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ABSTRACT

This study examined the possible relationship between scores on the Nelson-Denny Reading Test (current forms G and H) and performance on the Medical College Admissions Test (MCAT) and the United States Medical Licensing Examination (USMLE) Step 1 examination scores. Participants were 730 medical students at a mid-Atlantic university, and for 572 of these students, MCAT scores were also available. All four Nelson-Denny Reading Test variables (Vocabulary, Comprehension, Total Score, and Reading Rate) were positively correlated with the MCAT verbal reasoning score. Nelson-Denny Vocabulary and Total Scores were positively correlated with the USMLE Step 1 score, but the Nelson-Denny Comprehension score was not significantly related to the USMLE Step 1 score. MCAT scores have been shown to be correlated with USMLE scores. Results suggest that medical schools should consider using an index of reading to predict applicants who will achieve success in medical school. (Contains 15 references.) (SLD)

Running head: READING AND MEDICAL STUDENTS

Adult Learners: Relationships of Reading, MCAT, and USMLE Step 1 Test Results for Medical Students

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Adult Learners: Relationships of Reading, MCAT,
and USMLE Step 1 Test Results for Medical Students

Adult learners continue to refine their reading and other cognitive skills, and reading skills are tied to academic achievement as well as test taking. Haught and Walls (in press) reported new reading norms for the Nelson-Denny Reading Test for health-care professional students that demonstrate higher reading scores for those students than for four-year college graduates. Educators have attempted to identify various factors that contribute to academic success for medical students. Horshl and Kozeny (1997) reported that high school performance, written entrance examination, admission interview, and personality traits may significantly predict academic success for third-year medical students in the Czech Republic. Twenty-five studies which examined the relationship of learning style and medical student performance were summarized by Hylton and Harman (1996) who concluded that "many of the generalizations that have been made about the learning styles of medical students actually have little conclusive empirical data to support them" (p. 1411). Harward, Tresolini, Davis, and Kretchmar (1998) investigated the value of self-efficacy as a predictor of performance and reported that significant associations were observed between different types of educational experience (e.g., reading in a content area) and self-efficacy ratings on professional skills. Critical thinking skills as measured by the Watson-Glaser Critical Thinking Appraisal were moderately predictive of academic success in pre-clinical medical students (Scott & Markert, 1994).

Earlier versions of the Nelson-Denny Reading Test (Brown, Fischo, & Hanna, 1993) were found to be positively correlated with medical school achievement (Ambrosino, Brading, & Noval, 1974). It is generally accepted that medical schools require students with better reading ability because of the quantity of material to be read. Flaherty, Rezler, and McGuire (1982) found the Nelson-Denny Reading Test (*earlier* Form E or Form F) to be a better predictor of clinical reading skills than the reading subtest of the Medical College Application Test (MCAT). These researchers encouraged medical school admission committees to consider reading ability as part of the admission process.

Jackson and Brooks (1985) examined possible relationships between the MCAT Reading Subtest, the Nelson-Denny Reading Test, and medical school achievement. During orientation to

medical school, students completed the Nelson-Denny Reading Test (*earlier* Forms E or F). The criterion variables used to examine the predictive ability of these tests included (a) basic science and clinical science GPA and (b) total scores on Part I and Part II of the National Board of Medical Examinees (NBME) examination. These authors concluded "The NDRT was a better single predictor than the MCAT reading score..." (p. 479) with Total Score (one of four Nelson Denny Reading Test scores) being the best predictor and Reading Rate being the poorest predictor of academic achievement. The Nelson-Denny Reading Test was a better predictor of achievement (GPA and NBME) than the MCAT reading subtest. In this study (Jackson & Brooks, 1985) the Nelson-Denny Reading Test Total Score was moderately correlated ($r = .51$) to the MCAT reading score, but a higher correlation ($r = .69$) between these measures was reported earlier by Jackson, Dawson-Saunders, and Jackson (1984).

