisons were associated with cases in which Figure 4 showed extreme scores for certain groups. The category differences shown in Figure 4, as well as group differences shown in Figure 3, will be considered in the Discussion section.

Among other effects, two were significant for one-fourth of the passages or more. These are the effects of sex and region. First, concerning sex effects, adjusted scores were higher for males than females for Passages 3, 7, 13, 14, 17, and 19, but higher for females than males for Passages 4, 16, 18, and 20. (With adjusted scores, it is expected that the sex difference would be in one direction for some passages and in the other direction for others.) Examination of the major-field classification scheme in Appendix C shows no clearly identifiable difference between these two groupings of passages. Furthermore, the mean scores show that the sex differences for these passages, although significant, were relatively small. Perhaps a careful content analysis could identify aspects of these particular passages that might account for the sex differences. For the present purposes, sex served primarily as a control factor, showing that the principal effects of the study--the interactions involving student major-field area and passage type--were not due to confounding with students' sex.

The effect of region was significant for all but Passages 3, 6, and 19. Again, because adjusted scores were used, the effect for each passage reflects variability among regions with respect to the difference from average performance for each region. As seen in Appendix Table A6, the highest adjusted scores (or tied for highest adjusted scores) among regions were East and Southeast Asia: Passages 1, 9, 14, and 18; Europe: 4, 10, 11, and 20; Latin America: 5, 13, and 14; Middle East: 2, 7, 8, 12, and 17; and South Central Asia: 15, 16,

Table 5

Significant Effects in Analyses of Variance per Passage (Africa Excluded from Analyses)[a]

Passage No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Effect																					
Student Category (C)[b] (3)	—	—	—	7.57**	22.38**	4.39*	—	—	4.22*	4.32*	2.92	3.70	8.03**	13.56**	—	—	12.88**	6.40**	—	4.26*	4.53*
Sex (S) (1)	—	—	25.32**	5.32	—	—	4.07	—	—	—	—	—	8.58*	5.15	—	13.33**	7.61*	5.45	10.58*	6.45	—
C x S (3)	—	—	—	—	—	—	3.32	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Region (R) (4)	14.06**	3.59*	—	3.96*	24.88**	—	14.73**	4.50*	40.81**	6.58**	28.02**	41.77**	18.65**	10.85**	14.77**	14.92**	14.05**	35.36**	—	20.88**	23.95**
C x R (12)	—	—	—	—	—	—	1.79	—	—	—	—	—	2.21*	1.89	—	—	—	—	—	—	—
S x R (4)	—	—	—	—	—	—	4.01*	—		3.73*	5.92**	4.96**	—	—	—	—	—	—	—	—	—
C x S x R (12)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Contrast between H/S and B/P Students[c]	—	—	6.27	20.60**	34.44**	—	—	—	—	9.69*	—	—	13.45**	29.91**	6.23	—	28.69**	14.61**	—	11.21**	—
MS error	.065	.059	.068	.058	.088	.145	.058	.049	.050	.053	.067	.049	.043	.056	.041	.084	.053	.044	.052	.053	.076
df error	5532	5532	5532	5532	5532	5532	6506	6506	6506	6506	6506	9130	9130	9130	9130	9130	9015	9015	9015	9015	9015

[a] Entries are F values for effects.

[b] Student categories are humanities, social sciences, biological sciences, and physical sciences.

[c] H/S = humanities/social sciences; B/P = biological/physical sciences.

*p<.01; **p<.001; others, p<.05

Table 6

Significant Differences among Major-Field Categories in Tukey Comparisons for Each Passage

Passage Number	Passage Category	Comparison[a]	
1	S	S, P > B	
2	B	---	
3	S	---	
4	S	H > S, B, P	S > B, P
5	B	B > H, S, P	
6	P	P > H	
7	P	B > S, P	P > S
8	S	P > H, S	
9	B	H, B > S, P	
10	H	S > B, P	H > B
11	H	S > B, P	
12	B	B > H, S, P	
13	S	H, S > B, P	
14	P	B, P > H, S	
15	S	H, S > B	
16	S	---	
17	P	B, P > H, S	S > H
18	H	H > S, B, P	
19	S	S > H, B, P	
20	H	H > S, B, P	S > B, P
21	B	B > H, S, P	

[a]H = humanities students; S = social science students; B = biological science students; P = physical science students. Entries indicate cases in which the adjusted scores of one or more student categories were significantly greater than the adjusted scores of one or more other student categories.

and 21. The basis for these regional differences is difficult to determine without a comprehensive content analysis.

Other significant effects shown in Table 5 were found for only a small number of passages.

Analyses Involving Specific Major Fields

In the analyses reported thus far, comparisons were made at the level of groups or categories of major fields. In a final set of analyses, the specific major field to which each passage related was identified (here called the "target field"), and the interaction was determined between (a) passage type and (b) target field vs. other fields. For example, if a passage was classified as involving temperature and pressure--topics associated with physics--then students of physics (the target field) might be expected to perform better on this passage than students in other major fields, compared with their performance on other passages.

There were 14 passages for which the test-development specialists placed the passages in categories that related to single major fields (the other passages related to more than one major field). In 7 of those 14 cases, the number of students exceeded 50; in the remaining cases, the number of students was too small for the analyses to yield meaningful results.

For each of the seven passages for which analyses were appropriate, the judged subject matter of the passage, the target field, and the number of students in the target field were as follows:

Passage	Subject Matter	Target Field	Number of Students
Passage 9:	animal behavior	biology and zoology	N = 56
Passage 10:	architecture	architecture	N = 143
Passage 12:	animal behavior	biology and zoology	N = 116
Passage 13:	history	history	N = 62
Passage 14:	temperature and pressure	physics	N = 432
Passage 18:	fine arts	fine arts	N = 62
Passage 19:	law	law	N = 140

For each of the seven passages, analyses of variance were performed in which the independent factors were major field and sex. (Region could not be included as a factor because there were too few subjects to permit further subdivision of the cells in the analyses.) The dependent variable was the adjusted score on the passage.[5]

Three sets of analyses were performed. In SET I, students in the target field were compared with students in all other fields in the same major-field category (e.g., students in physics were compared with students in the other physical sciences). This comparison comprised the student-field factor in the analysis. In SET II, the student-field factor was the comparison between students in the target field and students in the other major-field category in the same group (e.g., students in physics were compared with all students in the biological sciences). In SET III, the student-field factor was a comparison between students in the target field and students in the opposite major-field group (e.g., students in physics were compared with students in the humanities and social sciences). Significant effects in these analyses are presented in Table 7. Means corresponding to these effects appear in Table A7 in Appendix A.

The results of principal interest are the effects involving the first factor, students' major field. The study's hypothesis tended to be borne out in the data, as the adjusted score for the target field generally exceeded that for the other groups with which it was compared. A significant difference in this direction was observed for three passages in analysis SET I, four passages in SET II, and five passages in SET III. These analyses thus provide further support for the notion that students specializing in the content area covered by a reading passage perform better than students specializing in other areas (controlling for group differences in overall reading proficiency).

In several cases a main effect of sex was also observed. Adjusted scores were higher for males than females on Passage 13 (history) in all three analyses, Passage 10 (architecture) in Set II,

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[5]The analysis could also have been conducted using the difference between performance on the target passage and the mean of the other passages in the test form containing the target passage. However, it was decided that the adjusted score--the difference between score on the target passage and all passages in the pertinent test form (which included the target passage)--would be convenient to use and would yield results that would not differ substantially from those obtained in the analyses just described; the tests would simply be more conservative.

Table 7

Significant Effects in Analyses Involving Specific Major Fields[a]

Effect and df	Passage 9	Passage 10	Passage 12	Passage 13	Passage 14	Passage 18	Passage 19
ANALYSIS SET I							
Student Field (F)(1)	--	--	--	7.14*	6.98*	--	9.90*
Sex (S)(1)	6.71*	--	--	9.09*	--	--	--
FxS (1)	--	--	--	--	--	--	--
MS error	.056	.055	.048	.043	.058	.046	.051
df error	801	639	1398	3011	4735	647	2745
ANALYSIS SET II							
F	--	--	--	7.10*	6.79*	5.15	11.22**
S	12.55**	19.53**	9.39*	10.73*	--	10.20*	--
FxS	--	--	--	--	--	--	--
MS error	.052	.053	.049	.043	.058	.044	.052
df error	3712	3359	6137	3763	6137	3396	3396
ANALYSIS SET III							
F	--	8.78*	--	19.40**	51.87**	6.58	17.16**
S	27.56**	--	--	12.81**	9.46*	8.17*	--
FxS	--	--	--	--	--	--	--
MS error	.053	.053	.056	.045	.057	.047	.052
df error	3415	3855	3879	6199	4195	5979	6057

[a]Entries are F values for effects.

*p<.01; **p<.001; others p<.05

and Passage 14 (physics) in Set III; adjusted scores were higher for females than males on Passage 9 (biology and zoology) in all three analyses, Passage 18 (fine arts) in Sets II and III, and Passage 12 (biology and zoology) in Set II. Without a comprehensive content analysis, interpretation of such sex effects would be premature. Perhaps more notable, however, is that in no case was there a significant interaction between sex and major field. This shows that effects of principal interest here--the major-field effects--were not attributable to students of one sex alone, nor were they substantially more pronounced for students of one sex than the other.

DISCUSSION

An interaction was observed between the students' major-field groups and the text content in determining reading performance. As seen in Figures 1 and 2, students in the humanities/social sciences outperformed students in the biological/ physical sciences on text related to the former major-field group, whereas the reverse was true for text related to the latter group. The effect was significant for Test Forms 1, 3 and 4, and in the same direction for Form 2.

These data thus provide convincing evidence for the hypothesis that students' reading performance is affected by the combination of their major-field area and the nature of the passages to be read. In supporting the hypothesis, the study tended to confirm a belief expressed by the authors of the reports reviewed earlier but not supported to their satisfaction in their own research. And by demonstrating the effect with a relatively large population of students taking operational TOEFLs, the study showed that the effect is quite reliable and pertains to both sexes and to students from all world regions.

Although statistically reliable, however, the effects can be seen to be of relatively small magnitude when expressed on the TOEFL scale. That the effects were not more sizable is believed to be due to the fact that TOEFL reading passages are taken from general sources and not from specialized textbooks. This study thus contrasts with studies whose main focus was the testing of English for specific purposes (ESP), such as Brown (1982) and Erickson and Molloy (1983). In the typical ESP study, technical materials in a field such as engineering are compared with nontechnical materials, where the technical materials are generally taken from textbooks in that field. Thus, in such studies, students with experience in the target field should substantially outperform other students. However, with the TOEFL, each passage is classified as involving the natural sciences or another area, but the information contained therein apparently is sufficiently general in nature that it can be understood by students in all intended major fields. The small (albeit statistically significant) effects observed in the present study indicate that a slight edge is provided to students of a given area of specialization when the reading passages contain terminology and concepts dealing with that particular area. And, although those effects should be borne in mind when practical test development decisions are made (see Practical Implications, below), the effects are not nearly of the same order of magnitude as those that might be expected if the materials were taken from highly specialized textbooks.

