Cognitive and Learning Styles as Predictors of Success on the National Board Dental Examination

L.S. Behar-Horenstein, Ph.D.; Cynthia W. Garvan, Ph.D.; B.J. Bowman; M. Bulosan, M.S., M.Ed.; S. Hancock, Ph.D.; M. Johnson; B. Mutlu, Ph.D.

Abstract: Using a deidentified retrospective dataset of three cohorts of matriculated dental students, we measured the degree to which selected student attributes, the Learning Type Measure, the Myers-Briggs Type Indicator, and Dental Admission Test subtests scores predicted passage on the National Board Dental Examination (NBDE), Parts I and II. Gender, Myers-Briggs Type Indicators, and the Dental Admission Test subtests for academic average and biology were found to be predictive of passing the NBDE Part I. Gender, a Myers-Briggs Type Indicator (thinking over feeling), and the Dental Admission Test subtests on reading and biology were found to be predictive of passing the NBDE Part II. The Learning Type Measure was not found to be predictive of passing the NBDE Part I or Part II. This study holds implications for heightening faculty members' awareness of students' aptitude and cognitive attributes, for teaching, and for the admissions process.

Dr. Behar-Horenstein is Distinguished Teacher Scholar and Professor, School of Human Development and Organization Studies, College of Education and Affiliate Professor, Department of Behavioral Science and Community Dentistry, College of Dentistry, University of Florida; Dr. Garvan is Associate Scholar, University of Florida; Ms. Bowman is an Ed.S. student, University of Florida; Ms. Bulosan is a nonprofit intern; Dr. Hancock is Assistant Professor of Early Childhood Education, Georgia College and State University; Ms. Johnson is a doctoral student in instructional technology, University of Florida; and Dr. Mutlu is a program director, College of Business, University of Florida. Direct correspondence and requests for reprints to Dr. L.S. Behar-Horenstein, School of Human Development and Organization Studies, College of Education, University of Florida, P.O. Box 117049, Gainesville, FL 32611-7049; 352-273-4330 phone; 352-846-2697 fax; lsbhoren@ufl.edu.

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Performance on the National Board Dental Examination (NBDE) determines whether or not U.S. dental students will become licensed to practice dentistry; passing both parts of this exam must be accomplished prior to graduation from an accredited dental school. While it is widely accepted that the nature and quality of instruction and learning experiences impact board scores, students enter their training with pre-existing attributes and aptitudes that also influence outcomes. The purpose of this study was to examine the relationship among the Dental Admission Test (DAT), Learning Type Measure (LTM), Myers-Briggs Type Indicator (MBTI), and student performance on the NBDE Parts I and II.

Background for the Study Variables

The NBDE aids state boards of dentistry by establishing criteria for dentists who seek licensure to practice. The exam assesses students' abilities to comprehend important information from related sciences and to apply such knowledge in problem-solving scenarios.[1] Part I of the NBDE assesses students' comprehension in the basic sciences in the following subtests: anatomical sciences, biochemistry and physiology, microbiology and pathology, and dental anatomy and occlusion. In the NBDE Part II, students are tested on their capacities to use decisive skills in interpreting, analyzing, and answering questions.[2] The NBDE Part I is comprised of 400 questions. Beginning in 2007, eighty (20 percent of all questions) were tailored to case-based scenarios.[2] The NBDE Part II is comprised of 100 case-based questions related to dental specialties and patient management and 400 stand-alone questions.[1] The NBDE has a genuine, if unintended, influence on the dental school curriculum.[3]

The DAT was developed in the 1940s to provide a uniform means of evaluating dental school applicants from different backgrounds. The DAT consists of six subtests and eight subtest scores. The six subtests are for reading comprehension, quantitative reasoning, the Perceptual Ability Test (PAT), biology, inorganic chemistry, and organic chemistry.

Two additional scores are for academic average and survey of natural sciences (SNS). The scores of the academic average and SNS are composite scores, calculated from three subtest and five subtest scores, respectively: the three subtests are biology, general chemistry, and organic chemistry, while the five subtests are quantitative reasoning, reading comprehension, biology, general chemistry, and organic chemistry. The validity and usefulness of the DAT have been a concern of the Council on Dental Education and Licensure since the test's inception.[4] Changes have been made to its content, scoring, and test delivery to satisfy the dental community's needs and to ensure that it remains valid.