There are substantial investments of human and financial resources in medical students. Universities and their schools of medicine experience pressures of escalating cost and diminishing resources. They seek to minimize their losses by admitting the applicants most likely to succeed in medical school. One of the present researchers has observed that some students who appear to know the content either (a) score low or (b) fail to pass various standardized tests (e.g., MCAT and USMLE Step 1 Boards). It is possible that they cannot read competently enough to complete the exam and give an accurate representation of their own knowledge. The present investigation examines the possible relationship of the Nelson-Denny Reading Test (*current* Forms G or H) performance with the MCAT scores and the USMLE Step 1 Board exam scores. Are there predictive relationships from the Nelson-Denny (N-D) Reading Test (using the most recent forms of the test) to (a) MCAT scores and (b) USMLE Step 1 Board exam scores? Initially, at the time of application, do scores of N-D Reading Vocabulary, N-D Reading Comprehension, N-D Total Reading Score, and N-D Reading Rate differentially predict MCAT verbal reasoning, MCAT physical sciences, and MCAT biological sciences scores (Research Question 1)? Two years later, are the Nelson-Denny measures of Reading Vocabulary, Comprehension, Total, and Rate predictive of the USMLE basic biomedical sciences score (Research Question 2)?

Method

Participants

The participants (N=730) were students in the School of Medicine at a major Mid-Atlantic university. There were 431 males and 299 females. The ethnic composition was approximately 90 percent White, 1 percent African-American, 1 percent Hispanic, and 8 percent Other (e.g., Eastern Indian). The testing took place from 1994 through 2001. As an example of the composition of medical students in a particular year, (a) 998 people applied to the medical school in 1999, (b) 255 applicants were interviewed, and (c) 88 applicants were admitted (51 males and 37 females). Of those students admitted, the mean undergraduate grade point average (GPA) in science courses was 3.60, and the mean overall GPA was 3.68. Average Medical College Admission Test (MCAT) scores of admitted applicants were 9.0 in Verbal Reasoning, 8.9 in Physical Sciences, 9.1 in Biological Sciences, and "P" for Writing. Of those 88 students admitted, 89% were from 20 to 23 years of age, and most had an undergraduate degree in the biological sciences (48%) or chemistry (22%). Most of the admitted applicants were state residents (97%). This medical school does not use reading test performance as a criterion for admission. The Nelson-Denny Reading Test is used after admission as a possible "red flag" to alert faculty and administrators that a student may experience academic difficulties. This investigation was approved by the Institutional Review Board for protection of human subjects and was conducted in accordance with American Psychological Association ethical guidelines.

Instruments

The Nelson-Denny Reading Test is a standardized instrument for assessing reading vocabulary, reading comprehension, and reading rate; the two most current forms are Form G and Form H. The N-D Reading Vocabulary score is based on 80 multiple-choice items (15 minutes). The N-D Reading Comprehension score is based on 38 multiple-choice items (20 minutes). The N-D Total Reading score is the sum of the vocabulary and comprehension scores. The N-D Reading Rate score is the number of words read during the first minute of the comprehension part of the test. Some participants (n=572) also completed the Medical College Admission Test (MCAT), a standardized, multiple-choice exam designed to assess problem

solving, critical thinking, and writing skills, as well as, knowledge of science concepts and principles prerequisite to the study of medicine. The MCAT provides separate scores in verbal reasoning, physical sciences, biological sciences, and writing (Federation of State Medical Board of the United States, 1998). Also, a subset of the participants (n=457) took the United States Medical Licensing Examination (USMLE) Part 1 at the end of their second year of study. This exam assesses knowledge of key concepts of basic biomedical sciences, with an emphasis on principles and mechanisms of health, disease, and modes of therapy (National Board of Medical Examiners, 2000).

Procedure

The Nelson-Denny Reading Test was administered during orientation to medical school. Participants completed either Form G or Form H. Time allotted in the orientation schedule for test completion was one hour, and the test was completed in a group setting. They were allowed 15 minutes for the vocabulary subtest and 20 minutes for the comprehension subtest. The first minute of the comprehension part of the Nelson-Denny Reading Test was used to determine reading rate. These reading test data are used herein for determining relationships to the MCAT (verbal reasoning, physical sciences, and biological sciences) and to the USMLE Step 1 Test score for medical students.