By looking at the effects for individual passages (Figure 3 and contrast effects in Table 5) and by examining the passages themselves (Appendix C), it is possible to see what kinds of text materials made

the largest contributions to the observed interactions between types of students and passage content.[6]

Among the passages that yielded significant student-group effects, those that tended to favor the biological/physical science students were Passages 5, 14, and 17. Inspection of these passages shows that each of them contained technical content related to the natural sciences: mechanisms underlying disease processes, convective flow of fluids, and extraction of minerals. It is not surprising, then, that these passages would tend to favor students of the natural sciences, as they dealt with concepts and terminology with which such students would be more familiar than would students of the humanities and social sciences.

Passages that tended to favor the humanities/social science students were Passages 3, 4, 10, 13, 15, 18, and 20. In four of those passages--3, 10, 13, and 15--humanities and social science students showed about equal performance, whereas in the other three cases--Passages 4, 18, and 20--humanities students were favored over social science students (as well as other categories). Of particular interest are the last three passages. It is perhaps not surprising that these passages tended to favor students of the arts and humanities, given the concepts discussed therein: rhythm in literature and music (Passage 4), Max Weber's style of artistic expression (Passage 18), and Constance Fenimore Woolson's literary style (Passage 20). Discussions of ESP teaching and testing often draw a distinction between "general" and "technical" material, where the latter term is typically used in connection with the natural sciences. It is clear, however, that a reading test can contain materials that are "technical" with respect to areas other than the natural sciences as well--in this case, the arts and humanities.

A few additonal observations are in order about the effects for the four major-field categories, shown in Figure 4. For 13 of the 21 passages, or nearly two-thirds, the student category for which the adjusted score was highest or tied for highest was the same as the category of the passage in question. In six of the remaining eight cases, the highest adjusted score was observed for the major-field category in the same group (H/S or B/P) as that of the passage in question. These results further demonstrate the validity of the hypothesis that student major-field area interrelates with text content in determining reading performance. The results are also consistent with (although the study does not directly test) the assumption that the four major-field categories can reasonably be

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[6]It must be remembered that Figure 3 presents adjusted scores, which reflect a group's deviation from its own average score on all passages in a test form.

regarded as falling into the two groups, humanities/social sciences, and biological/physical sciences.

Analyses also examined the role of a student's specific major field for those passages that were linked to specific fields and for which the sample sizes were adequate (seven passages in all). The results showed that in three cases students in the specific field in question--or "target" field--outperformed students in the same major-field category. In four cases, students in the target field outperformed students in the other major-field category within the same major-field group. And in five cases, students in the target field outperformed students in the opposite major-field group. Thus, there are passages that tend to favor students in the specific major fields related to those passages. Given that the number of significant effects increased across the three analyses just described, there is a suggestion (albeit tentative without a more comprehensive test) that the degree of difference between the target field and the group of fields against which it is compared is a factor in determining the likelihood of observing a significant effect.

Some final remarks are in order about the present results. First, it must be stressed that the present effects were obtained for graduate school applicants only, and it is not known what kinds of results would be observed for undergraduate applicants. The effects presumably would not be as great for the latter students, as these students would not yet have begun to specialize in particular areas of study.

Second, the observed effects likely are not due to differences between passage types in the kinds of questions asked (e.g., main idea, supporting detail, inference), since the balance of question types was roughly the same for the four major-field categories.

Third, while the emphasis here was on content, text style may also be an important factor. For example, Passage 20 (regarding Constance Fenimore Woolson) may have favored humanities students partly because of the literary style in which the passage is written. The extent to which text style played a role is unknown, however, as an extensive analysis of the passages would be required before conclusions could be drawn in this regard. This could be a valuable activity for further research.

Fourth, an occasional test question may favor students in a given major-field area simply because many such students already know the answer from their previous reading. The more material students have read in a given area of specialization, the more likely they are to have acquired the factual information covered in a reading passage related to that area.

Fifth, the observations offered above about specific passages were post hoc. Although these passages were said to be characterized

according to their degree of technical content, it cannot be inferred that there was necessarily a relation between amount of technical content in a passage and the magnitude of the group difference on the passage. As noted below under Practical Implications, a valuable activity for further research would be to have test development specialists judge the technical content of TOEFL passages by inspection and, then, to determine the relation between judged degree of technical content and observed group difference on the passages.

Finally, although the study demonstrated an interrelation between student major-field area and text content, the cognitive and motivational bases for these effects cannot be separated. When students read new material in their area of specialization, current theory suggests that the presence of a well-developed schema (i.e., a relevant knowledge base) allows the students to assimilate the new information with relative ease. The effects of schemata need not, however, have to do solely with cognitive aspects of knowledge acquisition; they may involve motivational and emotional factors as well. Students may be more interested in reading passages that relate to their own area of specialization and, thus, be more motivated to do so. They may also feel more self-assured when reading materials in their own area, as they may think that materials in other areas cannot be easily read without a knowledge base in those areas. In short, even if a passage can be easily read without background knowledge in the area to which the passage relates, students who have studied in that area may still be at an advantage. They have developed a knowledge base to which the new information can be readily assimilated and, as a result, they may be motivationally as well as cognitively more receptive to that information.

Practical Implications

By showing that students' major-field group and text content interact in determining reading performance, the study demonstrates the validity of a key assumption underlying construction of the TOEFL Reading Comprehension section--namely, that it is desirable to seek a balance of reading passages in the two principal major-field groups: humanities/social sciences, and biological/physical sciences.

At the same time, it is important to bear in mind that the interaction effect was relatively small in practical terms. The advantage that would be given to one group over another as a result of administering a test with all humanities/social science passages vs. a test with all biological/physical science passages translates into only a few points on the TOEFL scale. Thus, the consequences of failing to balance passage content adequately may not be substantial, particularly since TOEFL passages are taken from general reading materials that are designed to be understood by all examinees.

But even though TOEFL passages are taken from general reading materials, there are still passages that show a greater tendency than others to favor students in a particular major-field group. These are passages that are believed to contain somewhat technical concepts and terminology in the major-field area of the students who show better performance. It could be of value to focus particularly on these more technical passages when constructing the test. Given the objective of balancing the test by content, it would seem desirable to ensure that a passage that is relatively technical with regard to one major-field group be offset with one that is relatively technical with regard to the other major-field group.

Whether this last suggestion is feasible depends, of course, on whether mere inspection of a passage is enough to determine how technical it is. A content analysis addressing this issue would be a useful activity for further research. Test development specialists could judge the degree of technical content of reading passages. Then, to test the effectiveness of the judges' ratings, it would be possible to determine whether the rating for a given passage is associated with the degree to which the passage favors students in the expected major-field group. A strong relationship would suggest that it is indeed possible, on visual inspection alone, to identify passages that are more likely than others to favor one major-field group over another.

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Appendix A

Supplementary Tables

Table A1

Number of Students in Each Subgroup Defined by Major-Field Category, Sex, and Region[a]

	Humanities		Social Sciences		Biological Sciences		Physical Sciences	
	M	F	M	F	M	F	M	F
Form 1								
Africa (excl. N. Africa)	13	3	81	27	38	20	58	7
East and S.E. Asia	124	128	654	345	131	118	647	155
Europe	46	73	238	85	37	37	175	30
Latin America	27	28	158	95	80	35	171	35
Middle East (& N. Africa)	40	19	123	46	50	25	236	26
South Central Asia	14	22	289	72	97	53	744	64
Form 2								
Africa (excl. N. Africa)	16	5	79	37	42	8	49	5
East and S.E. Asia	148	208	868	523	153	148	962	212
Europe	40	47	229	96	27	20	165	28
Latin America	31	21	143	63	56	27	156	26
Middle East (& N. Africa)	24	20	120	35	71	19	211	29
South Central Asia	20	38	316	109	114	63	895	65
Form 3								
Africa (excl. N. Africa)	26	4	111	25	56	16	85	4
East and S.E. Asia	235	196	1043	639	490	306	2299	609
Europe	42	76	220	93	44	32	187	31
Latin America	20	27	136	68	70	41	129	25
Middle East (& N. Africa)	26	21	141	55	58	28	292	28
South Central Asia	26	15	276	72	136	59	814	65
Form 4								
Africa (excl. N. Africa)	8	2	47	14	24	11	39	2
East and S.E. Asia	214	228	1037	682	431	304	2412	603
Europe	32	43	173	76	28	27	148	32
Latin America	12	15	86	44	46	20	123	18
Middle East (& N. Africa)	18	9	97	38	59	15	210	24
South Central Asia	29	23	329	85	93	58	1046	88

[a]Excluded are (a) United States and possessions (8/10 of 1% of total sample), (b) the remainder of North America except Latin American region (1/4 of 1% of sample), (c) Oceania (1/5 of 1% of sample), and (d) students who failed to indicate their native countries (2.3% of sample).

Table A2

Means Associated with Significant Effects In Table 3 (Contrast between Humanities/Social Science and Biological/Physical Science Passages as Dependent Variable)

Student Group Effects	Form 1			Form 3			Form 4		
	H/S Pass.[a]	B/P Pass.	diff.[b]	H/S Pass.	B/P Pass.	diff.	H/S Pass.	B/P Pass.	diff.
Hum./Soc. Sci. Students	1.148	1.046	.102	.994	1.330	-.336	1.198	1.132	.066
Biol./Phys. Sci. Students	1.122	1.061	.060	.946	1.344	-.398	1.148	1.157	-.009

Sex Effects	Form 1			Form 4		
	H/S Pass.	B/P Pass.	diff.	H/S Pass.	B/P Pass.	diff.
Males	1.138	1.051	.087	1.171	1.165	.007
Females	1.125	1.064	.062	1.152	1.103	.050

Region Effects	Form 1			Form 2			Form 3			Form 4		
	H/S Pass.	B/P Pass.	diff.	H/S Pass.	B/P Pass.	diff.	H/S Pass.	B/P Pass.	diff.	R/S Pass.	B/P Pass.	diff.
Africa (excl. N. Africa)	1.137	1.041	.095	1.052	1.262	-.210	.957	1.345	-.388	1.182	1.134	.049
East & S.E. Asia	1.095	.986	.109	.962	1.210	-.248	.928	1.326	-.398	1.114	1.085	.029
Europe	1.270	1.197	.073	1.224	1.346	-.122	1.143	1.410	-.268	1.345	1.303	.042
Latin America	1.158	1.109	.049	1.085	1.218	-.133	1.008	1.386	-.378	1.246	1.198	.048
Middle East (& N. Africa)	.999	.921	.078	.900	1.141	-.241	.834	1.291	-.457	1.056	1.033	.022
South Central Asia	1.175	1.127	.047	1.199	1.320	-.120	1.067	1.358	-.291	1.296	1.332	-.036

Student Group x Region Effect (Form 3)	H/S Students			B/P Students		
	H/S Pass.	B/P Pass.	diff.	H/S Pass.	B/P Pass.	diff.
Africa (excl. N. Africa)	.939	1.324	-.385	.976	1.367	-.391
East & S.E. Asia	.964	1.315	-.352	.907	1.332	-.425
Europe	1.145	1.395	-.250	1.140	1.434	-.294
Latin America	.999	1.360	-.361	1.016	1.411	-.395
Middle East (& N. Africa)	.855	1.255	-.400	.821	1.312	-.491
South Central Asia	1.103	1.371	-.268	1.054	1.353	-.300

Sex x Region Effect (Form 2)	Males			Females		
	H/S Pass.	B/P Pass.	diff.	H/S Pass.	B/P Pass.	diff.
Africa (excl. N. Africa)	1.045	1.257	-.212	1.075	1.281	-.206
East & S.E. Asia	.966	1.205	-.239	.953	1.218	-.264
Europe	1.239	1.349	-.110	1.189	1.339	-.150
Latin America	1.096	1.223	-.127	1.054	1.204	-.150
Middle East (& N. Africa)	.876	1.134	-.258	1.001	1.169	-.169
South Central Asia	1.188	1.310	-.122	1.257	1.366	-.110

[a] Data shown for humanities/social science (H/S) passages and biological/physical science (B/P) are means of arcsin transformed scores.

