Sex differences in ability tilt in the right tail of cognitive abilities: A 35-year examination

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Abstract

Sex differences in cognitive ability level and cognitive ability pattern or tilt (e.g., math > verbal) have been linked to educational and occupational outcomes in STEM and other fields. The present study examines cognitive ability tilt across the last 35 years in 2,053,221 academically talented students in the U.S. (SAT, ACT, EXPLORE) and 7,118 students in India (ASSET) who were in the top 5% to 0.01% of cognitive ability, populations that largely feed high level STEM and other occupations. Across all measures and samples, sex differences in ability tilt were uncovered, favoring males for math > verbal and favoring females for verbal > math. As ability tilt increased, so did sex differences in ability tilt. Additionally, sex differences in tilt increased as ability selectivity increased. Broadly, sex differences in ability tilt remained fairly stable over time, were consistent across most measures, and replicated across the U.S. and India. Across time, exceptions to the general trend were females increased their verbal tilt advantage over males, on the EXPLORE, males increased their math tilt advantage over females, and in the top 0.01% of ability on the SAT, the male math tilt advantage decreased over time. Such trends should be carefully monitored given their potential to impact future workforce trends.

Keywords: Sex differences, Ability tilt, Cognitive abilities, STEM, Historical examination

1. Introduction

The underrepresentation of women in high level science, technology, engineering, and mathematics (STEM) careers is widely researched and discussed. Given the importance of ensuring the full development of female talent for STEM fields (National Academy of Sciences, 2010), understanding the origins of and solutions to such underrepresentation remains an important area of inquiry. Although recent research suggests that female representation has been improving on many indicators (e.g., Ceci, Ginther, Kahn, & Williams, 2014; Miller & Wai, 2015), women still hold only about 7-16% of tenured faculty positions and < 30% of doctorates and bachelor's degrees in math-intensive fields (Ceci et al., 2014). Many interlocking factors have been proposed to explain this differential, including interests, encouragement, and bias (Ceci & Williams, 2010; Halpern, Benbow, Geary, Gur, Hyde, & Gernsbacher, 2007; Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012).

Another factor that has received substantial attention that may contribute to explaining female underrepresentation in STEM fields are differences in representation in the extreme right tail or top 5% to 0.01% of the distribution of math ability (Benbow & Stanley, 1980, 1983; Wai, Cacchio, Putallaz, & Makel, 2010), which may be linked to greater male variability in various aspects (e.g., Ritchie et al., 2017). Representation differences at these select ability levels may matter because even within the top 1% of math ability, higher scores at age 13 are related to significantly higher STEM educational and occupational outcomes decades later, including earning a STEM PhD, STEM publication, STEM patent, STEM university tenure, and having a job in a STEM field (e.g., Park, Lubinski, & Benbow, 2007; Wai, Lubinski, & Benbow, 2005). Although studies suggest that at least on some math measures females have improved their representation among top scorers in recent years (Makel, Wai, Peairs, & Putallaz, 2016a), males continue to have higher representation in the right tail of math measures broadly and such a difference has been apparent for at least the last 35 years.

However, math abilities in isolation, especially relative to factors such as interests (e.g., Su, Rounds, & Armstrong, 2009), are likely a lesser factor explaining female STEM underrepresentation (e.g., Miller & Wai, 2015; Ceci et al., 2014). In addition to ability level, another factor that remains understudied is ability pattern or tilt (e.g., math > verbal, verbal > math) in the extreme right tail of cognitive abilities. Ability tilt on the SAT and ACT college entrance exams predict college majors and jobs in STEM fields (Coyle, Purcell, Snyder, & Richmond, 2014; Coyle, Snyder, & Richmond, 2015) among general population samples.

