Intelligence 50 (2015) 209–220

Contents lists available at ScienceDirect

Intelligence

Sex differences in ability tilt: Support for investment theory

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ARTICLE INFO

Article history:
Received 13 October 2014
Received in revised form 6 March 2015
Accepted 23 April 2015
Available online 16 May 2015

Keywords:
Ability tilt
College majors
Occupations
General intelligence (g)
Investment theories

ABSTRACT

This research examined sex differences in ability tilt, defined as within-subject differences in math and verbal scores on three tests (SAT, ACT, PSAT). These differences produced math tilt (math>verbal) and verbal tilt (verbal>math). Both types of tilt were correlated with specific abilities (e.g., verbal and math), based on the Armed Services Vocational Aptitude Battery. Tilt was also correlated with college majors in STEM (e.g., science and math) and the humanities (e.g., English and history), and with jobs in STEM and other occupations. Males showed math tilt and STEM preferences, whereas females showed verbal tilt and humanities preferences. For males and females, math tilt predicted math ability and STEM criteria (majors and jobs), and verbal tilt predicted verbal ability and verbal criteria. Tilt scores correlated negatively with competing abilities (e.g., math tilt and verbal ability). The results supported investment theories, which assume that investment in a specific ability boosts similar abilities but retards competing abilities. In addition, the results bolster the validity of tilt, which was unrelated to *g* but still predicted specific abilities, college majors, and jobs.

1. Introduction

This research examines sex differences in ability tilt, defined as within-subject differences in math and verbal scores on standardized tests such as the SAT (formerly, Scholastic Aptitude Test) and ACT (formerly, American College Testing). These differences produce two types of tilt: math tilt, in which math scores are higher than verbal scores, and verbal tilt, in which verbal scores are higher than math scores. Both types of tilt are unrelated to general intelligence (*g*), the variance common to mental tests (cf. Coyle, Purcell, Snyder, & Richmond, 2014; Park, Lubinski, & Benbow, 2007). *g* is strongly related to the predictive validity of tests, while non-*g* factors (factors unrelated to *g*) contribute little to predictive validity (Jensen, 1998, pp. 274–294). Tilt is an exception: Tilt is a non-*g* factor that does predict outcomes at school and work (Coyle et al., 2014; Lubinski, Webb, Morelock, & Benbow, 2001; Park et al., 2007).

Lubinski et al. (2001; Park et al., 2007) examined ability tilt on the SAT for profoundly gifted students who took the SAT before age 13 years and scored in the top 1% (top 1 in 10,000). Math and verbal tilt (on the SAT) predicted specific achievements in adulthood. Math tilt predicted achievements in math and science (e.g., patents and science doctorates). In contrast, verbal tilt predicted achievements in the humanities (e.g., novels and humanities doctorates). Both types of tilt were unrelated to SAT sum scores (math + verbal), which are highly *g* loaded (Coyle & Pillow, 2008; Frey & Detterman, 2004).

Lubinski et al. (2001; Park et al., 2007) also reported sex differences in tilt. Males generally showed math tilt, which predicted jobs and college degrees in science, technology, engineering, and math (STEM). In contrast, females generally showed verbal tilt, which predicted jobs and degrees in the humanities (e.g., art, English, history). Despite these differences, tilt relations with later achievements were similar for males and females. Math tilt generally predicted STEM achievements, whereas verbal tilt generally predicted humanities achievements (e.g., Lubinski et al., 2001, Fig. 3 and Table 1).

Coyle et al. (2014) extended Lubinski et al.'s (2001) research with SAT and ACT scores from the 1997 National Longitudinal Survey of Youth (NLSY), a representative sample of students

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http://dx.doi.org/10.1016/j.intell.2015.04.012
0160-2896/

drawn from the normal range of ability. Tilt was correlated with college majors in STEM and the humanities. Tilt was also correlated with math and verbal abilities, both based on the Armed Services Vocational Aptitude Battery (ASVAB), a battery of 12 cognitive tests. The results revealed a domain-specific pattern of effects. Math tilt predicted math ability and STEM majors, whereas verbal tilt predicted verbal ability and humanities majors. Moreover, math tilt was negatively related to verbal ability, whereas verbal tilt was negatively related to math ability. The negative effects are consistent with investment theories (cf. Cattell, 1987). Such theories predict that investment (of time and effort) in specific abilities (e.g., math) boosts similar abilities but retards competing abilities (e.g., verbal), which produces the negative effects.