[b] Each entry under "diff." is difference between mean for humanities/social science passages and mean for biological/physical science passages.

Table A3

Means Associated with Significant Effects in Table 4
(Overall Performance as Dependent Variable)[a]

Sex Effect (Form 2)	Males: 1.132	Females: 1.122		
Region Effects	**Form 1**	**Form 2**	**Form 3**	**Form 4**
Africa (excl. North Africa)	1.089	1.136	1.112	1.163
East and S. E. Asia	1.040	1.061	1.087	1.103
Europe	1.233	1.273	1.250	1.328
Latin America	1.134	1.138	1.159	1.227
Middle East (& North Africa)	.960	.996	1.017	1.047
South Central Asia	1.151	1.247	1.183	1.311

Student Group x Region Effects	Form 2		Form 3	
	H/S Stds.[b]	B/P Stds.	H/S Stds.	B/P Stds.
Africa (excl. North Africa)	1.104	1.178	1.093	1.133
East and S. E. Asia	1.070	1.050	1.104	1.077
Europe	1.276	1.269	1.245	1.257
Latin America	1.134	1.143	1.144	1.174
Middle East (& North Africa)	.995	.997	1.015	1.018
South Central Asia	1.301	1.225	1.210	1.174

Sex x Region Effects	Form 1		Form 2		Form 3		Form 4	
	Males	Females	Males	Females	Males	Females	Males	Females
Africa (excl. North Africa)	1.098	1.060	1.129	1.158	1.116	1.092	1.165	1.153
East and S. E. Asia	1.037	1.045	1.062	1.059	1.092	1.075	1.113	1.078
Europe	1.247	1.203	1.283	1.249	1.255	1.238	1.342	1.299
Latin America	1.143	1.113	1.147	1.114	1.171	1.133	1.238	1.195
Middle East (& North Africa)	.949	1.003	.979	1.068	1.013	1.033	1.033	1.110
South Central Asia	1.143	1.195	1.237	1.300	1.176	1.227	1.299	1.381

[a] Data shown are means of arcsin transformed scores.

[b] H/S Stds. = humanities and social science students; B/P Stds. = biological and physical science students.

Table A4

Raw Mean Score (with N and SD) for Each Passage, Broken Down by Student Major-Field Groups[a]

	Passage Number	Passage Group[b]	Humanities/Social Science Students		Biological/Physical Science Students	
			Mean	SD	Mean	SD
			(N=2914)		(N=3245)	
Test Form 1	1	H/S	.840	.186	.830	.183
	2	B/P	.853	.198	.852	.191
	3	H/S	.766	.243	.758	.236
	4	H/S	.675	.263	.651	.255
	5	B/P	.589	.322	.621	.319
	6	B/P	.586	.347	.594	.342
			(N=3363)		(N=3716)	
Test Form 2	7	B/P	.903	.185	.911	.171
	8	H/S	.796	.211	.806	.207
	9	B/P	.732	.235	.730	.234
	10	H/S	.700	.265	.675	.268
	11	H/S	.597	.307	.580	.302
			(N=3767)		(N=5141)	
Test Form 3	12	B/P	.965	.109	.959	.113
	13	H/S	.814	.207	.770	.219
	14	B/P	.766	.241	.800	.206
	15	H/S	.623	.261	.597	.256
	16	H/S	.519	.320	.494	.299
			(N=3400)		(N=5921)	
Test Form 4	17	B/P	.868	.194	.895	.173
	18	H/S	.863	.176	.846	.178
	19	H/S	.775	.208	.753	.208
	20	H/S	.758	.255	.708	.252
	21	B/P	.612	.297	.612	.290

[a]Data shown are means and standard deviations of raw scores.

[b]H/S = humanities/social sciences; B/P = biological/physical sciences.

Table A5

Raw Mean Score (with N and SD) for Each Passage, Broken Down by Student Major-Field Categories[a]

	Passage Number	Passage Category[b]	Humanities Students Mean	Humanities Students SD	Social Science Students Mean	Social Science Students SD	Biological Science Students Mean	Biological Science Students SD	Physical Science Students Mean	Physical Science Students SD
			N=570		N=2344		N=783		N=2462	
Test Form 1	1	S	.800	.214	.849	.178	.815	.180	.835	.183
	2	B	.835	.202	.857	.197	.844	.196	.855	.190
	3	S	.733	.260	.774	.239	.743	.237	.763	.235
	4	S	.671	.275	.676	.260	.639	.246	.655	.258
	5	B	.548	.324	.598	.320	.672	.317	.605	.318
	6	P	.537	.356	.597	.344	.565	.340	.603	.343
			N=643		N=2720		N=805		N=2911	
Test Form 2	7	P	.880	.203	.908	.179	.916	.167	.910	.172
	8	S	.764	.228	.804	.206	.790	.211	.810	.206
	9	B	.713	.245	.737	.233	.732	.243	.730	.231
	10	H	.661	.275	.710	.262	.662	.272	.679	.267
	11	H	.547	.320	.608	.302	.569	.304	.583	.301
			N=752		N=3015		N=1402		N=4739	
Test Form 3	12	B	.957	.125	.967	.104	.964	.103	.957	.116
	13	S	.797	.229	.818	.201	.763	.222	.772	.218
	14	P	.747	.262	.770	.235	.794	.211	.802	.204
	15	S	.617	.279	.625	.257	.580	.256	.602	.255
	16	S	.516	.322	.520	.320	.482	.298	.498	.300
			N=651		N=2749		N=1128		N=4793	
Test Form 4	17	P	.830	.216	.876	.188	.884	.181	.897	.171
	18	H	.862	.180	.864	.175	.837	.185	.848	.176
	19	S	.738	.226	.784	.203	.740	.218	.756	.206
	20	H	.747	.269	.761	.251	.699	.261	.711	.250
	21	B	.582	.300	.619	.296	.647	.281	.604	.291

[a]Data shown are means and standard deviations of raw scores.

[b]H = humanities; S = social sciences; B = biological sciences; P = physical sciences.

Table A6

Means Associated with Significant Effects in Table 5[a]

Sex Effects	Pass. 3	Pass. 4	Pass. 7	Pass. 13	Pass. 14	Pass. 16	Pass. 17	Pass. 18	Pass. 19	Pass. 20
Males	.066	-.096	.274	.061	.073	-.320	.209	.110	-.030	-.072
Females	.016	-.075	.269	.050	.054	-.298	.150	.134	-.038	-.038

Student Category x Sex Effect (Passage 7)	Humanities Students		Social Science Students		Biological Science Students		Physical Science Students	
	M	F	M	F	M	F	M	F
	.299	.250	.255	.266	.319	.285	.277	.281

Region Effects		East & S. E. Asia	Europe	Latin America	Middle East (& N. Africa)	South Central Asia
Passage No.	1	.192	.095	.103	.188	.142
	2	.217	.178	.166	.237	.179
	4	-.075	-.045	-.093	-.126	-.123
	5	-.212	-.091	-.078	-.195	-.103
	7	.291	.228	.284	.343	.227
	8	.054	.042	.075	.096	.094
	9	.006	-.082	-.125	-.054	-.083
	10	-.097	-.057	-.064	-.122	-.075
	11	-.254	-.131	-.171	-.263	-.163
	12	.391	.289	.368	.478	.344
	13	.038	.117	.131	.085	.071
	14	.086	.032	.086	.071	.005
	15	-.190	-.182	-.223	-.253	-.168
	16	-.326	-.257	-.361	-.380	-.252
	17	.201	.147	.176	.257	.167
	18	.149	.081	.105	.084	.027
	20	-.081	.027	-.016	-.078	-.036
	21	-.235	-.198	-.233	-.284	-.124

(cont.)

Table A6 (continued)

Student Category x Region Effects	Passage 7				Passage 13			
	Hum. Stds.[b]	Soc. Sci. Stds.	Biol. Sci. Stds.	Phys. Sci. Stds.	Hum. Stds.	Soc. Sci. Stds.	Biol. Sci. Stds.	Phys. Sci. Stds.
East & S.E. Asia	.277	.282	.331	.296	.066	.074	.012	.020
Europe	.232	.215	.224	.250	.141	.127	.093	.098
Latin America	.312	.288	.268	.280	.103	.126	.128	.148
Middle East (& N. Africa)	.347	.291	.403	.354	.100	.132	.039	.067
South Central Asia	.205	.190	.252	.241	.048	.077	.051	.075

Student Category x Region Effects	Passage 14			
	Hum. Stds.	Soc. Sci. Stds.	Biol. Sci. Stds.	Phys. Sci. Stds.
East & S.E. Asia	.018	.038	.115	.117
Europe	.002	.016	.080	.055
Latin America	.095	.057	.126	.092
Middle East (& N. Africa)	.024	.009	.084	.112
South Central Asia	.000	-.001	.000	.009

Sex x Region Effects	Passage 7		Passage 10		Passage 11		Passage 12	
	M	F	M	F	M	F	M	F
East & S.E. Asia	.295	.283	-.086	-.119	-.261	-.239	.384	.408
Europe	.218	.253	-.048	-.080	-.126	-.143	.280	.308
Latin America	.229	.298	-.066	-.058	-.157	-.210	.364	.376
Middle East (& N. Africa)	.357	.287	-.121	-.123	-.282	-.185	.477	.482
South Central Asia	.232	.204	-.081	-.048	-.167	-.143	.352	.299

[a]Data shown are means of adjusted transformed scores. Means for effects of student category are omitted here as they are shown in Figure 4; means for effects of the contrast between H/S and B/P students are also omitted here, as they are shown in Figure 3.