Additionally, because intra-individual discrepancies in ability scores appear larger for gifted students in the right tail of cognitive abilities in comparison to general population counterparts (e.g., Lohman, Gambrell, & Lakin, 2008), male-female tilt differences could have more salience for the academic, occupational, and creative pursuits for high ability populations. For students within the top 1% of ability, students who scored higher on math relative to verbal ability at age 13 (on the SAT) tended towards STEM occupations decades later, whereas students who scored higher on verbal relative to math ability at age 13 tended towards humanities occupations (Lubinski, Webb, Morelock, & Benbow, 2001; Park et al., 2007). Such trends have also been found in even more select samples of the top 0.01% (1 in 10,000 for their age group), where the pattern of ability, not just the magnitude of ability is associated with subsequent educational, occupational, and creative accomplishments (Kell, Lubinski, & Benbow, 2013; Makel, Kell, Lubinski, Putallaz, & Benbow, 2016b). Moreover, individuals who score well in both math and verbal domains have been found to be less likely to pursue careers in STEM fields than individuals who only score well in math (Wang, Eccles, & Kenny, 2013). This same research showed that females are more likely than males to score well in both math and verbal domains, thus giving females "more options" than males in terms of what fields they may choose to pursue. These links between early scores in ability tilt and subsequent pursuits suggest that in addition to ability level, ability tilt should be considered when investigating female STEM underrepresentation.

Examining whether ability tilt differences between males and females have remained stable or changed over time and whether ability tilt is similar in different cultural contexts is important to assess given the link between tilt and long-term STEM outcomes. One cultural context in which females may particularly face biases and barriers is in India. Males outnumber females beginning at birth (Sen, 1992, 2003) and literacy rates favor males (UNESCO, 2014). Indian female representation in STEM careers remains low (Leggon, McNeely, & Yoon, 2015), and females tend to have low representation among the prestigious Institutes of Technology (Rao, 2015), though some have argued that highly educated females may be doing well in terms of high level STEM and business careers (Hewlett & Rashid, 2010). Makel et al. (2016a) showed that patterns across male-female math ability differences in the extreme right tail replicate across the U.S. and India, however, it has not yet been established whether male-female ability tilt (math vs. verbal) differences in the extreme right tail replicate across cultural contexts.

2. Present Study

The current study examined math-verbal ability tilt ratios in the extreme right tail at different ability levels, whether those ratios have changed or stayed the same over time across the last 35 years, and whether the pattern of math-verbal ability tilt ratios are similar or different in the U.S. and India. Because the larger pattern of results and whether they replicate are more important than statistical noise that might occur on any specific test from one time point, we 1. grouped data into 5 year bins to help decrease statistical noise, provide more accurate longitudinal trends, and match the approach of prior research (Makel et al., 2016a; Wai et al., 2010) and 2. compared ratios to broadly address our basic research questions (RQs), which are as follows:

RQ1: Are there sex differences in ability tilt in the right tail of cognitive abilities?

RQ2: Do sex differences increase as ability tilt (distance between math and verbal scores) increases?

RQ3: Do sex differences in ability tilt increase as ability selectivity increases (top 5%, top 1%, and top 0.01% of academic ability)?

RQ4: Have sex differences in ability tilt changed over time?

RQ5: Do sex differences in ability tilt vary as a function of measure and cultural context?

3. Method

3.1. Participants

Data from the U.S. and India came from the Duke University Talent Identification Program (Duke TIP). To qualify for participation in the Duke TIP talent search, students must score in the top 5% on a within grade standardized test either on a composite score or relevant subtest. Students then take an above-level test. In the U.S., the above-level test is either the SAT or ACT; for the younger elementary aged students, the above-level test is the ACT EXPLORE test (hereafter referred to as EXPLORE). If sex was not clearly indicated, the participant was not included in this study. The full samples were as follows: SAT, 1981-2015, N = 1,343,890 (female = 673,756, male = 670,134), ACT, 1990-2015, N = 589,409 (female = 286,498, male = 302,911), and EXPLORE, 1996-2015, N = 119,922 (female = 57,002, male = 62,920). (see Appendixes A, B, and C for numbers of males and females within each cell for each measure).

For the Duke TIP India talent search, the above-level test is the ASSET test by Educational Initiatives. It is not a college entrance exam, but like in the U.S., 7th standard (7th grade) Indian students qualify for talent search participation by scoring at or above the 95th percentile on their regular grade-level tests. Then, in India, students took the version of the ASSET test designed and normed for typical Indian students in the 9th or 10th grade. Thus, the ASSET serves as an above level test with sufficient headroom capacity to capture the full spectrum right-tail of test scores in comparison to grade-level tests. Males outnumbered females in India roughly 1.74 to 1 in Indian talent search participation. From 2011 to 2015, there were N = 7,118 Duke TIP Indian talent search participants who took the ASSET (female = 2,595, male = 4,523).

