Validating Use of a Critical Thinking Test for the Dental Admission Test

Tsung-Hsun Tsai, Ph.D.

Abstract: The purpose of this study was to validate the use of a test to assess dental school applicants’ critical thinking abilities. The intent was to include this test on the Dental Admission Test (DAT) if it was shown to enhance the DAT’s validity. Correlation and regression analyses of undergraduate and dental school performance with scores on each of the tests on the DAT battery and the California Critical Thinking Skills Test (CCTST) were performed. Data were collected from 439 third- and fourth-year dental students who consented to participate and were enrolled at one of the ten accredited dental schools included in the study. These ten dental schools were from most regions of the United States. This study concluded that including the CCTST on the DAT did not significantly enhance the DAT’s validity.

Dr. Tsai is Consultant in Educational Measurement and Testing, Naperville, IL. Direct correspondence and requests for reprints to Dr. Tsung-Hsun Tsai, 2286 University Dr., Naperville, IL 60565; ttsai67@gmail.com.

Keywords: dental school admissions, Dental Admission Test, admission criteria, critical thinking, assessment

Submitted for publication 1/29/13; accepted 8/13/13

Each year a validity study is conducted to examine the relationship between Dental Admission Test (DAT) scores and dental school performance. The outcomes of these annual validity studies show that the DAT scores provide significant and useful information concerning dental applicants’ abilities in such areas as reading comprehension, fundamental knowledge of biology and general and organic chemistry, the ability to solve mathematical problems, and perceptual or spatial ability. The information gained from these studies adds another piece of information for dental school admissions committees to consider as part of the admission process.

The literature is replete with research studies examining the relationship between various admission criteria and success in dental school, and a number of these studies have included the DAT as one of the criteria. A study at the University of Florida College of Dentistry found that the DAT academic average score correlated with dental school grade point average (GPA) in the first and second years and that students with higher academic average scores were more likely to achieve higher scores on the National Board Dental Examination (NBDE) Parts I and II. Moreover, that study found that students who had difficulty progressing through the program tended to have lower academic average and perceptual ability test scores. A review of the literature by Ranney et al. found that college GPA and DAT scores were defensible criteria for U.S. and Canadian dental schools for selecting applicants. In a study of University of Iowa dental graduates from 2000 to 2007 that investigated numerous admission criteria, measures of dental school achievements, and scores on the NBDE, the strongest association between admission criteria and measures of dental school achievement occurred between DAT scores and NBDE scores. A similar study at the University of Mississippi found DAT scores to be predictive of success on NBDE Part I. This study was completed when NBDE Part I had four distinct subtests, and it found the DAT reading comprehension score was the most significant predictor for all four subtests (Anatomic Sciences, Biochemistry-Physiology, Microbiology-Pathology, and Dental Anatomy and Occlusion).

Although these studies have provided validity evidence that the DAT scores are predictive of academic success in the first and second years of dental education programs, those scores do not provide specific performance information regarding an applicant’s ability to reason and draw an appropriate conclusion concerning complex situations. This ability is often termed critical thinking. Critical thinking ability has been deemed important in predicting the clinical problem-solving ability of third- and fourth-year students practicing in the dental school clinic. This study was therefore designed to determine if including a critical thinking test on the DAT would...
enhance its overall validity. Of numerous tests on the market that have been developed to measure critical thinking skills, the American Dental Association (ADA)’s Council on Dental Education and Licensure (CDEL) through its Committee on Educational Measurement and Testing (which is charged with overseeing policy for the DAT) selected the California Critical Thinking Skills Test (CCTST) for this study.7 The committee and CDEL also selected the Clinical Problem-Solving Inventory as one of the criterion measures for this study. This inventory has been found to be a valid and reliable measure for evaluating dental students’ performance in the third and fourth years.8

The aim of the study was to investigate the validity of assessing critical thinking skills on the DAT. That is to say, it asked: are the scores derived from a critical thinking test superior predictors of performance on various criterion measures to the scores derived from the tests currently included in the DAT? To accomplish this objective, the study examined the intercorrelations among various predictors of success in dental school and criterion measures of dental school performance and students’ performance on Part I of the NBDE. One source of evidence to support including the CCTST on the DAT would be available to the extent that the correlations of the CCTST scores with the various criterion measures were superior to the correlations of the traditional DAT scores with the same measures.

Methods

The methods used for this study were predictor measures, criterion measures, and NBDE Part I performance. The predictors were undergraduate GPAs (predental and science GPAs); DAT scores, consisting of two DAT composite scores (total science and academic average) and six individual DAT scores (quantitative reasoning, reading comprehension, biology, general chemistry, organic chemistry, and perceptual ability); and an overall CCTST score. Criterion measures consisted of undergraduate and graduate GPAs, DAT scores, first- and second-year clinical faculty members’ ratings on the Clinical Problem-Solving Inventory (CPSI); and students’ performance on NBDE Part I, reported by their overall score on a scale score metric ranging from 49 to 99.