[b]Stds. = students

Table A7

Means Associated with Analyses of Specific Major-Field Effects[a]

Passage Number, Target Field of Passage, and N in Target Field	Students in Target Field			Remainder of Group Containing Target Field (Analysis Set I)			Other Category in Same Group as Target Field (Analysis Set II)			Opposite Major-Field Group (Analysis Set III)		
	M	F	Total	M	F	Total	M	F	Total	M	F	Total
9 Biology and Zoology (N=56)	-.043	.004	-.025	-.041	.003	-.024	-.048	-.014	-.041	-.059	-.016	-.043
10 Architecture (N=143)	-.047	-.031	-.043	-.079	-.103	-.094	-.058	-.096	-.073	-.100	-.104	-.101
12 Biology and Zoology (N=116)	.377	.443	.404	.406	.407	.406	.382	.402	.386	.373	.383	.377
13 History (N=62)	.147	.182	.159	.097	.072	.089	.096	.072	.088	.048	.024	.043
14 Physics (N=432)	.124	.100	.119	.086	.094	.087	.087	.091	.088	.035	.011	.027
18 Fine Arts (N=62)	.216	.164	.188	.149	.156	.153	.113	.138	.123	.106	.126	.110
19 Law (N=140)	.038	.066	.044	-.016	-.024	-.019	-.019	-.030	-.023	-.034	-.045	-.036

[a]Data shown are means of adjusted transformed scores, presented for both sexes and total group in each case.

Appendix B

Major Fields in Each of the Four Categories

HUMANITIES
- Archaeology
- Architecture
- Art History
- Classical Languages
- Comparative Literature
- Dramatic Arts
- English
- Far Eastern Languages and Literature
- Fine Arts, Art, Design
- French
- German
- Linguistics
- Music
- Near Eastern Languages and Literature
- Philosophy
- Religious Studies or Religion
- Russian
- Spanish
- Speech
- Other foreign languages
- Other humanities

SOCIAL SCIENCES
- American Studies
- Anthropology
- Business and Commerce
- Communications
- Economics
- Education (including M.A. in teaching)
- Educational Administration
- Geography
- Government
- Guidance and Counseling
- History
- Industrial Relations and Personnel
- International Relations
- Journalism
- Law
- Library Science
- Physical Education
- Planning (City, Community Urban, Regional)
- Political Science
- Psychology, Clinical
- Psychology, Educational
- Psychology, Experimental/ Developmental
- Psychology, Social
- Psychology, other
- Public Administration
- Social Work
- Sociology
- Other social sciences

BIOLOGICAL SCIENCES
- Agriculture
- Anatomy
- Audiology
- Bacteriology
- Biochemistry
- Biology
- Biomedical Sciences
- Biophysics
- Botany
- Dentistry
- Entomology
- Forestry
- Genetics
- Home Economics
- Hospital and Health Services Administration
- Medicine
- Microbiology
- Molecular and Cellular Biology
- Nursing
- Nutrition
- Occupational Therapy
- Pathology
- Pharmacy
- Physical Therapy
- Physiology
- Public Health
- Speech-Language Pathology
- Veterinary Medicine
- Zoology
- Other biological sciences

PHYSICAL SCIENCES
- Applied Mathematics
- Astronomy
- Chemistry
- Computer Sciences
- Engineering, Aeronautical
- Engineering, Chemical
- Engineering, Civil
- Engineering, Electrical
- Engineering, Industrial
- Engineering, Mechanical
- Engineering, other
- Geology
- Mathematics
- Metallurgy
- Oceanography
- Physics
- Statistics
- Other physical sciences

Appendix C

Reading Passages Used in the Study

Test Form 1

Passage 1

3 • 3 • 3 • 3 • 3 • 3 • 3

Questions 31-35

When Christopher Columbus landed in the New World, the North American continent was an area of astonishing ethnic and cultural diversity. North of the Rio Grande, which now marks the border between the United States and Mexico, was a population of over 12 million people representing approximately 400 distinct cultures, 500 languages, and a remarkable variety of political and religious institutions and physical and ethnic types. Compared to the Europeans, the Indian peoples were extraordinarily heterogeneous, and they often viewed the Europeans as just another tribe.

These varied tribal cultures were as diversified as the land the Indians inhabited. In the high plains of the Dakotas, the Mandan developed a peaceful communal society centered around agriculture. Only a few hundred miles away, however, in northwestern Montana, the Blackfeet turned from agriculture and began to use horses, which had been introduced by the Spaniards. As skilled riders they became hunters and fighters and developed a fierce and aggressive culture centered around the buffalo. In the eastern woodlands surrounding the Great Lakes, the Potawatomis were expert fishermen, canoe builders, and hunters. In the Northeast the six Iroquois nations were among the most politically sophisticated people in the world, forming the famed Iroquois Confederation, which included the Senecas and the Mohawks. This confederation, with its system of checks and balances, provided a model for the United States Constitution.

31. About how many different cultures existed among the fifteenth-century North American Indians?

    (A) 400
    (B) 500
    (C) 600
    (D) 1,200

32. The Mandan tribes could best be classified as

    (A) hunters
    (B) warriors
    (C) farmers
    (D) fishermen

33. Before the introduction of horses, the Blackfeet tribes were

    (A) peaceful farmers
    (B) aggressive hunters
    (C) fierce warriors
    (D) skillful sailors

34. It can be inferred from the passage that the life-styles of the various American Indian tribes were influenced most by which of the following?

    (A) Contact with other tribes
    (B) Environmental resources
    (C) Contact with Europeans
    (D) Governmental organization

35. According to the passage, how was the organization of the Iroquois Confederation a forerunner of the United States Constitution?

    (A) It was a union of smaller units.
    (B) It had a representative government.
    (C) Its form of government had a sophisticated way of selecting judges.
    (D) Its power was regulated by a system of checks and balances.

GO ON TO THE NEXT PAGE

Passage 2

Questions 36-40

The rattlers with which a rattlesnake warns of its presence are formed by loosely interlocking hollow rings of hard skin, which make a buzzing sound when its tail is shaken. As a baby, the snake begins to form its rattles from the button at the very tip of its tail. Thereafter, each time it sheds its skin, a new ring is formed. Popular belief holds that a snake's age can be told by counting the rings, but this is fallacious—a snake may lose its old skin as often as four times a year. Also, rattles tend to wear or break off with time.

36. According to the passage, a rattlesnake uses its rattles to
    (A) help it remove old skin
    (B) let other creatures know it is nearby
    (C) catch small animals for food
    (D) keep itself warm by providing insulation

37. A rattlesnake's rattles are made out of
    (A) skin
    (B) bone
    (C) wood
    (D) muscle

38. According to the passage, a snake's rattles develop only when the
    (A) snake sheds its skin
    (B) snake is fully mature
    (C) button on its tail is broken
    (D) snake shakes its tail

39. According to the passage, which of the following do many people believe to be true about the rattlesnake's rattles?
    (A) A snake sometimes takes them off in battle.
    (B) Snakes use them to communicate with each other.
    (C) A snake's age can be determined by the number of rings.
    (D) Young snakes must loosen them to make them buzz.

40. How often does a rattlesnake shed its skin?
    (A) Once every four months
    (B) Once every four years
    (C) Up to four times every year
    (D) Four times more often than other snakes

GO ON TO THE NEXT PAGE

Passage 3

3 • 3 • 3 • 3 • 3 • 3 • 3

Questions 41-45

During the American War of Independence, women were involved in the active fighting in three ways. First, as members of a distinct branch of the Continental Army, referred to as "Women of the Army," women staffed field hospitals and acted as military support in such roles as water carriers. In an emergency, women water carriers, who had plenty of opportunity to observe the firing of cannons, could replace a wounded comrade. The second way that women were involved in active fighting was as regular troop members who wore men's uniforms and fought side by side with their male counterparts. Theoretically, women were not supposed to be recruited into the Continental Army, but if a woman was a good soldier, no one made an issue of sex at a time when the army was so short of soldiers that boys not yet in their teens were also being recruited in violation of rules. Third, women were occasional fighters affiliated with local militia companies or committees of safety formed to protect the local community.

41. What is the main idea expressed in the passage?
    (A) Women played an important role in military hospitals during the Revolutionary War.
    (B) The Continental Army was successful in teaching women to fire cannons.
    (C) The services of women on committees of safety were crucial in winning the war.
    (D) Women were active in combat during the Revolutionary War.

42. Women sometimes fired cannons in battle because
    (A) they had observed the procedure and could therefore substitute for disabled men
    (B) local militia companies had trained them very carefully for emergency fighting
    (C) they had a better safety record than men for using weapons
    (D) it was against the law for young boys to fire weapons

43. What is probably the main reason that women were permitted to fight in the war even though their formal participation was discouraged?
    (A) Only women were successful as water carriers.
    (B) They were needed to make battle uniforms.
    (C) Colonial women were particularly healthy and strong.
    (D) The army desperately needed combat soldiers.

44. Women were involved in fighting the war for American independence in all of the following ways EXCEPT as
    (A) members of committees of safety
    (B) support personnel at medical facilities
    (C) recruiters of soldiers for the Continental Army
    (D) combat troops in the regular army

45. This passage would most probably be assigned reading for a course in what subject?
    (A) Nursing
    (B) History
    (C) Social Work
    (D) Labor Studies

GO ON TO THE NEXT PAGE

Passage 4

3 • 3 • 3 • 3 • 3 • 3 • 3

Questions 46-51

Rhythm in literature is a more or less regular occurrence of certain elements of writing: a word, a phrase, an idea, a pause, a sound, or a grammatical construction. We are also accustomed to this recurrence in the alternate heavy and light beats in music. Our love for rhythm seems to be innate: witness the responses of a small child to lively music. Children love to beat on toy drums or empty boxes. They stamp their feet and chant nursery rhymes or nonsense syllables, not unlike primitive dancers. As children grow older, they are taught to restrain their responses to rhythm, but our love of rhythm remains. We live in rhythms; in fact we are governed by rhythms.

Physiologically, we are rhythmical. We must eat, sleep, breathe, and play regularly to maintain good health. Emotionally we are rhythmical, too, for psychologists say that all of us feel alternate periods of relative depression and exhilaration. Intellectually we are also rhythmical, for we must have periods of relaxation following periods of concentration. It naturally follows then that rhythm, a fundamental aspect of our lives, must be a part of any good literary work--whether poetry or prose.

46. What is the main idea of the passage?
    (A) Rhythmic patterns in literature are helpful to physicians and psychologists.
    (B) Rhythmic patterns in literature are among the natural manifestations of rhythm in all facets of life.
    (C) Rhythm tends to be more accentuated in music than in poetry.
    (D) Rhythm tends to be more regular in literature than in other facets of life.