De Ball et al. compared the DAT and NBDE Part I (anatomical sciences, biochemistry and physiology, microbiology and pathology, and dental anatomy and occlusion) scores among 114 University of Mississippi dental students and found that the DAT reading comprehension score was a strong predictor of student performance in the microbiology-pathology subtest.[5] In 2005, Bergman et al. replicated De Ball et al.'s analysis, comparing DAT and NBDE Part I scores for 242 Harvard School of Dental Medicine students.[6] The average R^2 value for all four DAT subtests was .09, and they concluded that "The ability of the DAT scores to predict NBDE subtest performance is less for scores that are further from the national average and do not encompass the full range of possible scores."

The MBTI is designed to identify preferences of perception and judgment. Based on self-report, the results fall into four preferences or styles: 1) extraversion (E) or introversion (I); 2) sensing (S) or intuition (N); 3) thinking (T) or feeling (F); and 4) judging (J) or perceiving (P). The various combinations of the four styles result in sixteen different psychological types. Several studies have explored personality styles of dental students.[7-10] One group of researchers found that the MBTI was not useful for predicting academic success among dental students, but that it held potential benefits for predicting clinical success.[11]

A summary of the most common MBTI types of dental students in four studies is shown in Table 1. ESTJ was found to be one of the most common types in all four. In a study conducted in 1997 at the University of Florida on 256 dental students, 21.5 percent indicated this preference.[8] The top four styles (ESTJ, ESFJ, ISTJ, and ENTJ) in this study accounted for more than 62 percent of all students' types. Among 124 students at the University of Texas Health Science Center at Houston Dental Branch, the most common style was ESTJ, representing more than 20 percent of those studied.[7] The ESTJ, ESFJ, and ISFJ styles represented almost 56 percent of all students' types in that study. In a study of 299 dental students at the Leeds Dental Institute, ESTJ and ESFJ accounted for 81.8 percent and 75.2 percent of female and male dental students, respectively.[9] In a study of 372 dental students who took the Chinese version of the MBTI, ESTJ combined with ISTJ and ISFP accounted for more than 40 percent of the styles.[10] Only Jones et al. studied the MBTI types of dental students in relation to academic performance.[8] Student performance was measured by scores on the NBDE Part I and II, class rank, and issues of academic difficulty as measured by the Student Performance Evaluation Committee

Table 1. Most common MBTI types of dental students in four studies

	Jones et al.[1]	Morris[2]	Jessee et al.[3]	Wu et al.[4]
ESTJ	X	X	X	X
ESFJ	X	X	X	
ISTJ	X		X	X
ENTJ	X			
ISFJ			X	
ISFP				X

Sources:
1. Jones AC, Courts FJ, Sandow PL, Watson RE. Myers-Briggs Type Indicator and dental school performance. J Dent Educ 1997;61(12):928–33.
2. Morris DO. Personality types of dental school applicants. Eur J Dent Educ 2000;4:100–7.
3. Jessee SA, O'Neill PN, Dosch RO. Matching student personality types and learning preferences to teaching methodologies. J Dent Educ 2006;70(6):644–51.
4. Wu S, Miao D, Zhu X, Liang J, Liu X, Luo Z, Wang W. The personality types of Chinese dental postgraduate students. Soc Beh Pers 2007;35(8):1077–86.

(SPEC). Introversion was the only personality preference associated with mean performance on the NBDE. According to the SPEC, introverted students demonstrated a decreased mean class rank throughout their four years in the dental program and a greater risk for experiencing major academic difficulties.

The LTM is one of the other learning style inventories used for explaining an individual's learning styles. The LTM systematically determines an individual's preference for learning. The results graphically display an individual's degree of preference for each of the four types of styles with a composite of an individual's learning type, personal hemisphericity preference, and reliance upon watching or doing. The LTM is based on situational adaptations of Jung's constructs of feeling, thinking, sensing, intuition, extroversion, and introversion; behaviors modeled after Kolb's constructs of concrete experiential, reflective, abstract, and active learners; representations of hemisphericity drawn from Bogen; and McCarthy's field work. All of these dimensions make up the structural basis for the LTM.[12]

Concurrent validity of the LTM was established using two measures. Based upon the results of those (n=175) who took the LTM and the Learning Styles Inventory (LSI) (the chi-square value 137.43, df=9 was significant at p<.001), concurrent validity between the LTM and the MBTI was established.[12] Most often associated with the Learning Type 1 score is the feeling score, while introvert, thinking, and judging were most often associated with the Learning Type 2 score. The sensing score was most often associated with the Learning Type 3 score, and extrovert, intuition, and perceiving scores were most frequently associated with the Learning Type 4 score. The LTM is designed to objectify that area of attention given the highest priority and the relationship of this priority to the other three major aspects of knowing. Type 1 Learners perceive with feeling and process by watching, Type 2 Learners perceive with thinking and process by watching, Type 3 Learners perceive with thinking and process by doing, and Type 4 Learners perceive by feeling and process by doing. Internal consistency for the LTM item scales using Cronbach's alpha is .853 for Learning Type 1, .835 for Learning Type 2, .767 for Learning Type 3, and 0.885 for Learning Type 4. Analysis of the LTM scores yielded .71 for the test-retest reliability coefficient.[12]