3.2. Data analysis approach

In this paper, we examined math-verbal ability tilt across multiple measures in the U.S. (SAT, ACT, EXPLORE) and India (ASSET), across multiple ability levels (full sample, top 1%, top 0.01%), and across time (SAT: 1981 to 2015; ACT: 1990 to 2015; EXPLORE: 1996 to 2015; ASSET: one time point grouping, 2011 to 2015). Similar to previous reports (Benbow & Stanley, 1983; Makel et al., 2016a; Wai et al., 2010), the current study reports sex ratios of scores from students who had participated in a talent search across all these measures (Tables 1, 2, and 3) and corresponding sample sizes (Appendixes A, B, and C). However, we examine the new aspect of math-verbal ability tilt in this study and include comparisons across the U.S. and India by equating for initial participation (Table 4), and providing statistical comparisons of ratios to address our research questions (Table 5).

3.3. Method to determine math-verbal tilt and spread

We examined math-verbal ability tilt pattern within each U.S. measure by first looking at the spread of scores. For example, for the SAT, we first examined the male-female math-verbal tilt ratio where SAT-Verbal and SAT-Math scores were within 100 points of one another (indicated as 0 in Tables 1, 2 and 3), then used the 100 point differential as a measurement unit to determine degree of tilt in either direction. This spread the SAT scale to include ≤ -300 (SAT-M is 300 or more points lower than SAT-V) up through ≥ 300 (SAT-M is 300 or more points higher than SAT-V). A similar approach was used to determine metrics for the ACT and EXPLORE test after creating an ACT-Verbal composite (an average of the ACT-Reading and English subtests, hereafter referred to as ACT-V) and EXPLORE-Verbal composite (an average of the EXPLORE-Reading and English subtests, hereafter referred to as EXPLORE-V). For the ASSET test, tilt was determined by taking the difference between the ASSET-Math and ASSET-English (hereafter referred to as ASSET-V). However, because the math and verbal ASSET subtest measures were on very different scales, each scale was first translated into z-scores with a mean of 0 and standard deviation (SD) of 1 to make them comparable. Unit spread was then determined as a function of the difference between SDs across the math and verbal measures (ASSET-M is 2.25 or more SDs below ASSET-V up through ASSET-M is 2.25 or more SDs above ASSET-V). As math-verbal tilt increased, sample sizes correspondingly decreased, with very few students exhibiting tilt at the most extreme levels (see Appendixes A, B, and C).

3.4. Method to determine cut scores for ability level

To determine cut scores for each ability level above the full sample (i.e., top 1%, top 0.01%), cutoffs were drawn from prior research and translated into current cut scores. In 1995 the SAT was recentered, so we used conversion tables to transform scores prior to 1995 so that they would be comparable to post-1995 scores (ETS, 2010). Initial score benchmarks were drawn for the top 1% from Achter, Lubinski, Benbow, & Eftekhari-Sanjani (1999), and translated into current cut scores for the SAT (SAT-M 430+ or SAT-V 450+; female = 411,978, male = 448,787). Then, the SAT percentiles for each of these cut scores in their respective distributions were used to find matching cut scores for the ACT (ACT-M 16+ or ACT-V 19+; female = 199,736, male = 220,037), EXPLORE (EXPLORE-M 16+ or EXPLORE-V 18+; female = 34,180, male = 40,655), and ASSET (ASSET-M 17+ or ASSET-V 51+; female = 1,707, male = 3,180). Initial score benchmarks were drawn for the top 0.01% from Lubinski, Webb, Morelock, and Benbow (2001), and translated into current cut scores for the SAT (SAT-M 700+ or SAT-V 700+; female = 1,472, male = 3,451). Then, the SAT percentiles for each of these cut scores in their respective distributions was used to find matching cut scores for the ACT (ACT-M 27+ or ACT-V 32+; female = 1,094, male = 2,133), the EXPLORE (EXPLORE-M 25 or EXPLORE-V 25; female = 804, male = 1,582), and ASSET (ASSET-M 37+ or ASSET-V 67+; female = 16, male = 21). Due to the extremely small samples at the top 0.01% level for ASSET, data were not used for comparison purposes and cells are left blank in the respective tables. In some cases statistical comparisons to test our research questions were not possible for the full sample and the top 1% level for ASSET, but we report the data in respective cells in the tables and appendixes to show the patterns.