Results

To examine whether Nelson-Denny (N-D) Reading Test scores were related to performance on other standardized exams, Pearson Product-Moment Correlations were computed on the N-D Vocabulary, N-D Comprehension, N-D Total, and N-D Reading Rate raw scores with MCAT scores (verbal reasoning, physical sciences, and biological sciences) and the USMLE Step 1 score. The N-D *Vocabulary* score was positively correlated (a) with the MCAT verbal reasoning score ($r = .53, p < .01$), (b) with the MCAT physical science score ($r = .20, p < .01$), (c) with the MCAT biological science score ($r = .27, p < .01$), and (d) with the USMLE Step 1 score ($r = .14, p < .01$). As the N-D Vocabulary score increased so did the test scores on the MCAT and the USMLE exam. The strongest relationship was between the N-D Vocabulary score and the MCAT verbal reasoning score. The N-D *Comprehension* score also was positively correlated with the MCAT verbal reasoning score ($r = .41, p < .01$), with the

MCAT physical sciences score ($r = .13, p < .01$), and with the MCAT biological science score ($r = .12, p < .01$), but not with the USMLE score ($p > .05$). Similarly, the strongest observed relationship for N-D Comprehension was with the MCAT verbal reasoning score. The N-D *Total Reading* score was positively correlated to the four measures: MCAT verbal reasoning ($r = .56, p < .01$), MCAT physical science score ($r = .19, p < .01$), MCAT biological science score ($r = .23, p < .01$), and USMLE score ($r = .13, p < .01$). The N-D *Reading Rate* score was positively correlated only with the MCAT verbal reasoning score ($r = .24, p < .01$), but not with any remaining MCAT scores or with the USMLE score ($p > .05$).

To examine whether the MCAT scores were related to performance on the USMLE STEP 1 exam score, Pearson Product-Moment Correlations were computed on the MCAT verbal reasoning, MCAT physical sciences, and MCAT biological sciences scores and the USMLE Step 1 score. The USMLE Step 1 score was positively correlated with all parts of the MCAT. The USMLE Step 1 exam score was positively correlated with (a) the MCAT verbal reasoning score ($r = .18, p < .01$), (b) the MCAT physical sciences score ($r = .31, p < .01$), and (c) with the MCAT biological sciences score ($r = .34, p < .01$).

Multiple regression analyses were computed to determine whether the components of The N-D Reading Test (N-D Vocabulary, N-D Comprehension, N-D Reading Rate) were predictors of MCAT and USMLE Step 1 criterion variables. The N-D Total was not included as a predictor in these analyses because that total is a combination of N-D Vocabulary and N-D Comprehension. First, when MCAT verbal reasoning was the criterion variable and the three Nelson-Denny scores were predictor variables, the stepwise multiple regression showed the N-D Vocabulary score ($p < .01$), the N-D Comprehension score ($p < .01$), and the N-D Reading Rate score ($p < .05$) to be significant predictors. Second, when MCAT physical science was the criterion variable and the three Nelson-Denny scores were predictor variables, the stepwise multiple regression demonstrated that the N-D Vocabulary score was a significant predictor ($p < .01$). Third, when MCAT biological science was the criterion variable and the three Nelson-Denny scores were predictor variables, the stepwise multiple regression revealed that the N-D Vocabulary score was a significant predictor ($p < .01$). Fourth, when the USMLE Step 1

score was the criterion variable and the three Nelson-Denny scores were predictor variables, the stepwise regression demonstrated that the N-D Vocabulary score was a significant predictor ($p < .01$).

The strongest relationship established in the correlation analyses was between N-D Total and MCAT verbal reasoning ($r = .56$). To further examine the effects of the N-D Total as related to crucial medical school indices, the N-D Total was divided into quartiles so that approximately one-fourth of the participants was in each group. A one-way analysis of variance was computed with the N-D Total quartiles as the independent variable for each of four dependent variables (MCAT verbal reasoning, MCAT physical sciences, MCAT biological sciences, and the USMLE Step 1 score).

The analysis of variance for MCAT verbal reasoning yielded $F(3, 568) = 65.54$, $p < .01$, and the Tukey multiple comparisons test indicated that all quartiles differed from one another except Quartiles 2 and 3. MCAT verbal reasoning raw scores ranged from 4 to 15. The MCAT verbal reasoning means progressed from Quartile 1 to Quartile 4 in an orderly fashion (Q1 = 7.58, Q2 = 8.78, Q3 = 9.15, and Q4 = 9.94).

