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Ability tilt for whites and blacks: Support for differentiation and investment theories

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ABSTRACT

This research is the first to examine race differences in ability tilt for whites and blacks, two groups that show an average difference in *g* (favoring whites) of about one standard deviation. Tilt was defined as within-subject differences in math and verbal scores on three aptitude tests (SAT, ACT, PSAT). These differences yielded math tilt (math > verbal) and verbal tilt (verbal > math), which were correlated with specific abilities (verbal and math) and college majors in STEM (science, technology, engineering, math) and the humanities. Math tilt was higher for whites than blacks, whereas verbal tilt was similar for both groups. In addition, tilt correlated positively with similar majors and abilities (e.g., math tilt and math ability), and negatively with competing majors and abilities (e.g., math tilt and verbal ability). Tilt effects were generally stronger for whites, and were unrelated to *g*. The results support differentiation theories, which predict higher levels of tilt for higher ability subjects, and investment theories, which predict negative tilt effects for competing abilities (e.g., math tilt and verbal ability).

1. Introduction

This research examines race differences in *ability tilt* (hereafter tilt) for whites and blacks. Tilt refers to within-subject differences in math and verbal scores on aptitude tests such as the SAT (formerly, Scholastic Aptitude Test) and ACT (formerly, American College Test). The SAT and ACT are college admissions tests, and are strongly related to IQ and general intelligence (*g*), the variance common to mental tests (e.g., Coyle & Pillow, 2008, Frey & Detterman, 2004). The SAT and ACT yield two types of tilt: math tilt (math > verbal), which indicates math strength, and verbal tilt (verbal > math), which indicates verbal strength. Both types of tilt are unrelated to *g*, but still predict later achievements (e.g., academic performance and college majors). The predictive power of tilt is surprising, because non-*g* factors generally have little predictive power (Coyle, 2014).

Tilt was first examined in the Study of Mathematically Precocious Youth (SMPY), a longitudinal study of profoundly gifted subjects (top 1 in 10,000 in ability) (Lubinski, Webb, Morelock, & Benbow, 2001; Park, Lubinski, & Benbow, 2007). Tilt scores on the SAT were obtained at age 12 years, and were correlated with educational and occupational achievements in adulthood. Although males showed math tilt and females showed verbal tilt, tilt relations with later achievements were similar for both sexes. Math tilt predicted achievements in science, technology, engineering, and math (STEM) (e.g., patents, math degrees). In contrast, verbal tilt predicted achievements in the humanities (e.g., novels, English degrees). Both types of tilt were unrelated to SAT sum scores (math + verbal), which are highly *g* loaded (Coyle & Pillow, 2008; Frey & Detterman, 2004).

Tilt was also examined using the 1997 National Longitudinal Survey of Youth (NLSY), a large sample of U.S. students in the normal range of ability (Coyle, Purcell, Snyder, & Richmond, 2014; Coyle, Snyder, & Richmond, 2015). Tilt was computed on the SAT, ACT, and PSAT (Preliminary SAT) for males and females, and was correlated with college majors, jobs, and specific abilities (e.g., math and verbal). (The PSAT is typically taken in the sophomore or junior year of high school, one year before the SAT.) The results confirmed those of the SMPY. While males showed math tilt and females showed verbal tilt, tilt relations were similar for both sexes. Math tilt predicted math ability and STEM outcomes, whereas verbal tilt predicted verbal ability and humanities outcomes (e.g., majors and jobs). In addition, tilt negatively predicted competing abilities (e.g., math tilt and verbal ability). The negative effects support investment theories (cf. Cattell, 1987), which predict that investment of time and effort in one ability (e.g., math) boosts similar abilities but retards competing abilities (e.g., verbal).

While prior research on tilt has examined undifferentiated samples (Coyle et al., 2014) or sex differences (Coyle et al., 2015; Park et al., 2007), the current study is the first to examine race differences in tilt for whites and blacks. Whites and blacks show an average difference in *g* (based on *g*-loaded tests) of about one standard deviation, with whites being the higher ability group (Rushton & Jensen, 2005; see also, Coyle, Purcell, & Snyder, 2013). This white–black difference in *g* may be related to tilt, a possibility predicted by differentiation theories (Deary et al., 1996; see also, Garrett, 1946; Woodley, 2011). Differentiation theories predict that mental abilities become more differentiated (and less *g* loaded) at higher levels of ability. This differentiation is assumed to reflect

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cognitive specialization, which increases the effects of specific abilities. If tilt reflects specific abilities (math or verbal), it follows that tilt levels and effects may be higher for whites, the higher ability group. Such a prediction could not be tested in tilt research on sex differences, because sex differences in average ability are generally negligible (Jensen, 1998, pp. 536–542; but see, Jackson & Rushton, 2006; Nyborg, 2003, pp. 187–222), or are much smaller than race differences in average ability (Jensen, 1998, pp. 350–402; see also, Rushton & Jensen, 2005).

Tilt was examined using the NLSY, the same dataset used in prior studies of tilt (Coyle et al., 2014, 2015). Tilt was based on within-subject differences in math and verbal scores on the SAT, ACT, and PSAT, and was correlated with specific abilities and college majors. The specific abilities included academic abilities (math and verbal) and non-academic abilities (speed and technical), both based on the Armed Services Vocational Aptitude Battery (ASVAB), a battery of 12 diverse cognitive tests. The college majors were in STEM fields (e.g., science and math) and the humanities (e.g., English and history).