4. Results

4.1. RQ1: Are there sex differences in ability tilt in the right tail of cognitive abilities?

Data from the "Total" rows in Tables 1, 2, and 3 for each respective measure indicate that the overall data patterns across measures suggests there are sex differences in ability tilt in the right tail of cognitive abilities. To provide specific examples, for the full sample (Table 1), there were 4.41 males for every female who had SAT-M scores 300 or more points higher than SAT-V scores and 0.80 males for every female who had SAT-M scores 300 or more points lower than SAT-V scores. The roughly equivalent values were 4.37 and 0.39 on the ACT and 4.07 and 0.55 on the EXPLORE. For the ASSET at this level, the sample size was not sufficient to compute a significance test (standard binomial requirement that for each sample n(p) and n(1-p) must both be equal to or greater than 5), thus we used the next most extreme tilt categories: 6.07 and 0.44. Table 5 provides each corresponding statistical test, which were all significant. See Appendixes A, B, and C for Ns corresponding to Tables 1 through 3, which show that as tilt increases, sample size correspondingly decreases. For example, in Appendix A, on the SAT math - verbal overall, the raw samples for males and females were (≤ -300: M = 107, F = 133; ≤ -200: M = 3,023, F = 4,719; ≤ -100: M = 46,101, F = 69,445; 0: M = 503,880, F = 538,734; ≥ 100: M = 120,153, F = 65,577; ≥ 200: M = 11,726, F = 3,607; ≥ 300: M = 596, F = 135).

4.2. RQ2: Do sex differences increase as ability tilt increases?

Data from the "Total" rows in Tables 1, 2, and 3 for each respective measure indicate that the overall data patterns across measures suggests that sex differences increase as ability tilt increases. For example, for the full sample (Table 1), there were 0.94 males for every female who had SAT-M and SAT-V scores within 100 points of each other. This male-female difference increased going from math > verbal by ≥ 100 points (1.83), ≥ 200 points (3.25), and ≥ 300 points (4.41). The only exception was for the SAT, where the difference increased going from math < verbal by ≤ -100 points (0.66) to ≤ -200 points (0.64) but then decreased for ≤ -300 points (0.80). Table 5 provides statistical comparisons, which were significant across all measures.

Male-female differences also increased going from math < verbal on the ACT, EXPLORE, and ASSET. For example, ACT math < verbal of ≤ -4 points (0.66), ≤ -8 points (0.53), and ≤ -12 points (0.39) showed that sex differences increase as ability tilt increases in the verbal direction. Table 5 provides statistical comparisons, which were significant on the ACT, EXPLORE, and ASSET, but not the SAT.

4.3. RQ3: Do sex differences in ability tilt increase as ability selectivity increases?

The "Total" rows in Tables 1, 2, and 3 for each respective measure indicate that the overall data patterns across measures suggest sex differences in ability tilt was generally stable as ability selectivity increased. There was no evidence of any pattern change as ability selectivity increased (all *p*'s > .05), so broadly tilt remained consistent. It may appear that tilt increased with selectivity, for example, for SAT math > verbal by ≥ 300 points or more, this ratio appeared to slightly increase from the full sample (Table 1: 4.41) to the top 1% (Table 2: 4.45), to the top 0.01% (Table 3: 4.78), but again, this was not statistically significant. Similar findings were uncovered on the ACT (Full sample = 4.37, top 1% = 4.31, top 0.01% = 9.43), EXPLORE (Full sample = 4.07, top 1% = 4.29, top 0.01% = 4.45), and ASSET (Full sample = 9.27, top 1% = 11.50). Table 5 provides statistical comparisons, however, which indicate though the pattern was similar across measures, the differences were not significant. Table 5 also shows that for math < verbal for the full sample vs. the top 0.01%, none of the comparisons were significant.

4.4. RQ4: Have sex differences in ability tilt changed over time?

Tables 1, 2, and 3 show data across time for each measure. We examined whether differences were significant over time by systematically comparing the oldest two year groupings with the most recent two year groupings for each measure and at each ability level to ensure sample size was sufficient to conduct a statistical test to determine meaningful differences. To remain consistent across tilt level and to ensure sufficient sample size we used the second to most extreme tilt category in either direction (e.g., for the SAT, ≤ -200 and ≥ 200). When the sample size was not sufficient to compute a significance test (standard binomial requirement that for each sample n(p) and n(1-p) must both be equal to or greater than 5), we used the next most extreme tilt category (e.g., SAT ≥ 100 instead of ≥ 200). The comparisons we made were: full sample and top 1% (SAT ≤ -200 and ≥ 200, ACT ≤ -8 and ≥ 8, EXPLORE ≤ -4 and ≥ 4); top 0.01% (SAT ≤ -200 and ≥ 100, ACT ≤ -8 and ≥ 4, EXPLORE ≤ -4 and ≥ 4). Table 5 provides all corresponding statistical comparisons.