47. According to the passage, what is rhythm?
    (A) A regular occurrence of an action or response
    (B) A special kind of music
    (C) A kind of emotional disorder
    (D) A stage in the development of young children

48. According to the passage, an adult's reaction to rhythm in music would probably be
    (A) uninhibited
    (B) indifferent
    (C) restrained
    (D) responsible

49. It can be inferred from the passage that conscious thought plays the most significant part in creating
    (A) physiological rhythms
    (B) emotional rhythms
    (C) psychological rhythms
    (D) literary rhythms

50. According to the passage, which of the following pairs of activities best illustrates intellectual rhythm?
    (A) Studying a science book and then studying a psychology book
    (B) Learning a poem and then taking a nap
    (C) Playing ball at the beach and then going swimming
    (D) Solving a math problem and then solving a chemistry problem

51. What would the next paragraph probably discuss?
    (A) How to write poetry
    (B) How to understand rhythm in music
    (C) The kinds of rhythm found in good literature
    (D) The importance of rhythm in planning our lives

GO ON TO THE NEXT PAGE

Passage 5

3 • 3 • 3 • 3 • 3 • 3 • 3

Questions 52-56

The record of the past half century has established, I think, two general principles about human disease. First, it is necessary to know a great deal about underlying mechanisms before one can really act effectively; one had to know that the pneumococcus causes lobar pneumonia before one could begin thinking about antibiotics.

Second, for every disease there is a single key mechanism that dominates all the others. If one can find it, and think one's way around it, one can control the disorder. This generalization is harder to prove and arguable -- it is more like a strong hunch than a scientific assertion—but I believe that the record thus far tends to support it. The most complicated, multicell, multitissue, and multiorgan diseases I know are tertiary syphilis, chronic tuberculosis, and pernicious anemia. In each, there are at least five major organs and tissues involved, and each appears to be affected by a variety of environmental influences. Before they came under scientific appraisal, each was what we now call a "multifactorial disease." And yet, when all the necessary facts were in, it was clear that by simply switching off one thing—the spirochete, the tubercle bacillus, or a single vitamin deficiency—the whole array of disordered and seemingly unrelated pathological mechanisms could be switched off, at once.

52. What is the main idea of the passage?
    (A) Scientific appraisal shows that multifactorial diseases are often due in part to environmental conditions.
    (B) In the past half century, scientists have been able to find only a few principles that apply to all diseases.
    (C) Each disease has a single underlying mechanism that must be understood before the disease can be cured.
    (D) Many diseases that were once life-threatening can now be cured by antibiotics.

53. The author uses the example of lobar pneumonia to show that
    (A) understanding the cause of a disease precedes curing it
    (B) the record of the past half century is one of medical progress
    (C) antibiotics led to an understanding of underlying disease mechanisms
    (D) many diseases are now called multifactorial

54. What do the three diseases mentioned in the second paragraph have in common?
    (A) They have the same cause.
    (B) They affect several organs.
    (C) They affect the same area of the body.
    (D) They can be cured by antibiotics.

55. Which of the following diseases is caused by a vitamin deficiency?
    (A) Lobar pneumonia
    (B) Tertiary syphilis
    (C) Chronic tuberculosis
    (D) Pernicious anemia

56. The author of this passage is most probably
    (A) a historian
    (B) a doctor
    (C) a nutritionist
    (D) an environmentalist

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Passage 6

Questions 57-60

If robots ever come to enjoy a prominent place in the future, they may owe at least a small debt of gratitude to a "micromouse" named Moonlight Special. The micromouse is a robot rodent that can "feel" its way through a maze and memorize the correct path after two passes. On the third run through the maze, Moonlight Special can crawl from start to finish without bumping into a wall or making a wrong turn.

57. What is Moonlight Special?
    (A) A bionic mouse
    (B) A species of rodent
    (C) A small robot
    (D) An electronic game

58. What can the micromouse do?
    (A) Memorize a maze.
    (B) Construct maze variations.
    (C) Distinguish between two lights.
    (D) Remember one path out of two.

59. What will the micromouse do after two runs through a maze?
    (A) Run rather than crawl.
    (B) Alter its course.
    (C) Avoid turns and bumps.
    (D) Perform without errors.

60. From the passage, it can be inferred that in the future the micromouse could
    (A) reduce the need for robots
    (B) provide a new kind of robot memory
    (C) suggest new methods for traveling to the moon
    (D) decrease visual handicaps

THIS IS THE END OF SECTION 3

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON SECTION 3 ONLY.
DO NOT READ OR WORK ON ANY OTHER SECTION OF THE TEST.

Test Form 2

Passage 7

3 • 3 • 3 • 3 • 3 • 3 • 3

Questions 31-34

Climate, more than any other single factor, determines the distribution of life on Earth. Climatic boundaries establish the limits within which organisms can survive. Plants, even more than animals, must be well adapted to climate in order to survive. They cannot move about or take shelter but must be equipped to endure whatever weather conditions are likely to occur. In the harsh conditions of the tundra, for example, low growing mosses, lichens, and a few flowering plants all hug the ground for shelter from icy winds.

Animals, despite their ability to move about and find shelter, are just as much influenced by climate as plants are. Creatures such as the camel and the penguin are so highly specialized that they have an extremely limited distribution. Others, such as bears, are flexible enough to adapt to a broad range of climates. Ocean-dwelling organisms are just as sensitive to climatic changes—in this case temperature and salinity—as land animals. Reef corals can survive only in clear warm seawater. Certain foraminifers are so sensitive to changes in their environment that their presence can be taken as an index of sea temperature. Human beings are among the least specialized of all animals and can live almost anywhere. Their clothes and their homes act as a sort of "miniature climate" that can be taken with them everywhere.

31. According to the passage, plants on the tundra grow close to the ground
    (A) to avoid being eaten by arctic animals
    (B) because fertilizer is not readily available
    (C) to minimize exposure to the cold
    (D) because unfrozen water supplies are very scarce

32. According to the passage, which of the following can be found in the greatest number of different climate areas on Earth?
    (A) Reef corals
    (B) Penguins
    (C) Bears
    (D) Camels

33. It can be inferred from the passage that foraminifers are a
    (A) kind of weather pattern
    (B) form of sea life
    (C) species of tundra plant
    (D) type of miniature penguin

34. According to the passage, human beings can survive almost everywhere on Earth because
    (A) they have developed advanced forms of transportation
    (B) they have learned how to process seawater for drinking
    (C) their body temperature can vary considerably
    (D) their shelters and clothing help them to adapt to the environment

GO ON TO THE NEXT PAGE

Passage 8

3 • 3 • 3 • 3 • 3 • 3 • 3

Questions 35-40

Wood carving began as a necessity in America and developed into an art. Because of the lack of other materials, early settlers were forced to make tools and utensils out of wood. At first, these articles were whittled with a knife, but when pioneer craftsmen set up their primitive shops most of them were fashioned on a lathe—a machine which holds an object and rotates it while it is being shaped by a tool.

However, even after Massachusetts-born Thomas Blanchard designed a lathe which could turn irregular shapes—an innovation that made possible mass production of gunstocks, shoe lasts, oblong and square woodenware—craftsmen who could use knife and chisel skillfully were still in demand. Some found ready employment in shops of cabinetmakers and chairmakers, while others carved decoys. Still others specialized in creating shop signs, ship figureheads, or in decorating interior woodwork. A few even accepted commissions to make busts of prominent citizens.

35. This passage most likely came from a longer work about early American
    (A) arts and crafts
    (B) political leaders
    (C) logging industries
    (D) fashion design

36. According to the passage, the first settlers used wood for their utensils and tools because it was
    (A) durable
    (B) inexpensive
    (C) available
    (D) attractive

37. The passage suggests that the early shops for making tools were
    (A) not very sophisticated
    (B) known for doing very quick work
    (C) dependent on imported materials
    (D) frequented only by fashionable people

38. It can be inferred from the passage that, before Thomas Blanchard's invention, lathes
    (A) were not made of wood
    (B) could not produce square objects
    (C) were found only in cabinetmaking shops
    (D) could be used to make most tools and utensils

39. Which of the following objects was an important woodworking tool used by early American craftsmen?
    (A) A bust
    (B) A decoy
    (C) A figurehead
    (D) A chisel

40. According to the passage, when wooden articles began to be mass-produced, what did many individual woodworkers do?
    (A) They moved out of Massachusetts.
    (B) They found work making specialized items.
    (C) They made demands on government leaders.
    (D) They took jobs on ships as sailors.

GO ON TO THE NEXT PAGE

Passage 9

3 • 3 • 3 • 3 • 3 • 3 • 3

Questions 41-47

When a young short-toed treecreeper hatches from the egg, it is naked, blind, and helpless. At birth it weighs 0.8 gram. Its manifestations of life are wholly out of tune with its quest to achieve a weight of 8 to 9 grams as quickly as possible, the latter being the weight of an adult treecreeper. To achieve this end the fledgling must eat, and it must also be warmer than its environment. It gets food from its parents, but warmth from its mother alone. In all this the youngster does not do much of an active nature. On the first day it often stretches out of its own accord, raising its neck high and opening its beak. It also responds to the feeding calls of its parents, which are uttered only if the chick does not open up. During the first few days, the chick cannot see, but it can induce the parents to provide feedings by emitting a begging call.

Haartman (1953) took six of seven young pied flycatchers (relatives of the treecreeper) out of their nest. Since there was now only one chick in the nest, the parents were not as quick to provide frequent feedings. The other six chicks, now hungry, were then brought near the nest so that their parents could hear all seven even though they could see only one. At once the rate of attempted feedings doubled. The one chick in the nest could not handle this glut of food, naturally, so the parents ended up eating some of it themselves.

41. How many different types of birds are referred to in the passage?
    (A) One
    (B) Two
    (C) Six
    (D) Seven

42. In the passage, the author refers to a young bird as all of the following EXCEPT a
    (A) chick
    (B) fledgling
    (C) youngster
    (D) hatchling

43. According to the passage, which of the following is most important in satisfying the baby treecreeper's need for warmth?
    (A) The materials in the nest
    (B) The mother bird
    (C) The father bird
    (D) The baby bird's siblings

44. The purpose of the parent treecreeper's feeding calls is to
    (A) note the need for food
    (B) alert the babies to danger
    (C) increase the variety of food
    (D) get the baby to open its mouth

45. Which of the following helps newborn treecreepers to gain weight?
    (A) Begging noises
    (B) Low body temperature
    (C) Insulating feathers
    (D) Good vision

46. It can be inferred from the passage that the purpose of Haartman's experiment was to
    (A) study food deprivation in young birds
    (B) determine what makes birds select a nesting site
    (C) observe what stimulates parent birds to feed their young
    (D) test the eyesight of adult birds

47. It is most likely that the author is using these two paragraphs as
    (A) an introduction to a discussion of various kinds of birds
    (B) a broad description of bird development
    (C) a set of instructions for raising birds
    (D) specific examples of a preceding general statement about bird feeding

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Passage 10

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Questions 48-53

Unlike any earlier building complex anywhere in the world, Rockefeller Center in New York City was built, not as a place where people could live, but as a city in which they could work. It was the biggest building project of its kind, a city within a city, and the forerunner of projects that have sprung up all over the world. Thirty architects, 120 draftsmen, and hundreds of other artists and technicians were employed just to draft the plans. Before the buildings could be erected, 229 old buildings had to be emptied of 4,000 tenants and razed. Just to buy up the leases took over two years and cost over $6,000,000. The unusual shape and setbacks of the seventy-story RCA building resulted primarily from practical considerations such as lighting, the movement of people, and the building's services. The lower concourse and basement level were set aside for shops. A sunken plaza, complete with gardens and fountains, was designed to provide access to these shops. Today the plaza, which is used for ice-skating in winter and dining and dancing in summer, is one of the center's most popular attractions.