The CCTST, published by the California Academic Press, contains thirty-four multiple-choice questions to assess five critical thinking skills: analysis, inference, interpretation, evaluation, and explanation.7 The Critical Thinking Test subcommittee of CDEL’s Committee on Educational Measurement and Testing evaluated current tests available at the time of selection. While there have been other tests developed in recent years, the CCTST was deemed to be the most appropriate one available. The six scores given by the CCTST consist of an overall score (the number of correct answers based on thirty-four items) and subscores for five critical thinking skills.7 In this study, the overall scores from the administration of the CCTST to third- and fourth-year dental students who consented to participate in this study were used as a predictor.

The twenty-four-item CPSI was developed to measure the clinical problem-solving abilities of the third- and fourth-year dental students.8 Each of the twenty-four items represents one type of problem-solving ability required during the dental education experience.8 The CPSI was validated in 2000. The validity study was conducted using a sample of fifty-seven faculty members from four dental schools. A total of 183 third- and fourth-year dental students who consented to participate in the validity study were rated using the CPSI by the faculty members who were familiar with the students. Faculty members’ ratings on the CPSI were based on a scale of uniformly increasing agreement from 1 to 5, with 1=most disagreement and 5=most agreement. Faculty members could select a response of “Don’t Know” if they could not evaluate certain abilities. Ratings were analyzed by the Rasch measurement model.9

In the Rasch model, ratings from the twenty-four items were calibrated across all rating categories, so the underlying characteristics of items on the CPSI could be quantified and converted into an overall criterion value. Results from the study showed that the CPSI is valid and concluded that the CPSI could be used as a criterion measure for validating the use of a critical thinking test on the DAT.8

Regarding the DAT results, the DAT scores were collected as part of the regular scoring process. If a student took the DAT more than once, the scores from the first attempt were used. This rule is consistent with the rule in the annual DAT validity studies.

Pearson product-moment correlation coefficients were computed and used to evaluate the relationships among the overall CCTST score, undergraduate GPAs, DAT scores, first- and second-year dental school GPAs, NBDE Part I scores, and ratings achieved on the CPSI. Multiple regression analyses were also performed. The squared multiple correla-
Correlations between students’ dental school performance, ratings on the CPSI, and NBDE Part I scores and their undergraduate GPAs, all DAT scores, and overall CCTST score are shown in Table 2. The following results were found. The overall CCTST score was positively correlated with first- and second-year GPAs in dental schools at the 0.05 level of significance, i.e., correlations were all greater than 0.30. All DAT scores were significant predictors (at the 0.05 level of significance) of dental school performance with one exception. The predictive power of the perceptual ability score was insignificant relative to second-year biomedical GPA.

Regarding the use of the CPSI as a criterion measure for evaluating the predictive power of the overall CCTST score, the following results were found. The clinic faculty members’ ratings on the CPSI were highly reliable, i.e., an internal consistency reliability coefficient of 0.98 was found. This suggests that the faculty members rated students consistently. The highest correlation coefficient, 0.18, was found between the overall CCTST score and the ratings on the CPSI. Additional significant positive correlations were found among predental GPA, science GPA, general chemistry score, academic average, and ratings on the CPSI. Regarding NBDE Part I, significant positive correlations among the quantitative reasoning, biology, organic chemistry, total science, and perceptual ability scores, as well as academic average with the NBDE Part I scores, were found.

Results from the multiple regression analyses are shown in Table 3. The amount of explained variance in all criterion measures except the NBDE Part I score increased from 2 percent (clinic faculty members’ ratings on the CPSI) to 9 percent (first-year preclinical dental technique GPA) as additional

Correlations of each test on the current DAT battery with the overall CCTST score are shown in Table 1. Correlation of the DAT academic average with the overall CCTST score is also reported. As shown, the overall CCTST score was positively correlated with the reading comprehension score (0.46), the quantitative reasoning score (0.38), and the academic average (0.39) at the 0.05 level of significance.

Results

Data were gathered from the ten participating dental schools for 272 third- and 167 fourth-year students. These ten schools were from most of the major regions of the country: the Pacific, South Atlantic, East North Central, West North Central, and East South Central. Of these 439 students, twenty-four from one school were excluded from the analysis because certain data were unavailable, resulting in a sample of 415 students. The unavailable data were not associated with the study’s design.