Student success originates from a comfortable learning environment where curriculum and teaching strategies are responsive to students' learning needs. Dental students have unique learning needs since they must acquire content knowledge of multiple subjects as well as psychomotor skills. Understanding the interplay between students' learning styles and success on national boards may hold implications for dental curricular experiences. However, research on dental students' learning styles has been rare. Also, there is little to no research about what role, if any, they play in dental student success on their board exams. To address this knowledge gap, we investigated the following in a deidentified retrospective dataset of three cohorts of matriculated dental students: 1) the relationship between demographic variables (gender, age, race) and cognitive/learning styles and DAT scores; 2) the relationship between cognitive (MBTI) and learning (LTM) styles; 3) the relationship between cognitive/learning styles and DAT scores; and 4) the relationship among demographic variables (gender, age, race), cognitive/learning styles, DAT scores, and performance on the NBDE Parts I and II.

Methods

Using a deidentified retrospective dataset, scores were obtained from the College of Dentistry's Office of Education at the University of Florida for the graduating classes of 2006, 2007, and 2008. The university's Institutional Review Board determined that the study was exempt. The dataset was comprised of 209 graduates of the college. The mean age was 29.2 years (SD=2.6). Of the 209 students, ninety-five (45 percent) were female, and 114 (55 percent) were male. One hundred fifty students (71.8 percent) were white, twenty-eight (13.4 percent) were Asian/Pacific Islander, twenty-three (11.0 percent) were black, five (2.4 percent) were Hispanic, and three (1.4 percent) were unspecified. Given the low number of Hispanic, black, and unspecified students, this group was designated as a separate category "Other," comprised of thirty-one (14.8 percent) students.

Cognitive style and learning type are assessed in the first semester, in the fall of the students' incoming year, so they can acquire insight about their own learning, modify their study habits as needed, and enhance their knowledge of faculty teaching methodologies. The MBTI administered at the site since 1972 was used to assess cognitive attributes. The LTM was used to assess students' learning styles.

Of the students' MBTI preferences, forty-seven (22 percent) were ESTJ, twenty-nine (14 percent) were ESFJ, and twenty-eight (13 percent) were ISTJ. Twenty (10 percent) were ISFJ, and fifteen (7 percent) were ENTJ. Eleven (5 percent) were ISTP, eleven (5. percent) were ENFJ, and nine (4 percent) were ESTP. The remaining eight (20 percent) psychological types (ENFP, INTP, INFP, ISFP, INTJ, ENTP, ESFP, and INFJ) were each 3 percent or less of the total sample and were grouped into the category of Other. The most predominant LTM across the participants was equally Type 2 and 3 (n=66, 32 percent), followed by Type 1 (n=41, 20 percent) and Type 4 (n=35, 16 percent). The mean NBDE Part I score was 87.73 (SD=41); the scores ranged from 79 to 99. The mean NBDE Part II score was 82.98 (SD=3.91); the scores ranged from 74 to 93. A passing score is 75 or higher.

Wilcoxon rank-sum, Kruskal-Wallis, Spearman correlation, chi-square, and Fisher's exact tests (in the case of data sparseness) were run to determine: 1) the relationship between cognitive (MBTI) and learning style (LTM); 2) the relationship between demographic variables (gender, age, race) and cognitive/learning styles; and 3) the relationship among demographic variables (gender, age, race), cognitive/learning styles, and admission test scores (DAT). Multiple regression was performed to determine which factors were most predictive of NBDE Parts I and II scores. Due to the highly correlated nature of the DAT subscales and in order to develop a parsimonious model, we performed a preliminary stepwise regression to select the DAT subscales most predictive of the participants' board scores. Results of the bivariate analyses and stepwise regression were used to select the cognitive (MBTI), the learning style (LTM), and demographic and DAT variables for the regression models. SAS software (version 9.2; Cary, NC) was used for all analysis. A level of significance was set at .05 for all statistical testing.