Based on investment theories, math tilt was expected to predict math ability and STEM majors, whereas verbal tilt was expected to predict verbal ability and humanities majors. In addition, tilt was expected to correlate negatively with competing abilities (e.g., math tilt and verbal ability). Based on differentiation theories, tilt levels and effects were expected to be higher for whites (the higher ability group). Such a pattern would provide the first support for differentiation and investment theories using tilt scores for groups that differ substantially in *g*.

2. Method

2.1. Participants

Test scores were drawn from the 1997 NLSY, a representative sample of U.S. youth born between 1980 and 1984 ($N = 8984$). Following Coyle et al. (2014, 2015), subjects were selected if they had ASVAB scores and SAT or ACT scores. The race and ethnicity codes of the NLSY determined classification as white (white race and non-black/non-Hispanic ethnicity) or black (black race and black ethnicity). The final sample consisted of 1281 whites (593 males) and 378 blacks (146 males). College majors in STEM or the humanities were available for 252 whites and 58 blacks.

2.2. Variables

2.2.1. Test scores

Test scores were available for the math and verbal subtests of the SAT, the math and reading (verbal) 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: arithmetic reasoning (AR), assembling objects (AO), automobile information (AI), coding speed (CS), electronics information (EI), general science (GS), math knowledge (MK), mechanical comprehension (MC), numerical operations (NO), paragraph completion (PC), shop information (SI), and 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 analyses.

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, 2015; see also, Park et al., 2007), tilt scores were computed by standardizing subtest scores and taking the within-subject difference (math − verbal) between math and verbal scores. Positive scores (math > verbal) indicated math tilt; negative scores (verbal > math) indicated verbal tilt. Because the math and verbal scores of each subject differed 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, history, fine arts, foreign languages, philosophy, and theology. These majors were also used by Coyle et al. (2014, 2015), and have 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 achievement, and high SAT verbal scores predict humanities achievement.

2.3. Analytical plan

The analytical plan involved three steps. First, white-black differences in mean levels of tilt were examined. Second, tilt relations with specific abilities were examined using correlations and structural equation modeling (SEM). Third, tilt differences for college majors (STEM and humanities) were examined using analyses of variance (ANOVAs). Relations among variables are reported as standardized coefficients (r or β), with the mean of several coefficients reported in parentheses (M_r or M_β). Significant effects are reported at $p < .05$.

3. Results

3.1. Race differences in mean levels of tilt

Table 1 (Analysis 1, 2, 3) reports white–black differences in mean levels of tilt, *g*, and the aptitude tests (SAT, ACT, PSAT). Analysis 1 shows that tilt difference scores (math − verbal) differed for whites and blacks on all aptitude tests, with group differences being moderate in size ($M_d = .26$). Blacks showed verbal tilt (negative scores) ($M = -.18$), whereas whites showed trivial math tilt (positive scores) ($M = .02$). Tilt scores differed significantly from zero (which indicates no tilt) for blacks but not whites.[2]

A potential problem with tilt difference scores (math − verbal) is that a group comprising subjects with high math or verbal tilt would have an average tilt difference score near zero, suggesting no tilt bias. Such a pattern was observed for whites. Whites included subjects who showed high math or verbal tilt (Table 1, Analysis 2), yielding a tilt difference score near zero (Table 1, Analysis 1). A tilt difference score near zero suggests that whites showed no tilt bias, when in fact they showed both tilt biases. To avoid invalid inferences about tilt, race differences were also examined separately for subjects who showed math or verbal tilt.

Table 1 (Analysis 2) reports race differences in tilt for subjects who showed either math tilt (positive scores) or verbal tilt (negative scores) on each test (SAT, ACT, PSAT). The results extended the prior analyses. Math tilt was significantly higher for whites than blacks ($M_d = .55$), whereas verbal tilt was similar for both groups ($M_d = .04$). An additional measure of tilt was based on the sum of the average absolute values of math and verbal tilt scores on all tests (SAT, ACT, PSAT). The absolute values measured the average deviation of tilt from zero (i.e., no tilt). Consistent with differentiation theories, the sum of the absolute values was higher for whites ($M = .65$) than blacks ($M = .54$).

Table 1 (Analysis 3) also reports white–black differences in *g* and the aptitude tests (SAT, ACT, PSAT). *g* was based on the first factor of a principal factor analysis (PFA) of all ASVAB tests. *g* scores for individual subjects were estimated as the sum of standardized ASVAB scores, weighted by *g* factor score coefficients (e.g., Tabachnick & Fidell, 2007,

[2] Supplemental analyses examined race differences in tilt as a function of sex. Tilt scores (math − verbal; positive scores = math tilt) were analyzed separately for each test using 2 (sex) by 2 (race) ANOVAs. The analyses yielded significant main effects of race and sex. (Because race differences are reported in Table 1, only sex differences are described here.) Males showed math tilt (positive scores) on the SAT ($M = .10, SD = .76$), ACT ($M = .12, SD = .83$), and PSAT ($M = .16, SD = .89$). In contrast, females showed verbal tilt (negative scores) on the SAT ($M = -.17, SD = .67$), ACT ($M = -.11, SD = .79$), and PSAT ($M = -.16, SD = .76$). Interactions between race and sex were not significant for any test ($p > .23$).