48. What is the main idea of the passage?
    (A) The importance of a pleasant work environment
    (B) The purpose of the RCA building setbacks
    (C) The recreational facilities at Rockefeller Center
    (D) The architectural significance of Rockefeller Center

49. According to the passage, Rockefeller Center was originally planned to serve as what kind of complex?
    (A) Commercial
    (B) Housing
    (C) Recreational
    (D) Tourist

50. According to the passage, which of the following is true of Rockefeller Center?
    (A) It was patterned after an ancient design.
    (B) It has been imitated numerous times.
    (C) All shopkeepers were required to take two-year leases.
    (D) Four thousand tenants are located in the complex.

51. According to the passage, which of the following had to be done before the actual construction of the complex could start?
    (A) Six million dollars in rent had to be collected.
    (B) Over four thousand workers had to be hired.
    (C) Over two hundred buildings had to be torn down.
    (D) The future occupants had to be put under contract.

52. According to the passage, what does the shape of the RCA building reflect?
    (A) Architectural creativity
    (B) City regulations
    (C) Practical considerations
    (D) Decreased space needs

53. The sunken plaza at Rockefeller Center was originally designed as
    (A) an entrance to shops
    (B) an ice-skating rink
    (C) an outdoor restaurant
    (D) a tourist attraction

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Passage 11

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Questions 54-60

Minnie Marx was determined to see her sons, Leonard, Adolph, Milton, Julius, and Herbert, succeed in show business. In 1908 she organized her motley teen-agers into an act and propelled them onto the vaudeville stage. By the end of the First World War the brothers had changed their names to Chico, Harpo, Gummo, Groucho, and Zeppo, respectively; Zeppo, who had been too young to play the circuit, replaced Gummo. Their break came in 1924, when (following in the footsteps of their famous uncle, Al Shean, half of the team of Gallagher and Shean) they left the circuit to open in their own Broadway musical, *I'll Say She Is*. Its success led to even greater acclaim in the stage comedies *The Cocoanuts* and *Animal Crackers* and, when these productions were filmed by Paramount Pictures, to the Marx Brothers' debut in movies.

Sound was essential to an appreciation of the Marx Brothers' fast-paced mixture of verbal and visual gags (even the mute Harpo's honking horns and harp solos required a sound track). The brothers' contrapuntal verbal styles relied for humor on puns, aphorisms, malapropisms, wisecracks, gags, insults, and sheer nonsense. Their wit, every line of it delivered with split-second timing, made the Marx Brothers' films, from *The Cocoanuts* in 1929 to *Love Happy* in 1950, as popular as any ever shown in America and the best of them—*Monkey Business*, *Horse Feathers*, *Duck Soup*, *A Night at the Opera*, and *A Day at the Races*—unforgettable classics.

54. What is the main topic of the passage?
    (A) The role of Minnie Marx in her sons' success
    (B) The career of the Marx Brothers
    (C) The best films of the Marx Brothers
    (D) The stage names of the Marx Brothers

55. According to the passage, Julius' stage name was
    (A) Harpo
    (B) Gummo
    (C) Groucho
    (D) Zeppo

56. What led to the Marx Brothers' first appearance in films?
    (A) Their success in the theater
    (B) Their mother's determination
    (C) Their uncle's influence
    (D) Their verbal style of comedy

57. The first movie that the Marx Brothers appeared in was called
    (A) *I'll Say She Is*
    (B) *The Cocoanuts*
    (C) *Monkey Business*
    (D) *Love Happy*

58. Which of the Marx Brothers did not appear in movies?
    (A) Chico
    (B) Zeppo
    (C) Harpo
    (D) Gummo

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Passage 11 (continued)

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59. The author thinks which of the following about the Marx Brothers' movies?

(A) Some are truly great.
(B) They contain too much nonsense.
(C) Those that rely primarily on visual humor are best.
(D) Their popularity is undeserved.

60. The author implies that the Marx Brothers' success in films depended on the technical innovation of

(A) slow motion
(B) color film
(C) the split screen
(D) the sound track

THIS IS THE END OF SECTION 3

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON SECTION 3 ONLY.
DO NOT READ OR WORK ON ANY OTHER SECTION OF THE TEST.

Test Form 3

Passage 12

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Questions 31-34

The bee, like the ant, is a social insect. Bees live in groups in a hive, and every bee does certain work that helps the other members of the group. In a beehive there are three kinds of bees: the queen bee, the drones, and the workers. The worker bees go from flower to flower collecting nectar, or juice, which is composed mostly of sugar mixed with water. Bees draw this nectar into the honey sacks of their bodies, and enzymes in their bodies turn the nectar into honey. This newly made honey oozes from the underside of the bees and is stored in cells in the hive to be used as food during the winter months. Some people are in the honey business and keep hundreds of hives. Beekeepers remove honey from the hives and pack it in bottles or jars. Honey usually appears as a clear golden-colored liquid, but this depends on the kind of flower from which the bees have taken the nectar.

31. Bees are called social insects because they
    (A) live in groups
    (B) live near people
    (C) need beekeepers
    (D) work hard

32. What do bees do with nectar?
    (A) Change it into sugar.
    (B) Convert it into honey.
    (C) Give it to the queen bee.
    (D) Use it to build their hives.

33. Honey is usually sold in
    (A) beehives
    (B) golden-colored packs
    (C) honey sacks
    (D) bottles or jars

34. The color of honey in its final stage depends on the
    (A) type of flower from which the nectar was taken
    (B) amount of sugar the beekeepers give the bees
    (C) quantity of water available to the bees
    (D) season in which the nectar is collected

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Passage 13

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Questions 35-41

In 1955 Martin Luther King, Jr., gained national recognition for his nonviolent methods used in a bus boycott in Montgomery. This peaceful boycott, under Dr. King's guidance, changed the law which required Black people to ride in the backs of buses. After this success, Dr. King used his nonviolent tactics in efforts to change other discriminatory laws.

Dr. King urged Blacks to use nonviolent sit-ins, marches, demonstrations, and freedom rides in their efforts to gain full freedom and equality. Arrested for breaking discriminatory laws, Dr. King went to jail dozens of times. He became a symbol around the world for people to protest peacefully against unjust laws. In recognition of his work for peaceful change, Dr. King received the 1964 Nobel Peace Prize.

35. What is the best title for the passage?
    (A) The Effectiveness of Nonviolent Methods
    (B) Martin Luther King, Jr.: Nobel Prize Winner
    (C) The Need to Change Discriminatory Laws
    (D) Martin Luther King, Jr.: Advocate of Nonviolence

36. According to the passage, as a consequence of his protest in 1955, Dr. King became
    (A) peaceful in his tactics
    (B) famous in the United States
    (C) frustrated in his efforts
    (D) successful in the transportation business

37. It can be inferred from the passage that Dr. King continued his nonviolent methods because
    (A) they were legal in Montgomery
    (B) they were effective
    (C) most people are incapable of violence
    (D) most people believed he would receive the Nobel Peace Prize

38. Which of the following is mentioned in the passage as a means by which Dr. King tried to bring about social justice?
    (A) Store boycotts
    (B) Congressional debates
    (C) Peaceful marches
    (D) Visits to jails

39. According to the passage, how many times was Dr. King put in jail?
    (A) One
    (B) Between two and ten
    (C) Twelve
    (D) At least twenty-four

40. The author implies that in the 1960's Dr. King was known .
    (A) to few people in Montgomery
    (B) to people in many countries
    (C) primarily by the medical profession
    (D) personally by several lawyers

41. The passage answers which of the following questions?
    (A) When were discriminatory laws established in Montgomery?
    (B) Who arrested Dr. King for breaking discriminatory laws?
    (C) How many marches took place in 1955?
    (D) What special award was given to Dr. King?

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Passage 14

Questions 42-46

Convective flow should be familiar to anyone who has noted the boiling of a heated liquid. The most elementary type of convection can be explained by the fact that heat rises. In the simplest cases, convective flow begins when a fluid is heated from below. As the bottom layer of the fluid is heated, it expands and thus becomes less dense than the layers above. The warmer and lighter bottom layer then tends to rise and the cooler layer tends to sink in a continuous cycle. The same mechanism of convective flow is responsible for the great ocean currents and for the global circulation of the atmosphere. In an ocean, the water is warmed by the Sun to a depth of perhaps thirty meters, and evaporation near the water's surface is responsible for the cooling effect.

42. The main purpose of this passage is to
    (A) explain the basic principle of convection
    (B) describe regular changes in the Earth's atmosphere
    (C) explain the boiling temperatures of liquids
    (D) state the principles of ocean currents

43. According to the passage, what happens as a fluid is warmed?
    (A) The bottom layer sinks.
    (B) The circulation stops.
    (C) It becomes very sensitive to light.
    (D) It becomes less dense.

44. What does the passage say about ocean currents?
    (A) They circulate locally as well as globally.
    (B) They usually cause a rise in air temperature.
    (C) They interfere with atmospheric circulation.
    (D) They are caused by circular flow.

45. According to the passage, which of the following is the result of convective flow?
    (A) The electric currents in the atmosphere
    (B) The power of oceangoing vessels
    (C) The movement of air around the Earth
    (D) The daily rotation of the globe

46. A simple example of convection could be seen in
    (A) a cake baking
    (B) a pot of soup heating
    (C) sunlight being absorbed by a plant
    (D) water dripping from a faucet

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Passage 15

Questions 47-54

By about A.D. 500 the Mound Builder culture was declining, perhaps because of attacks from other tribes or perhaps because of severe climatic changes that undermined agriculture. To the west another culture, based on intensive agriculture, was beginning to flourish. Its center was beneath present-day St. Louis, and it radiated out to encompass most of the Mississippi watershed, from Wisconsin to Louisiana and from Oklahoma to Tennessee. Thousands of villages were included in its orbit. By about A.D. 700 this Mississippian culture, as it is known to archaeologists, began to send its influence eastward to transform the life of most of the less technologically advanced woodland tribes. Like the Mound Builders of the Ohio region, these tribes, probably influenced by Meso-American cultures through trade and warfare, built gigantic mounds as burial and ceremonial places. The largest of them, rising in four terraces to a height of one hundred feet, has a rectangular base of nearly fifteen acres, larger than that of the Great Pyramid of Egypt. Built between A.D. 900 and 1100, this huge earthwork faces the site of a palisaded Indian city which contained more than one hundred small artificial mounds marking burial sites. Spread among them was a vast settlement containing some 30,000 people by current estimations. The finely crafted ornaments and tools recovered at Cahokia, as this center of Mississippi culture is called, include elaborate ceramics, finely sculpted stonework, carefully embossed and engraved copper and mica sheets, and one funeral blanket fashioned from 12,000 shell beads. They indicate that Cahokia was a true urban center, with clustered housing, markets, and specialists in toolmaking, hide-dressing, potting, jewelry-making, weaving, and salt-making.