Results

Demographic Variables Related to Cognitive/Learning Styles and DAT Scores

Males scored significantly higher than females on all DAT subtests with the exception of reading in which scores were comparable (20.8 and 20.6, respectively). Females scored significantly higher on the MBTI feeling (56 percent, 26 percent, respectively; p<.0001) and judging (82 percent, 68 percent, respectively; p<.0236) when compared to males. There was a significant gender difference on the LTM (p<.0002) and MBTI (p<.0001). Females showed a greater preference for LTM 1 compared to males: 32 percent and 10 percent, respectively. Males and females were nearly comparable on LTM 2: 33 percent and 31 percent, respectively. Males' preference for LTM 3 was nearly twice as much as females': 41 percent and 21 percent, respectively. Males and females scored similar on their preference for LTM 4: 19 percent and 15 percent, respectively. Females' preference for ESFJ compared to males was notably higher: 25 percent and 4 percent, respectively. Males' performance on all DAT subtests except reading and organic chemistry was significantly higher than females' (see Table 2).

Age in years was significantly related to extraversion and introversion: 28.8 (SD=2.2) and 29.8 (SD=3.1), respectively (p-value=0.0095). Age was not found to be significantly related to any other cognitive style variable or to learning style. Age was significantly and negatively correlated with five of the DAT scores: academic (r=-0.21, p-value=.0027), quantitative (r=-0.21, p-value=.0024), biology (r= -0.18, p-value 0.0089), organic chemistry (r=-0.19, p-value=.0058), and survey of natural science (r= -0.23, p-value=0.0010).

Participant race was not found to be significantly related to any of the four MBTI cognitive styles but was found to be significantly related to learning style (p-value=.0022). For whites, 14 percent, 31 percent, 35 percent, and 20 percent had learning styles 1, 2, 3, and 4, respectively. For Asian Americans, 29 percent, 39 percent, 32 percent, and 0 percent had learning styles 1, 2, 3, and 4, respectively. For the "Other" group, 36 percent, 36 percent, 9 percent, and 18 percent had learning styles 1, 2, 3, and 4, respectively. Race was significantly related to two of the admission test scores: inorganic chemistry (p-value=.0136) and survey of natural science (p-value=.0055). Means (SD) of whites for inorganic chemistry and survey of natural science were 19.3 (2.7) and 19.0 (1.8), compared to 21.0 (3.4) and 20.0 (2.2) for Asian Americans and 20.0 (2.5) and 20.0 (1.9) for "Other."

Relationship Between Cognitive and Learning Styles

Extraversion and intuition were significantly related to LTM 4: p=.028 and p<.0001, respectively. Feeling was significantly related to LTM 1 (p<.0001), and judging was significantly related to LTM 3 (p=.0126). See Table 3 for further detail.

Table 2. Comparison of males and females on learning style, cognitive style, and Dental Admission Test (DAT)

	Males % or M (SD)	Females % or M (SD)	p-value
V7: Extraversion	56%	65%	.1796
V8: Intuition	30%	22%	.2070
V9: Feeling	26%	56%	<.0001
V10: Judging	68%	82%	.0236
MBTI			
ENFJ	4%	7%	.0001
ENTJ	9%	5%	
ESFJ	4%	25%	
ESTJ	25%	20%	
ESTP	7%	1%	
ISFJ	6%	14%	
ISTJ	18%	9%	
ISTP	6%	4%	
Other	21%	15%	
LTM			
1	10%	32%	.0002
2	31%	33%	
3	41%	21%	
4	19%	15%	
Academic	19.9 (1.6)	19.4 (1.5)	.0084
Perceptual Ability Test	18.4 (1.8)	17.5 (1.7)	.0004
Quantitative Reasoning	19.1 (3.1)	18.3 (2.9)	.0371
Reading	20.8 (2.6)	20.6 (2.5)	.6581
Biology	19.3 (2.2)	18.6 (2.1)	.0272
Inorganic Chemistry	20.1 (3.0)	19.1 (2.5)	.0283
Organic Chemistry	20.1 (2.8)	19.5 (2.9)	.1778
Survey of Natural Sciences	19.6 (1.9)	18.9 (1.9)	.0115

Table 3. Comparison of cognitive style by learning style

	LTM 1 n=41	LTM 2 n=66	LTM 3 n=66	LTM 4 n=35	p-value
E	66%	53%	53%	80%	.0280
N	27%	20%	14%	60%	<.0001
F	76%	41%	20%	31%	<.0001
J	80%	70%	85%	57%	.0126

Cognitive/Learning Styles Related to DAT Scores

Participants with a preference for introversion (18.3, SD=1.8) over extraversion (17.8, SD=1.8) scored significantly higher (p=.0145) on the PAT subtest. Participants with a preference for introversion (21.3, SD=2.4) over extraversion (20.4, SD=2.6) scored significantly higher (p=.0025) on the reading subtest. Participants with a preference for thinking (19.1, SD=3.0) over feeling (18.3, SD=3.1) scored significantly higher (p=.0157) on the reading subtest. Participants with a preference for LTM 2 (mean=20.0, SD=1.6) scored significantly higher (p=.031) on the academic subtest compared to LTM 1 (19.3, SD=1.6), LTM 3 (19.5, SD=1.6), and LTM 4 (20.0, SD=1.5). Participants with a preference for LTM 4 (20.4, SD=3.9) scored significantly higher (p=.0012) on the quantitative subtest compared to LTM 1 (17.8, SD=2.6), LTM 2 (19.0, SD=2.7), and LTM 3 (18.4, SD=2.7). (See Table 4.)