In summary, for the full sample and the top 1%, these findings suggest females have significantly increased their verbal tilt advantage over males over time and that on the EXPLORE, males have significantly increased their math advantage over females. In the top 0.01%, however, on the SAT, the math-verbal tilt advantage for males has significantly decreased over time. Apart from these significant findings, ability tilt over time was fairly stable.

4.5. RQ5: Do sex differences in ability tilt vary as a function of measure and cultural context?

Results from RQ1 suggest that sex differences in ability tilt overall are present on all measures. Answers to RQ2 through RQ4 suggest that findings were not uniform across all measures as already described. To initially address the issue of whether findings differed across cultural context, statistical comparisons were made across U.S. and Indian measures in the top 1% at the highest level examined for math > verbal tilt where sufficient samples for statistical tests were possible (see Table 5). For example, Table 5 shows individual comparisons of SAT M – V ≥ 300, ACT M – V ≥ 12, and EXPLORE M – V ≥ 6 vs. ASSET M – V ≥ 2.25. Table 5 also shows individual comparisons where verbal was greater than math. All these comparisons across the U.S. and India were statistically significant, with the exception of the ACT math < verbal comparison.

Additionally, Table 4 shows data on the full sample and top 1% across the U.S. (SAT, ACT, EXPLORE) and Indian (ASSET) measures in 2011-2015 after equating for participation using baseline male-female participation during this time period. We equated for participation to reduce the likelihood that such ratios were skewed especially for the Indian sample which had 1.74 males participate for every female. Overall, in the top 1% at the highest level examined for math > verbal tilt, in the U.S. there were about 3.28 to 5.67 males for every female whereas in India there were 6.61 males for every female. Overall, in the top 1% at the highest level examined for verbal > math tilt, in the U.S. there were about 0.73 to 0.34 males for every female whereas in India there were 0.08 males for every female. Though we could not conduct statistical tests after equating for participation, the general pattern appeared to show that India math > verbal tilt was slightly higher than in the U.S. and India verbal > math tilt was much higher than in the U.S.

5. Discussion

The present study builds upon prior work examining sex differences in the right tail of cognitive abilities (Makel et al., 2016a; Wai et al., 2010) as well as in ability pattern (Kell et al., 2014; Makel et al., 2016b; Park et al., 2007) by examining the additional role of sex differences in the right tail of math-verbal cognitive ability tilt in the U.S. and India. Findings broadly replicated across the U.S. and India, with Indian male math > verbal tilt slightly higher than in the U.S. and Indian female verbal > math tilt much higher than in the U.S. Overall, it appears that there are sex differences in ability tilt and such differences increase as ability tilt increases. As ability selectivity increased, tilt showed general stability. There have been changes in ability tilt across the last 35 years, although not uniform across all measures. Females have significantly increased their verbal tilt advantage over males, and on one measure (EXPLORE) males have significantly increased their math tilt advantage over females.

However, in the top 0.01% on the SAT, the math-verbal tilt advantage has significantly decreased over time. For example, for SAT-M > SAT-V by ≥ 100 points, the male-female tilt ratio was 14.50 to 1 in 1981-1985 but by 1991-1995 this ratio had dropped to 4.47 to 1 and in 2011-2015 had dropped to 2.79 to 1. This parallels the male-female math ability ratio of 13.50 to 1 in 1981-1985, a drop to 3.87 to 1 by 1991-1995, and a recent ratio of 2.53 to 1 in 2011-2015. In the top 0.01% on the ACT, ACT-M > ACT-V by ≥ 4 points indicated a drop across time (1990-2000 to 2006-2015) from 16.60 to 1 to 5.04 to 1. In the top 0.01% on the EXPLORE, EXPLORE-M > EXPLORE-V by ≥ 4 points indicated a slight increase across time (1996-2005 to 2006-2015) from 3.03 to 1 to 3.99 to 1. Given that in the U.S. top 0.01% on math ability on the SAT and ACT there are currently about 2.46 to 2.53 males for every female, and that in the top 0.01% of math > verbal ability tilt there are about 3.16 to 6.26 males for every female, as discussed below, this suggests that ability tilt favoring males on math ability in the extreme right tail of cognitive abilities may play a role in the underrepresentation of women in STEM. Also, moving from the full sample to the top 1% to the top 0.01% showed that as ability selectivity increased, math-verbal tilt ratios favoring males slightly increased, though these changes were not significant. It’s unclear why we see larger gaps among younger students on the EXPLORE test. It’s possible something is happening in the intervening years between 4th through 7th grade or that the differences are measure specific and/or due to the smaller sample tested (relative to the SAT and ACT) on that measure.