Correlations of each test on the current DAT battery with the overall CCTST score are shown in Table 1. Correlation of the DAT academic average with the overall CCTST score is also reported. As shown, the overall CCTST score was positively correlated with the reading comprehension score (0.46), the quantitative reasoning score (0.38), and the academic average (0.39) at the 0.05 level of significance.

| Table 1. Correlations between the DAT subscores and the California Critical Thinking Skills Test (CCTST) |
|----------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Quantitative Reasoning          | 1.000           | 0.320           | 0.403           | 0.579           | 0.421           | 0.552           | 0.376           | 0.759           | 0.378           |
| Reading Comprehension           | 0.320           | 1.000           | 0.253           | 0.349           | 0.190           | 0.321           | 0.151           | 0.565           | 0.458           |
| Biology                         | 0.403           | 0.253           | 1.000           | 0.508           | 0.514           | 0.826           | 0.305           | 0.693           | 0.218           |
| General Chemistry               | 0.579           | 0.349           | 0.508           | 1.000           | 0.631           | 0.816           | 0.322           | 0.840           | 0.258           |
| Organic Chemistry               | 0.421           | 0.190           | 0.514           | 0.631           | 1.000           | 0.814           | 0.317           | 0.759           | 0.137           |
| Survey of Natural Sciences      | 0.552           | 0.321           | 0.826           | 0.816           | 0.814           | 1.000           | 0.346           | 0.894           | 0.250           |
| Perceptual Ability              | 0.376           | 0.151           | 0.305           | 0.322           | 0.317           | 0.346           | 1.000           | 0.406           | 0.233           |
| Academic Average                | 0.759           | 0.565           | 0.693           | 0.840           | 0.759           | 0.894           | 0.406           | 1.000           | 0.386           |
| CCTST                            | 0.378           | 0.458           | 0.218           | 0.258           | 0.137           | 0.250           | 0.233           | 0.386           | 1.000           |

*Bold values signify that the correlation was significant at the 0.05 level.
predictors were added to the regression model. The predictors included at each step were as follows: 1) the overall CCTST score and all DAT scores, 2) the overall CCTST score and all DAT scores except the reading comprehension score, 3) the overall CCTST score and all DAT scores except the quantitative reasoning score, and 4) the overall CCTST score and all DAT scores except the quantitative reasoning and reading comprehension scores.

Discussion

There was no significant contribution of CCTST to the final regression model with dental student performance as a predictor. For the purposes of this study, explained variance can be thought of as the influence of predictor scores on changes in the criteria. Adding the CCTST to the current DAT battery did not significantly enhance the predictive power related to academic performance in dental schools. A possible explanation for the lack of significant increase could be that some of the attributes measured in the CCTST were already being measured or accounted for by the DAT reading comprehension and quantitative reasoning tests. This contention was supported by empirical analyses of the content structure. Members of test construction committees determined that both the reading comprehension and the quantitative reasoning tests require examinees to think critically in order to correctly respond to some of the items included on these two tests. Test constructors tend to be educators from predoctoral dental schools around the country and are approved by CDEL.

Some limitations associated with this study include the following. The design of this study did not allow for the gathering of DAT scores and CCTST scores at the same time. Thus, one limitation relates to the extent to which critical thinking is fluid and changing over time. All participating schools were traditional curriculum-based dental schools. Schools with a problem-based learning curriculum did not participate. The results might be influenced by the way in which curriculum is delivered to students. In addition, while these participating dental schools were from most regions of the United States, the total number of participating students was 415. This represents only approximately 5 percent of total third- and fourth-year students and a relatively small sample size compared to the targeted sample size of 1,000 students.
A final limitation relates to the extent to which faculty members are able to successfully and accurately rate students on the CPSI. That is to say, faculty members might not know students well enough to provide the ratings on the CPSI. Practical considerations related to the use of a critical thinking skills test as a replacement for one of the tests on the current DAT battery include, but are not limited to, the following: the costs associated with adding a critical thinking skills test; the impact on testing time if the critical thinking skills test was added to the current DAT battery; and the need for an ongoing test development process to ensure a robust pool of critical thinking items for the examination.

**Conclusion**

This study evaluated the potential use of a test (the CCTST) that would measure a dental school applicant’s critical thinking ability in an attempt to enhance the overall validity of the DAT. In this study, correlation and regression analyses of numerous criterion measures with DAT scores, the overall CCTST score, and undergraduate achievement were performed. Results from the study showed that including the CCTST on the DAT did not significantly enhance the overall validity of the DAT, although positive correlations with some criterion measures were found.

The Council on Dental Education and Licensure through its Committee on Educational Measurement and Testing reviewed the critical thinking skills measured by major postgraduate admission testing programs (e.g., GRE, GMAT, LSAT, MCAT) and the outcomes of this study that suggest current tests on the DAT indirectly measure critical thinking skills. CDEL made the following suggestions regarding the content and structure of the DAT: retain the same number of algebra items; eliminate items on numerical calculations; add items on data analysis, interpretation, and sufficiency; eliminate items on conversions; add items on quantitative comparison; increase the number of items on probability and statistics; eliminate items on geometry; eliminate items on trigonometry; and retain the same number of items on applied mathematics (word) problems.

**Acknowledgments**

The author thanks Gene A. Kramer, Laura M. Neumann, and anonymous reviewers for their comments. The information and opinions contained in this article reflect and are solely the work of the author and are not those of the American Dental Association or its employees or members.

**REFERENCES**