Demographic Variables Related to Cognitive/Learning Styles and DAT/NBDE Scores

Results from the bivariate analysis of demographic variables (gender, age, race), cognitive/learning styles, admission test scores (DAT), and performance on the NBDE Parts I and II are shown in Table

5. A summary of the relevant findings follows. Age was significantly and negatively related to the NBDE Part I (p=.0148). The MBTI was significantly related to the NBDE Part I (p=.0155). The DAT subtests on academic average, quantitative, reading, biology, organic chemistry, and survey of natural sciences were significantly related to the NBDE Part I (p<.0001) as well as inorganic chemistry (p<.0002). For the NBDE Part II, there were significant relationships with the MBTI preferences introversion (p=.0354) and thinking (p=.0015). The DAT subtests on survey of natural sciences (p=.0088), academic average, reading, and biology were significantly related to the NBDE Part II (p<.00001).

To determine which factors were most predictive of the NBDE Parts I and II, multiple regression analysis was performed. Since the DAT variables were highly correlated, we used stepwise regression to select the DAT variables for inclusion in our multiple regression models for the NBDE Parts I and II. The academic average and biology variables were retained in the stepwise model for the NBDE

Table 4. Mean (SD) of DAT scores by cognitive style (MBTI) and learning style

	Academic Average M (SD) p-value	PAT M (SD) p-value	QUANT M (SD) p-value	Reading Comprehension M (SD) p-value	Biology M (SD) p-value	Inorganic Chemistry M (SD) p-value	Organic Chemistry M (SD) p-value	SNS M (SD) p-value
V7								
Extraversion	19.6 (1.6)	17.8 (1.8)	18.7 (3.0)	20.4 (2.6)	18.7 (1.8)	19.8 (2.8)	19.7 (2.8)	19.2 (1.8)
Introversion	19.8 (1.6)	18.3 (1.8)	19.0 (3.1)	21.3 (2.4)	19.4 (2.6)	19.3 (2.8)	19.9 (3.1)	19.3 (2.1)
	.2043	.0145	.5592	.0025	.0632	.2126	.6232	.7701
V8								
Intuition	19.8 (1.6)	18.1 (1.7)	19.0 (2.8)	20.4 (2.7)	19.3 (2.2)	19.9 (3.1)	19.7 (3.0)	19.4 (2.0)
Sensing	19.7 (1.6)	18.0 (1.8)	18.7 (3.1)	20.9 (2.5)	18.9 (2.2)	19.5 (2.7)	19.9 (2.8)	19.2 (1.9)
	.6510	.8900	.1977	.3989	.2528	.4742	.5682	0.4986
V9								
Feeling	19.5 (1.5)	17.7 (1.6)	18.3 (3.1)	20.6 (2.4)	18.6 (2.1)	19.7 (2.9)	19.5 (2.8)	19.1 (2.0)
Thinking	19.8 (1.6)	18.2 (1.9)	19.1 (3.0)	20.8 (2.7)	19.2 (2.2)	19.6 (2.8)	20.0 (2.9)	19.4 (1.8)
	.1474	.0717	.0157	.6575	.0967	.7318	.2607	.2256
V10								
Judging	19.6 (1.6)	18.0 (1.9)	18.6 (2.9)	20.7 (2.6)	18.9 (2.2)	19.5 (2.9)	19.8 (2.8)	19.2 (1.9)
Perceiving	19.9 (1.5)	18.0 (1.6)	19.2 (3.3)	20.9 (2.4)	19.2 (2.0)	19.9 (2.7)	19.9 (3.0)	19.4 (1.8)
	.1043	.9575	.2025	.4519	.3623	.2780	.8397	.5371
MBTI								
ENFJ	18.9 (1.4)	16.9 (1.0)	17.8 (2.5)	18.9 (2.9)	18.4 (1.3)	19.5 (3.3)	18.7 (1.7)	18.8 (1.6)
ENTJ	19.7 (1.4)	18.2 (2.1)	19.8 (2.5)	20.7 (2.3)	18.9 (1.9)	19.6 (3.1)	18.7 (2.4)	19.1 (1.9)
ESFJ	19.4 (1.4)	17.7 (1.7)	18.3 (2.8)	20.7 (2.1)	18.3 (2.1)	19.2 (2.5)	19.6 (2.1)	18.9 (1.8)
ESTJ	19.9 (1.9)	18.1 (2.0)	18.8 (3.2)	20.6 (3.0)	19.1 (1.8)	20.1 (3.1)	20.5 (3.2)	19.7 (1.9)
ESTP	19.8 (1.3)	17.1 (1.4)	20.4 (3.4)	20.9 (2.8)	18.1 (0.9)	20.1 (1.9)	19.0 (1.4)	18.9 (0.8)
ISFJ	19.6 (1.8)	17.7 (1.9)	18.7 (3.4)	21.1 (2.3)	18.6 (2.4)	19.4 (3.1)	19.4 (3.4)	19.0 (2.4)
ISTJ	19.4 (1.3)	18.6 (1.6)	18.2 (2.2)	20.7 (2.6)	19.2 (3.1)	18.7 (1.9)	19.8 (2.5)	19.1 (1.8)
ISTP	20.1 (1.5)	17.7 (2.1)	18.8 (3.0)	21.9 (2.3)	19.7 (1.4)	18.7 (3.2)	20.5 (3.0)	19.5 (2.0)
Other	20.0 (1.6)	18.5 (1.5)	19.2 (3.4)	20.9 (2.5)	19.5 (2.3)	20.2 (2.9)	20.1 (3.3)	19.6 (2.0)
	.3732	.0617	.2393	.2903	.2378	.4789	.4784	.7195
LTM								
1	19.3 (1.6)	18.0 (1.7)	17.8 (2.6)	20.1 (2.5)	18.5 (2.3)	19.3 (2.5)	20.0 (3.2)	19.1 (2.2)
2	20.0 (1.6)	18.3 (2.1)	19.0 (2.7)	21.1 (2.4)	19.4 (2.3)	20.0 (2.9)	20.0 (2.8)	19.6 (1.9)
3	19.5 (1.6)	18.0 (1.7)	18.4 (2.7)	20.7 (2.7)	18.8 (2.1)	19.3 (3.2)	19.6 (2.7)	19.1 (1.9)
4	20.0 (1.5)	17.7 (1.6)	20.4 (3.9)	20.9 (2.6)	18.9 (2.0)	19.8 (2.2)	19.7 (3.1)	19.2 (1.5)
	.0310	.5836	.0012	.2949	.2482	.1381	.8124	.3369