Prior research showed that even within the extreme right tail of abilities more math ability (Wai et al., 2005) and math > verbal ability tilt (Coyle et al., 2014, 2015; Park et al., 2007) matters for STEM major choice and eventual high level STEM careers. The current findings contribute to the empirical evidence of relevant factors in the discussion surrounding female representation in high level STEM careers (Ceci et al., 2014; Halpern et al., 2007) by showing that in addition to math ability, math > verbal ability tilt has been fairly stable across the last 35 years. Data from this paper, when connected to this body of prior work, suggests that math abilities likely remain a factor in contributing to the explanation of the underrepresentation of women in high level STEM careers. On the SAT, and perhaps to some extent on the ACT, male-female tilt differences may be narrowing. However, on the EXPLORE, these differences actually slightly increased. On the EXPLORE, the finding is similar to Lakin (2013), who found using the Cognitive Abilities Test (CogAT) that the male math advantage had actually increased over time. Females have significantly increased their verbal tilt advantage over males over time, suggesting that such differences may also have an impact on lower male representation in verbal major choice (e.g. humanities) and eventual high level verbal careers (Coyle et al., 2014, 2015; Park et al., 2007).

5.1. Limitations and future directions

Multiple measures were utilized in this study to determine whether the broad pattern of ability tilt and changes over time were measure and sample specific or potentially more robust through replication pattern. Broadly, in the right tail of cognitive abilities, it appears that sex differences in ability tilt exist, and that over time, especially in more recent years, ability tilt is fairly stable. This does not mean that the exceptions to these broad trends on a subset of measures is not of significance. For example, it's unclear whether changes on measures over time might have been caused by factors such as potential ceiling effects on measures (e.g., Wai et al., 2012), the removal of certain items to reduce gender differences (e.g., Loewen, Rosser, & Katzman, 1988), or the differing content across the measures examined given revamping of tests (e.g., Kobrin & Melican, 2007; Lohman & Lakin, 2009).

Because the U.S. and Indian samples in this study had no overlap in the tests they took, we could not develop a direct concordance across these samples, limiting what we can state about the degree of tilt differences across these two cultural contexts (Makel et al., 2016a). Correcting for initial participation differences, however, indicated that the broad pattern across the U.S. and India regarding math-verbal ability tilt replicated in pattern, though differed in degree to some extent. Compared to the U.S. samples, the Indian sample was relatively smaller, though the general patterns appeared to replicate across these two contexts.

To mirror prior investigations of ability tilt in gifted (e.g., Lubinski et al., 2001; Park et al., 2007) and general population (e.g., Coyle et al., 2014, 2015) samples, we compared math to verbal tilt only. The ACT, EXPLORE, and ASSET all include science and writing measures, and none of these measures include spatial abilities (e.g., Kell, Lubinski, Benbow & Steiger, 2013; Wai, Lubinski, & Benbow, 2009). Measures including spatial abilities may be worth investigating in future research given their potential link to later STEM outcomes.

5.2. Conclusion

The magnitude of ability pattern varies across tests and cultures. However, the "pattern of ability patterns" (Steen, 1988) remains relatively consistent across tests and time. Prior research shows that within general population samples and right tail ability samples more math ability and math > verbal ability tilt in adolescence is related to the earning of STEM PhDs, STEM publications, STEM patents, and ending up in a STEM occupation many years later and verbal > math ability tilt in adolescence is related to the earning of verbal and humanities outcomes many years later. Our findings in this study confirm adolescent sex differences in ability tilt in the right tail broadly. Such male-female ability tilt differences should therefore be taken into consideration when examining the underrepresentation of women in math or STEM careers and men in verbal or humanities careers. When combined with research on sex differences in interests (Su et al., 2009), these ability tilt patterns may become more relevant. Across the last 35 years, differences may be narrowing on some measures and on other measures differences may be increasing. Such trends should be monitored in the future.