The analysis of variance for MCAT physical sciences produced $F(3, 568) = 7.96$, $p < .01$. The Tukey multiple comparisons test showed that Quartile 1 differed significantly from Quartiles 3 and 4 (both $p < .05$), and no other comparisons were significantly different ($p > .05$). MCAT physical science scores ranged from 4 to 14. The MCAT physical science means showed gradual increases from Quartile 1 through Quartile 4 (Q1 = 8.10, Q2 = 8.59, Q3 = 8.68, and Q4 = 9.01).

The analysis of variance for MCAT biological sciences resulted in $F(3, 568) = 11.10$, $p < .01$, and the Tukey multiple comparisons test revealed that Quartile 1 differed from Quartiles 3 and 4, and Quartile 2 differed from Quartile 4 ($p < .05$). No differences were observed between Quartiles 1 and 2, 2 and 3, and 3 and 4 ($p > .05$). MCAT biological science means ranged from 3 to 14, and mean scores for Quartiles 1, 2, 3, and 4 were 8.60, 8.71, 9.18, and 9.48, respectively. The analysis of variance for USMLE Step 1 score was not significant ($p > .05$).

Discussion

All four Nelson-Denny Reading Test variables (Vocabulary, Comprehension, Total Score, and Reading Rate) were positively correlated with the MCAT verbal reasoning score. The present findings, using the *current* N-D Reading Test Forms G and H, show that the MCAT verbal reasoning score is strongly correlated with N-D Vocabulary ($r = .53$), N-D Comprehension ($r = .41$), and N-D Total Score ($r = .56$). A smaller, but significant positive correlation was observed between MCAT verbal reasoning and the N-D Reading Rate ($r = .24$). With *earlier* forms (E and F) of the N-D Reading Test, Jackson and Brookes (1985) reported comparable results between the MCAT reading measure and N-D Vocabulary ($r = .44$), N-D Comprehension ($r = .48$), N-D Total ($r = .51$), and N-D Reading Rate ($r = .09$). The newer forms (G and H) of the N-D Reading Test yielded somewhat better prediction of MCAT verbal reasoning than reported by Jackson and Brooks. Given that a different university was involved 15 years later, this is indicative that the N-D Reading Test has remained an effective screening or predictive instrument. In addition to the significant correlations with the MCAT verbal reasoning, the N-D Vocabulary, N-D Comprehension, and N-D Total scores were positively correlated with the MCAT physical sciences and MCAT biological sciences scores (all $p = <.01$). The multiple regression analyses supported the viability of N-D Vocabulary, N-D Comprehension, and N-D Reading Rate as predictors of MCAT verbal reasoning scores for medical students.

The N-D Vocabulary and N-D Total scores were positively correlated with the USMLE Step 1 score (both $p <.01$). The N-D Comprehension score was not significantly related to the USMLE Step 1 score. The MCAT scores (verbal reasoning, physical sciences, and biological sciences) that are taken prior to admission to medical school show a significant relationship to the USMLE Step 1 score that is taken at the end of the second year of medical school. Given the observed positive relationships between components of the Nelson-Denny Reading Test with components of the MCAT and between the MCAT with the USMLE Step 1 exam, it is reasonable to suggest that medical schools should consider using an index of reading to better predict those applicants who will achieve success in medical school. As reported earlier, many factors contribute to academic success for medical students (Harward et al., 1998; Horshl & Kozeny, 1997). Reading ability (vocabulary, comprehension, and rate) is another factor to consider.

The 572 medical students were divided into Quartiles 1, 2, 3, and 4 based on their N-D Total Score. The analysis of variance with MCAT verbal reasoning as the dependent variable yielded a huge F-value. Once again, the powerful relationship between N-D Total and MCAT verbal reasoning was demonstrated.

Medical schools recruit highly capable individuals. By being selective, they are able to maximize success and minimize loss. But even a small proportion of unsuccessful students, common to every program, has a negative impact on medical education. The N-D Total and MCAT verbal reasoning scores undoubtedly tap into Spearman's "g" factor of intelligence. An extremely modest investment of financial and time resources in the Nelson-Denny Reading Test can yield disproportionate dividends for medical programs.

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