PAT=Perceptual Ability Test; QUANT=quantitative reasoning; SNS=Survey of Natural Sciences

Table 5. Bivariate relationship among demographic variables (gender, age, race), cognitive style (MBTI), learning styles (LTM), DAT scores, and performance on the NBDE Parts I and II

	NBDE Part I		NBDE Part II	
	M (SD) or r	p-value	M (SD) or r	p-value
Gender				
Male	87.6 (4.0)	.4945	82.9 (3.5)	.6103
Female	87.9 (4.2)		83.0 (4.4)	
Age	-0.16845	.0148	0.06429	.3563
Race				
White	87.7 (4.0)	.4843	83.4 (3.7)	.1606
Asian American	88.7 (4.4)		81.8 (4.4)	
Other	87.3 (4.0)		82.4 (4.5)	
V7				
Extraversion	87.8 (4.2)	.7931	82.4 (3.6)	.0354
Introversion	87.6 (3.9)		83.9 (4.2)	
V8				
Intuition	87.3 (4.1)	.3802	82.4 (3.9)	.0973
Sensing	87.9 (4.1)		83.2 (3.9)	
V9				
Feeling	87.1 (4.4)	.0563	82.2 (4.1)	.0255
Thinking	88.1 (3.9)		83.5 (3.7)	
V10				
Judging	87.8 (4.2)	.9182	83.0 (3.9)	.4960
Perceiving	87.6 (3.7)		82.8 (3.9)	
MBTI				
ENFJ	84.6 (3.8)	.0155	80.8 (2.6)	.3862
ENTJ	89.3 (4.7)		82.7 (4.3)	
ESFJ	88.4 (4.3)		82.3 (3.1)	
ESTJ	88.6 (4.3)		83.1 (3.1)	
ESTP	86.6 (3.1)		82.6 (4.2)	
ISFJ	86.6 (5.2)		83.4 (4.8)	
ISTJ	87.1 (2.9)		84.2 (3.8)	
ISTP	90.3 (3.7)		84.5 (3.9)	
Other	87.1 (3.5)		82.7 (3.9)	
LTM				
1	86.6 (4.5)	.1971	81.9 (4.2)	.1324
2	88.2 (4.1)		83.7 (4.1)	
3	88.1 (4.0)		83.4 (3.7)	
4	87.5 (3.7)		82.2 (3.2)	
Academic Average	.45	<.0001	.27	<.0001
PAT	.06	.3865	.13	.0618
Quantitative Reasoning	.32	<.0001	.22	.0015
Reading Comprehension	.27	<.0001	.31	<.0001
Biology	.44	<.0001	.27	<.0001
Inorganic Chemistry	.26	.0002	.08	.2459
Organic Chemistry	.29	<.0001	.09	.2092
Survey of Natural Sciences	.42	<.0001	.18	.0088