47. What is the main topic of the passage?
    (A) The Mississippian culture
    (B) The decline of Mound Builder culture
    (C) The architecture of Meso-American Indians
    (D) The eastern woodlands tribes

48. The paragraph preceding this one most probably discussed
    (A) the Mound Builder culture
    (B) warfare in A.D. 500
    (C) the geography of the Mississippi area
    (D) agriculture near the Mississippi River

49. In relation to the Mississippian culture, the Mound Builder culture was located
    (A) in essentially the same area
    (B) farther south along the watershed
    (C) to the east
    (D) to the west

50. The Mississippian culture influenced the culture of the
    (A) eastern woodland tribes
    (B) Mound Builders
    (C) Meso-Americans
    (D) Egyptians

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Passage 15 (continued)

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51. According to the passage, the mounds were used as

(A) palaces for the royal families
(B) fortresses for defense
(C) centers for conducting trade
(D) places for burying the dead

52. According to the passage, how does the mound at Cahokia compare with the Great Pyramid?

(A) It is higher.
(B) Its artifacts are more elaborate.
(C) It is fifteen times as heavy.
(D) Its base covers a larger area.

53. The mound at Cahokia was made of

(A) stone
(B) dirt
(C) ceramics
(D) metal

54. Which aspect of the Mississippian culture is discussed the LEAST in the passage?

(A) The construction of mounds
(B) Agricultural methods
(C) Urban settlement
(D) The forms of artwork

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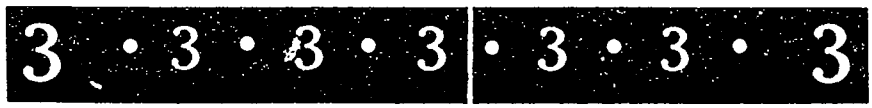
Passage 16



Questions 55-60

Watch a baby between six and nine months old, and you will observe the basic concepts of geometry being learned. Once the baby has mastered the idea that space is three-dimensional, it reaches out and begins grasping various kinds of objects. It is then, from perhaps nine to fifteen months, that the concepts of sets and numbers are formed. So far, so good. But now an ominous development takes place. The nerve fibers in the brain insulate themselves in such a way that the baby begins to hear sounds very precisely. Soon it picks up language, and it is then brought into direct communication with adults. From this point on, it is usually downhill all the way for mathematics, because the child now becomes exposed to all the nonsense words and beliefs of the community into which it has been so unfortunate as to have been born. Nature, having done very well by the child to this point, having permitted it the luxury of thinking for itself for eighteen months, now abandons it to the arbitrary conventions and beliefs of society. But at least the child knows something of geometry and numbers, and it will always retain some memory of the early halcyon days, no matter what vicissitudes it may suffer later on. The main reservoir of mathematical talent in any society is thus possessed by children who are about two years old, children who have just learned to speak fluently.

55. What does the passage mainly discuss?
    (A) The impact of language on mathematics
    (B) Children's ability to learn languages
    (C) How basic concepts of physics are learned
    (D) Math-learning strategies for babies

56. According to the passage, which of the following activities would teach a baby about geometry?
    (A) Picking up a wooden block
    (B) Recognizing the number 2
    (C) Uttering a nonsense word
    (D) Looking at distant objects

57. According to the author, at what age does a child probably begin to learn about sets and numbers?
    (A) Six months
    (B) Nine months
    (C) Fifteen months
    (D) Eighteen months

58. The use of the word "ominous" shows that the author believes the child's
    (A) linguistic future is threatened
    (B) nerves will deteriorate
    (C) hearing will suffer
    (D) mathematical ability will decline

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Passage 16 (continued)

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59. The passage supports which of the following conclusions?

(A) The language concepts used in early education interfere with mathematical reasoning.
(B) It is hopeless to try to teach children mathematics after the age of two.
(C) Language teaching should incorporate some mathematical formulas.
(D) Preschool education should stress society's beliefs and conventions.

60. The author's attitude toward early childhood education can best be described as somewhat

(A) indifferent
(B) compromising
(C) indulgent
(D) cynical

THIS IS THE END OF SECTION 3

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON SECTION 3 ONLY.
DO NOT READ OR WORK ON ANY OTHER SECTION OF THE TEST.

Test Form 4

Passage 17

Questions 31-35

Magnesium is another mineral we now obtain by collecting huge volumes of ocean water and treating it with chemicals, although originally it was derived only from brines or from the treatment of such magnesium-containing rocks as dolomite, of which whole mountain ranges are composed. In a cubic mile of seawater there are about four million tons of magnesium. Since the direct extraction method was developed about 1941, production has increased enormously. It was magnesium from the sea that made possible the wartime growth of the aviation industry, for every airplane made in the United States (and in most other countries as well) contains about half a ton of magnesium metal. And it has innumerable uses in other industries where a lightweight metal is desired, besides its long-standing utility as an insulating material, and its use in printing inks, medicines, and toothpastes.

31. What is the main topic of this passage?
    (A) Uses of seawater
    (B) Treatment of seawater
    (C) Chemical properties of magnesium
    (D) Derivation and uses of magnesium

32. According to the passage, magnesium was first obtained from
    (A) rocks found on land
    (B) great amounts of ocean water
    (C) the sea floor
    (D) major industrial sites

33. According to the passage, which of the following was a direct consequence of the new method of obtaining magnesium?
    (A) The development of insulation materials
    (B) Increased airplane production
    (C) Improved medical facilities
    (D) The development of cheap inks for printing

34. According to the passage, why is magnesium important to industry?
    (A) It is strong.
    (B) It conducts heat well.
    (C) It weighs little.
    (D) It is inexpensive to produce.

35. It can be inferred from the passage that during the past fifty years the demand for magnesium has
    (A) declined greatly
    (B) remained stable
    (C) increased slightly
    (D) risen dramatically

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Passage 18

3 • 3 • 3 • 3 • 3 • 3 • 3

Questions 36-42

Russian-born Max Weber grew up in New York, studied art there, and then went back to Europe to familiarize himself with contemporary artistic developments. On returning to the United States, Weber worked in the new styles he had discovered in Paris and soon became recognized as a pioneer of American abstract painting. An example of his work at the National Gallery of Art in Washington, D.C., is a 1915 painting entitled "Rush Hour, New York." Using abstract, geometrical forms, Weber has expressed the movement, noise, and vibrancy of the great metropolis. The picture blends elements of two European styles: cubism, which shows objects from a number of different angles of vision at the same time, and futurism, which portrays speed and objects in motion. Forceful lines and spiky forms throughout the composition convey the energy and vitality of the city. Weber expresses the city's diversity by juxtaposing forms with rounded and angular shapes to suggest specific elements of the urban landscape: skyscrapers, flashing lights, and hurrying people.

36. Which of the following would be the most appropriate title for this passage?
    (A) Cubism
    (B) American Art
    (C) Works of the National Gallery of Art
    (D) An Innovative American Artist

37. According to the passage, which of the following best describes the development of Weber's art?
    (A) It began as a hobby late in his life.
    (B) It gradually inspired diversity among his European contemporaries.
    (C) It evolved as one of America's earliest examples of abstract painting.
    (D) It came to represent the first purely American style.

38. The painting discussed in the passage can be found in
    (A) Paris, France
    (B) Washington
    (C) New York
    (D) Moscow, Russia

39. "Rush Hour, New York" was completed in the
    (A) early nineteenth century
    (B) late nineteenth century
    (C) early twentieth century
    (D) late twentieth century

40. The mood of the painting "Rush Hour, New York" can be best described as
    (A) depressing
    (B) vigorous
    (C) hostile
    (D) cheerful

41. According to the passage, Weber uses the style of cubism when he
    (A) shows an object simultaneously from many viewpoints
    (B) portrays objects with geometric exactness
    (C) leaves all human faces blank
    (D) represents all forms isolated within boxes

42. According to the passage, an element of futurism that Weber's painting displays is the
    (A) impression of movement
    (B) inclusion of many human forms
    (C) portrayal of skyscrapers
    (D) application of forceful colors

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Passage 19

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Questions 43-48

The United States court system, as part of the federal system of government, is characterized by dual hierarchies: there are both state and federal courts. Each state has its own system of courts, composed of civil and criminal trial courts, sometimes intermediate courts of appeal, and a state supreme court. The federal court system consists of a series of trial courts (called district courts) serving relatively small geographic regions (there is at least one for every state), a tier of circuit courts of appeal that hear appeals from many district courts in a particular geographic region, and the Supreme Court of the United States. The two court systems are to some extent overlapping, in that certain kinds of disputes (such as a claim that a state law is in violation of the Constitution) may be initiated in either system. They are also to some extent hierarchical, for the federal system stands above the state system in that litigants (persons engaged in lawsuits) who lose their cases in the state supreme court may appeal their cases to the Supreme Court of the United States.

Thus, the typical court case begins in a trial court—a court of general jurisdiction—in the state or federal system. Most cases go no further than the trial court: for example, the criminal defendant is convicted (by a trial or a guilty plea) and sentenced by the court and the case ends; the personal injury suit results in a judgment by a trial court (or an out-of-court settlement by the parties while the court suit is pending) and the parties leave the court system. But sometimes the losing party at the trial court cares enough about the cause that the matter does not end there. In these cases, the "loser" at the trial court may appeal to the next higher court.

43. What does the passage mainly discuss?
    (A) Civil and criminal trial courts
    (B) Typical court cases
    (C) The court system in the United States
    (D) The appeal court process

44. According to the passage, district courts are also known as
    (A) circuit courts
    (B) supreme courts
    (C) intermediate courts
    (D) trial courts

45. In the last sentence of the first paragraph, the phrase "engaged in" could best be replaced by which of the following?
    (A) committed to
    (B) involved in
    (C) attentive to
    (D) engrossed in

46. The passage indicates that litigants who lose their cases in the state trial court may take them to a
    (A) different trial court in the same state
    (B) court in a different geographic region
    (C) federal trial court
    (D) state supreme court

47. It can be inferred from the passage that typical court cases are
    (A) always appealed
    (B) usually resolved in the district courts
    (C) always overlapping
    (D) usually settled by the Supreme Court

48. Which of the following is most likely to be the subject of the paragraph following the passage?
    (A) The process of an appeal
    (B) Out-of-court settlements
    (C) The state court structure
    (D) Sentencing procedures

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Passage 20

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Questions 49-54

As the South was beginning to find itself after the American Civil War, the North, too, focused its interest on the lands below the Mason-Dixon line. Northerners swarmed over the South: journalists, agents of prospective investors, speculators with plans for railroads, writers anxious to expose themselves to a new environment.