The current study differed from research by Coyle et al. (2014) and Lubinski et al. (2001). First, whereas Coyle et al. (2014) examined tilt effects for an undifferentiated sample, [1]the current study examined sex differences in tilt. Second, whereas Lubinski et al. (2001) examined gifted subjects (top 1 in 10,000), the current study examined subjects drawn from the normal range of ability (in the NLSY). Such subjects are assumed to show less cognitive differentiation (i.e., less specialization), which can suppress tilt effects (cf. Coyle et al., 2014). Third, whereas Coyle et al. (2014) and Lubinski et al. (2001) analyzed the SAT and ACT, the current study also analyzed the PSAT (Preliminary SAT). The PSAT is taken in 10th or 11th grade (before the SAT or ACT), and determines eligibility for National Merit Scholarships. Finally, whereas Coyle et al. (2014) predicted college majors and specific abilities, the current study also predicted occupations. The occupations included common jobs (e.g., sales, business, office support) and STEM jobs, which provided another test of investment theory.

Tilt effects in the current study might differ from tilt effects in prior studies with gifted subjects (e.g., Lubinski et al., 2001; Park et al., 2007). Tilt effects are based on within-subject discrepancies in test scores. Such discrepancies are relatively large for gifted subjects, who show more cognitive differentiation (i.e., specialization), and are relatively small for average ability subjects, such as those in the NLSY, who show less differentiation (e.g., Lohman, Gambrell, & Lakin, 2008). The smaller discrepancies for average ability subjects could suppress variance in tilt, which in turn could suppress sex differences and tilt effects.

Predictions were based on investment theories and prior research (e.g., Coyle et al., 2014; Lubinski et al., 2001). First, if tilt profiles are similar to those of gifted subjects (e.g., Lubinski et al., 2001), males should show math tilt and females should show verbal tilt. Second, if these tilt profiles predict the usual pattern of occupational and educational preferences, males should show STEM preferences and females should show humanities/verbal preferences. Finally, if tilt boosts similar abilities but retards competing abilities (for either sex), tilt should positively predict similar abilities and negatively predict competing abilities. Such findings would support investment theories and provide the first demonstration of sex differences in tilt for diverse criteria (abilities, majors, jobs) with subjects in the normal range of ability.

2. Method

2.1. Subjects

Subjects were drawn from the NLSY ($N = 8984$), a nationally representative sample of youth in the United States (Hering & McClain, 2003, pp. 1–14). The sample used in the current study was comprised of students with ASVAB scores who took the SAT or ACT ($N = 1950$; 866 males and 1084 females). The same selection criteria were used by Coyle et al. (2014).

2.2. Variables

2.2.1. Test scores

Appendix A reports the means and *SD*s for all tests. Test scores were available for the math and verbal subtests of the SAT, the math and verbal (reading) subtests of the ACT, and the math and verbal subtests of the PSAT. Subtest scores could range from 200 to 800 for the SAT, 1 to 36 for the ACT, and 20 to 80 for the PSAT. ASVAB scores were available for 12 subtests: (a) arithmetic reasoning (AR), (b) assembling objects (AO), (c) automobile information (AI), (d) coding speed (CS), (e) electronics information (EI), (f) general science (GS), (g) math knowledge (MK), (h) mechanical comprehension (MC), (i) numerical operations (NO), (j) paragraph completion (PC), (k) shop information (SI), and (l) word knowledge (WK). ASVAB scores were based on item response theory statistics, with higher scores indicating better performance. Test scores were standardized ($M = 0$, $SD = 1$) prior to analysis.

2.2.2. Ability tilt

Tilt was based on within-subject differences between math and verbal scores on the SAT, ACT, and PSAT. Following prior research (Coyle et al., 2014; see also, Park et al., 2007), tilt scores were obtained for each test after (a) standardizing the subtest scores in the full sample, and (b) taking the within-subject difference between the scores (math minus verbal). Positive scores (math>verbal) indicated math tilt; negative scores (verbal>math) indicated verbal tilt. Because math and verbal scores differed for each subject after being standardized, all subjects showed some degree of tilt.

2.2.3. College majors

College majors were obtained in two domains: STEM, which included physical (inorganic) science, computer science, engineering, and math; and the humanities, which included English, fine arts, foreign languages, history, philosophy, and theology. These majors were also used by Coyle et al. (2014). The distinction between these majors has been validated in prior SAT research (Achter, Lubinski, Benbow, & Eftekhari-Sanjani, 1999; Lubinski et al., 2001; Park et al., 2007): High SAT math scores predict STEM outcomes (e.g., patents and math doctorates), and high SAT verbal scores predict humanities outcomes (e.g., novels and English doctorates).

[1] It is worth noting that Coyle et al. (2014) reported tilt relations with ASVAB abilities for males and females in a brief footnote (Footnote 7). The relations were based on the SAT and ACT, and were collapsed (averaged) across the two tests. The results did not vary by sex: For males and females, tilt positively predicted similar abilities (e.g., math tilt and math ability) and negatively predicted competing abilities (e.g., math tilt and verbal ability). In contrast to Coyle et al. (2014), the current study analyzed sex differences in tilt for the PSAT (and also for the SAT and ACT). More importantly, the current study also analyzed sex differences in levels of tilt, sex differences in tilt relations with college majors and jobs, and sex differences in distribution of tilt types (math or verbal) in different majors and jobs. These issues were not addressed by Coyle et al. (2014).