Part I. The PAT, reading, and biology were retained in the stepwise model for the NBDE Part II. Based on results from the bivariate and stepwise analyses, the multiple regression model for the NBDE Part I included gender, age, MBTI, academic average, and biology. After adjusting for other variables in the model, only age was not found to be significant (see Table 6). Gender, MBTI indicators, and the DAT subtests academic average and biology predicted 32 percent of the variance in passing the NBDE Part I. The multiple regression model for the NBDE Part II included gender, age, Myers-Briggs cognitive types introversion and extraversion, Myers-Briggs cognitive types feeling and thinking, PAT, reading, and biology. After adjusting for other variables in the model, age, Myers-Briggs cognitive types introversion and extraversion, and PAT were not found to be significant (see Table 6). Gender, MBTI thinking over feeling, and the DAT subtests reading and biology predicted 19 percent of the variance in passing the NBDE Part II.

Table 6. Multiple regression results

Variable	NBDE Part I Model R2=.32 p-value	NBDE Part II Model R2=.19 p-value
Gender	.0455	.0458
Age	.5544	.2985
v7	NI	.1098
v9	NI	.0133
MBTI	.0127	NI
Academic Average	<.0001	NI
PAT	NI	.0826
Reading Comprehension	NI	.0023
Biology	.0182	.0092

Notes: R^2=.32 [F=7.80, df=(12, 196), p<.0001] for the NBDE Part I Model; R^2=.19 [F=6.52, df=(7, 200), p<.0001] for the NBDE Part II Model.

NI=not included in model

Discussion

Gender was found to be predictive of passing the NBDE Parts I and II. This finding partially supports the findings of Fields et al.[13] In their study, males had significantly higher performance than women on all DAT subtests except reading and biology. In our study, males scored significantly higher than females on all DAT subtests except reading and organic chemistry. These findings partially support Stewart et al., who found that men outperformed females on academic average and PAT.[14] On the NBDE Part II, gender differences support Fields et al., who found that males significantly outperformed females. These findings suggest that gender plays a role in performance on the NBDE Part I. Historically, women have scored lower than men on board exams even though they tend to do as well as men in the classroom and on course-related tests.[13] Our findings suggest that instructors may need to modify instruction to eliminate gender bias.

The observed negative relationships between age and five of the DAT scores (academic average, quantitative, biology, organic chemistry, and survey of natural sciences) suggest that the older the student is, the less well he or she performs on these subtests. However, age was not predictive of passing the NBDE Part I or II.

In our study, 36 percent of the participants preferred a single learning style type, while most students (64 percent) preferred multiple learning styles. These findings partially support Lujan and DiCarlo, who found that first-year medical students preferred learning through multiple learning styles.[15] LTM was not found to be predictive of passing the NBDE Part I or II.

The DAT findings of our study contradict those in De Ball et al. and Bergman et al.[5,6] In De Ball et al., the reading comprehension section of the DAT was found to be a strong predictor of success on the NBDE Part I on the subtest microbiology-pathology.[5] However, this result should be interpreted with caution because each version of the DAT reading comprehension subtest covers different subject areas such as music, arts, science, and social science. Therefore, an examinee who takes other versions of the reading comprehension test might perform differently because of his or her background knowledge. Bergman et al. also found that the DAT scores were a predictor of success on the NBDE Part I.[6] This study showed that the DAT subtests academic average and biology were most predictive of passing the NBDE Part I. The MBTI was found to be predictive of the NBDE Part I. The DAT subtests reading and biology were most predictive of passing the NBDE Part II.