One of these was Constance Fenimore Woolson, a young woman from New Hampshire, a grandniece of James Fenimore Cooper, who like many Northerners, was drawn to the unhappy South by affection, compassion, admiration, or the charm of the life there. With her singular gift of minute observation and a talent for analysis, her imagination lingered over the relics of the ancient South, the quaintly emblazoned tablets and colonial tombs, the wrecked old mansions that stood near by, perhaps in ruined rice lands, amid desolated fields and broken dikes. Such was the dwelling on the Georgia sea island that sidled and leaned in *Jupiter Lights* with one of its roofless wings falling into the cellar. After St. Augustine, Charleston especially attracted Miss Woolson, crumbling as it was but aristocratic still.

In a later novel, *Horace Chase*, one of the best of all her books, she anticipated Thomas Wolfe in describing Asheville, in which the young capitalist from the North who falls in love with the Southern girl sees the "Lone Star" of future mountain resorts.

Miss Woolson was a highly conscious writer, careful, skillful, subtle, with a sensitive, clairvoyant feeling for human nature. with the gift of discriminating observation that characterized Howells and Henry James. She was surely best in her stories of the South, fascinated as she was by its splendor and carelessness, its tropical plants, flowers, odors and birds, and the pathos and beauty of the old order as she saw it in decay.

49. Which of the following is the best title for the passage?

(A) The Rebuilding of the South
(B) Literature After the Civil War
(C) Thomas Wolfe's Influence on Woolson
(D) Constance Fenimore Woolson and Her Works

50. Which of the following are NOT mentioned in the passage as the kind of people who went to the South after the Civil War?

(A) Railroad builders
(B) Newspaper writers
(C) Northern politicians
(D) Investment agents

51. According to the passage, Constance Fenimore Woolson was originally from

(A) St. Augustine
(B) Georgia
(C) Charleston
(D) New Hampshire

GO ON TO THE NEXT PAGE

Passage 20 (continued)

3 • 3 • 3 • 3 • 3 • 3 • 3

52. As it is used in the first sentence of the second paragraph, the word "drawn" is closest in meaning to which of the following?

(A) attracted
(B) sketched
(C) traced
(D) hauled

53. Why does the author mention Howells and James?

(A) To explain why Woolson chose writing as a career
(B) To suggest that Woolson was the object of discrimination
(C) To compare Woolson to some of her fellow writers
(D) To question modern opinion of Woolson's abilities

54. In the last sentence of the passage, the words "its splendor" refers to the splendor of

(A) observation
(B) human nature
(C) the South
(D) Woolson's best story

GO ON TO THE NEXT PAGE

Passage 21

3 • 3 • 3 • 3 • 3 • 3 • 3

Questions 55-60

Our multimillion nerve-cell central nervous system has its roots in the scattered nerve cells of tiny, lowly organisms that lived in water half a billion years ago. Nerve cells evidently first appeared in coelenterates—"hollow-gutted" organisms like hydra and the sea anemone. A coelenterate's nerve network lacks any kind of centralized control. This probably began with flatworms—the first creatures to possess a head. Specialized sense cells help flatworms respond more flexibly than sea anemones to outside stimuli. But like most animals without a backbone, flatworms act mostly by instinct and reflex.

Intelligent behavior remained impossible until the appearance of relatively big, complex types of brain—the types we find among the backboned animals, or vertebrates. The tiniest fish has a larger brain than the largest insect. But the development of a fish's three-part brain reflects that beast's unintellectual priorities. Much of the forebrain deals only with smell. The midbrain handles vision, the hindbrain, balance.

With early mammals the brain grew larger and more complex. Sense coordination shifted from the midbrain to the forebrain, a developing structure capped by a folded cerebrum to handle memory and learning. Meanwhile the hindbrain gained a large cerebellum to coordinate complicated movements.

Advanced mammals such as monkeys, apes, and humans (the primates) have brains derived from ancestors that took to living in the trees, where vision mattered more than smell. Accordingly the once-big "smell" part of the forebrain grew smaller, while the part that handles vision grew much larger.

55. With what topic is the passage mainly concerned?
    (A) The sensory organs of invertebrates
    (B) The anatomy of tiny organisms
    (C) The origin of the brain and central nervous system
    (D) The importance of vision for fish and advanced mammals

56. The hydra is a kind of
    (A) flatworm
    (B) coelenterate
    (C) sea anemone
    (D) nerve cell

57. It can be inferred from the passage that insects do not have
    (A) brains
    (B) backbones
    (C) nerve cells
    (D) reflexes

58. According to the passage, what helps to coordinate the complex physical activity of a mammal?
    (A) The cerebellum
    (B) The forebrain
    (C) The cerebrum
    (D) The midbrain

GO ON TO THE NEXT PAGE

Passage 21 (continued)

3 • 3 • 3 • 3 • 3 • 3 • 3

59. In the last paragraph, the phrase "took to" could best be replaced by which of the following?

(A) began
(B) fled to
(C) carried to
(D) became friendly toward

60. What does the paragraph following the passage most likely discuss?

(A) An explanation of why some animals live in trees
(B) The difference between the brains of fish and primates
(C) A comparison of the sense of smell among various species of monkeys
(D) The continued growth of the mammalian brain

THIS IS THE END OF SECTION 3.

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON SECTION 3 ONLY.
DO NOT READ OR WORK ON ANY OTHER SECTION OF THE TEST.

Appendix D

TOEFL Subject Matter Classifications

TOEFL Subject Matter Classifications

A. The Humanities (the following arts in America and their histories, artists and their biographies, and aesthetic theories)

1. Aesthetics (the nature of art and style and the place of art in different periods of history)
2. Architecture (public and commerical, private dwellings)
3. Crafts (pottery, furniture, jewelry, weaving)
4. Fine arts (painting and drawing, sculpture)
5. Literature (fiction, nonfiction, poetry, drama)
6. Theater
7. Music
8. Dance (ballet, modern, folk, ethnic)
9. Film (motion picture, still photography)

B. Philosophy (philosophical theories and principles, ethics, logic, epistemology, metaphysics, leading philosophers and schools of thought)

C. The Social Sciences

1. Anthropology/Archeology and Sociology
   - 1.1 Ritual systems (birth, marriage, and funerary customs; myth and symbol; folklore)
   - 1.2 Family structure
   - 1.3 Archeological evidence of early humans and their lives and customs

2. Sociology
   - 2.1 The city, suburbs, and small towns (their forms, functions, and comparative structures)
   - 2.2 Social and educational institutions

3. Mass communication, including advertising, periodicals, radio, television, and their impact on society

4. Economics
   - 4.1 Ecomomic development (industrialization, land, industrial production, transportation)
   - 4.2 Applied economics (consumer behavior, business cycles, government policies, international trade, money and banking, taxation)
   - 4.3 Labor force (employment and unemployment, hours of work, labor relations and unions)

5. Geography (including cartography, demography, regions and regionalism, topography)

6. History
   6.1 American history (including major figures, events, and ideas concerning the social, political, and economic aspects of American history)
   6.2 World history of science (not exclusively Americana)
   6.3 World history of technology (not exclusively Americana)

7. Law (including the judicial process, jurisprudence, law and legal institutions)

8. Political Science (emphasizing the structure and function of the various components of the American government)
   8.1 Branches of the federal government
   8.2 The Constitution and constitutionalism
   8.3 Elections, lobbying, and political parties
   8.4 Local government

9. Psychology and Psychiatry (excluding physiological aspects)
   9.1 Drives and motivations, emotions
   9.2 Perception and the senses (hearing, skin, smell, vision; sensory and motor development)
   9.3 Language and learning (cognitive organization and processes, intellectual development)
   9.4 Schools of thought and leading thinkers

10. Education (educational theory and practice, major figures in education)

D. The Physical Sciences

1. Atomic and subatomic particles: their structure, properties, and behavior

2. Chemical principles (properties and behavior of chemical elements; properties and behavior of molecules and chemical compounds; chemical reactions)

3. Heat, energy, and radiation

4. Gases: their properties and behavior

5. Liquids: their properties and behavior

6. Solids: their properties and behavior

7. Effects of temperature and pressure

8. Electricity and magnetism (including electronics)

9. Waves and wave motion (light, sound, lasers, other waves, including microwaves)

10. Mechanics (friction, velocity and acceleration, inertia and momentum, aerodynamics)

11. The universe (origin, structure, and history of the universe; galaxies and stars; the solar system; the Sun, the Moon, the planets; comets, meteors, asteroids, and other bodies)

12. The atmosphere (including weather and climate)

13. The hydrosphere (oceans and other saltwater bodies, freshwater bodies)

14. Soils, minerals, and rocks

15. Physical processes on the Earth (earthquakes and volcanoes, erosion, wind action, glaciation)

16. History and evolution of the Earth

E. The Life Sciences

1. Paleontology: the fossil record

2. Evolution (natural selection and adaptation, mutation, phylogeny, lines of descent)

3. Differentiation among and variation within species (characteristic features of species, biological toxonomy, hybridization)

4. Molecular and cellular biology and biochemistry (including vital processes)

5. Genetics (DNA, gene-splicing, chromosome behavior, laws of heredity)
   5.1 Animal genetics (including humans)
   5.2 Plant genetics

6. Anatomy and physiology
   6.1 Anatomy and physiology of animals (including humans)
   6.2 Anatomy and physiology of plans

7. Behavior of organisms
   7.1 Animal behavior (excluding humans)
   7.2 Plant behavior

8. Structure, functions, and behavior of other organisms (viruses, bacteria, fungi, algae, molds, lichen, protozoa)

9. The Biosphere (communities and ecosystems; processes in the biosphere--nitrogen cycle, carbon cycle, succession; distribution of living things; natural resource management, pollution)

10. Health and disease (immunology, etiology, and epidemiology; environmental influences on health; the treatment of disease; public health)

F. Applied Science and Technology

1. Technology of tools and machines (including intermediate and appropriate technology)
2. Agriculture and food production
3. Home economics (textiles and clothing, food preparation)
4. Forestry and wood technology
5. Technology of industrial production
6. Construction technology
7. Transportation technology
8. Technology of information processing and communication (including computer science)
9. Technology of urban life (systems for supplying water, systems for supplying energy, pollution control, fire and traffic control)
10. Technology of Earth and space exploration
11. Health and medical technology (including drugs)

G. Mathematics and Statistics

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