The most common MBTI styles for the students in our study corresponded to the most common preferences found in other studies.[7-10] In this study, the four most common MBTI styles were ESTJ, ESFJ, ISTJ, and ISFJ. All four of these preferences emerged as some of the most common in other studies. The most common styles in Jones et al.[8] were ESTJ, ESFJ, and ISTJ. The findings in our study matched three of those four. In addition, the most common preference in Jones et al. and our study was ESTJ. Jones et al.'s finding that introversion was a significant predictor of passing the NBDE was not supported by our study. However, the MBTI was predictive of passing the NDBE Part I, and thinking over feeling was predictive of passing the NDBE Part II. More research is needed to find out how the DAT, learning type measures, and the MBTI affect student performance as it relates to teaching. For example, most of the research on the MBTI styles of dental students is descriptive.[7,9,10] Only Jones et al. looked at how those styles might impact academic success.[8] Also, since the findings relative to the NBDE are predominantly tied to preclinical education, more research is needed on the relationships among the DAT, LTM, and MBTI and how they impact later performance in the dental school's clinical learning environment.

Our results are limited by the scope of the study since participants were representative of only three cohorts (N=209) from a single dental school in the southeast. The results cannot be construed to be representative of all dental students in the United States. Nationally, NBDE scores from the study's cohorts on Part I fall into the top 10 percent. The pass rates on Part II, available for only one of the three cohorts, ranged from the top 10 percent to the mid-range (53 percent). All students take a review course in the sixth semester prior to taking the NBDE Part I. At least 95 percent of students from all three cohorts passed the NBDE Part I on the first attempt. Remaining student participants in this study passed the NBDE Parts I and II on the second attempt. Our study is also limited due to modest sample size. It is important to recognize that the NBDE will soon become pass/fail. The potential implications of that change in light of the study's findings suggest the need for further study.

Many questions are raised but unanswered by the results. For example, are these findings related to students' preference for learning or the ways in which they are taught? Are students taught to the test? The findings may catalyze awareness among faculty members so that they recognize that students' DAT scores and cognitive attributes do influence pass rates on the NBDE. Future studies might explore the relationship between faculty members' and students' MBTI styles. Future research might also include qualitative inquiry to better understand the correspondence between faculty members' teaching and their own personality styles. Other forms of inquiry could focus on determining if faculty members' identification of their own and their students' cognitive attributes would result in the provision of a more diverse set of learning experiences that correspond to varied students' learning and personality styles.

The findings reported here suggest that dental admissions, the DAT, and the dental school curriculum may play a unique role in predicting passing the NBDE and begs this question: does the selection of students based on DAT scores and the taught curriculum predict that all students will pass the NBDE irrespective of trait variables? If dental schools maintained a database of students' cognitive attributes and NBDE pass rates, the relationship between cognitive attributes and student success in the context of demographic variables might be better understood. To investigate generalizibility of findings, it would be interesting to compare the cohorts in this study to other U.S. dental schools with similar passing rates. If these trends are sustained, then perhaps it would be possible to determine if dental students nationally exhibit particular cognitive attributes. Moreover, if trends show that only students with particular cognitive attributes do or do not pass the national boards, those findings might suggest a role for observing instructional practices.

Understanding the predictability of student attributes and the DAT subtest scores has implications for shaping the curriculum and teaching students from varied backgrounds. For example, if faculty members had information about students' cognitive attributes, they would be in a better position to tailor instruction to respond to students' learning style types and increase their capacity in areas where their preferences are weak. If instructors are given a profile of their students' cognitive attributes, they can be more proactive in meeting their learning needs. Also, when faculty members take the time to reflect upon their own teaching practices, they can consider if how they teach is appropriate to students' cognitive attributes.[12] Having information about students' preferences can help instructors move away from a predisposition to treat students as if they all learn in similar ways.[12] Conducting semistructured observations of instructors while they teach can also provide faculty members with a portrait illustrating their behavior as well as insight into their practices. As Behar-Horenstein et al. noted, "First-hand observations allow the inquirer to be open, discovery-oriented, and inductive because the observer has less need to rely on prior conceptualizations of classroom teaching. The observer also has an opportunity to discover things that no one else has really paid attention to and a chance to learn things" (p. 642).[16]

Oftentimes, instructors are unaware of how they teach or lack the vocabulary to describe their instructional practices. Successive four-year studies of student cohort groups, instructors' teaching practices, students' cognitive attributes, and student success on national boards might give admission committees adequate information about the taught curriculum, student attributes, and national board scores to clarify the role that the taught curriculum plays in the relationship between student cognitive attributes and board scores. Additionally, trying to better understand the relationship between students' LTM and MBTI attributes and their noncognitive performance in preclinical and clinical courses could also be used to depict the relationships among teaching, learning, and student dispositions in clinical learning environments. Finally, the findings in this study can be used to refocus faculty attention on learning: identifying the relationships among how faculty learn and teach, relating to how students learn, and considering how faculty members utilize information about student dispositions to assess and improve their own teaching practices.

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