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Table 1. Full sample male/female ratios.

SAT	SAT M is 300 (or more) points lower than SAT V			SAT V and SAT M are within 100 points of each other			SAT M is 300 (or more) points higher than SAT V
	≤ -300	≤ -200	≤ -100	0	≥ 100	≥ 200	≥ 300
1981-1985	0.82	0.74	0.72	0.91	1.97	3.58	5.50
1986-1990	0.88	0.76	0.72	0.90	1.68	3.45	5.14
1991-1995	0.60	0.71	0.74	0.93	1.84	3.71	7.38
1996-2000	1.00	0.61	0.67	0.99	1.79	3.01	5.26
2001-2005	1.40	0.58	0.63	0.95	1.90	3.42	4.25
2006-2010	0.64	0.55	0.61	0.94	1.86	3.26	4.10
2011-2015	0.69	0.50	0.58	0.89	1.80	2.89	3.08
Total	0.80	0.64	0.66	0.94	1.83	3.25	4.41
ACT	ACT M is 12 (or more) points lower than ACT V			ACT M and ACT V are within 4 points of each other			ACT M is 12 (or more) points higher than ACT V
	≤ -12	≤ -8	≤ -4	0	≥ 4	≥ 8	≥ 12
1990-1995	0.44	0.53	0.63	1.09	2.40	6.04	5.00
1996-2000	0.38	0.52	0.64	1.14	2.45	3.94	3.75
2001-2005	0.33	0.51	0.66	1.11	2.46	5.40	7.00
2006-2010	0.38	0.54	0.67	1.13	2.34	3.80	4.17
2011-2015	0.38	0.56	0.70	1.17	2.32	4.36	4.32
Total	0.39	0.53	0.66	1.13	2.37	4.27	4.37
EXPLORE	Explore M is 6 (or more) points lower than Explore V			Explore M and Explore V are within 2 points of each other			Explore M is 6 (or more) points higher than Explore V
	≤ -6	≤ -4	≤ -2	0	≥ 2	≥ 4	≥ 6
1996-2000	0.65	0.76	0.87	1.33	2.04	2.37	2.57
2001-2005	0.57	0.67	0.77	1.14	1.85	2.53	3.70

2006-2010	0.47	0.57	0.71	1.18	2.21	3.19	4.75
2011-2015	0.47	0.57	0.69	1.14	2.24	3.34	5.82
Total	0.55	0.65	0.76	1.18	2.07	2.85	4.07
ASSET	ASSET M is 2.25 (or more) SDs below ASSET V			ASSET M and ASSET V are within 0.75 SDs of each other			ASSET M is 2.25 (or more) SDs above ASSET V
	≤ -2.25	≤ -1.5	≤ -0.75	0	≥ 0.75	≥ 1.5	≥ 2.25
2011-2015	0.14	0.44	0.81	1.82	4.47	6.07	9.27

Note. "M" stands for mathematics. "V" stands for a verbal test or composite formed for this study. For example, ACT V and EXPLORE V are composites of the respective English and Reading subtests.

Table 2. Top 1% male/female ratios.

SAT	SAT M is 300 (or more) points lower than SAT V			SAT V and SAT M are within 100 points of each other			SAT M is 300 (or more) points higher than SAT V
	≤ -300	≤ -200	≤ -100	0	≥ 100	≥ 200	≥ 300
1981-1985	0.82	0.73	0.76	1.14	2.31	3.65	11.00
1986-1990	0.88	0.76	0.73	1.05	1.91	3.45	5.14
1991-1995	0.60	0.70	0.72	1.01	1.98	3.71	7.38
1996-2000	1.00	0.61	0.66	1.05	1.92	3.14	5.26
2001-2005	1.40	0.57	0.60	1.02	2.03	3.63	4.25
2006-2010	0.64	0.51	0.59	1.00	2.01	3.38	4.10
2011-2015	0.69	0.49	0.56	0.92	1.91	3.03	3.08
Total	0.80	0.63	0.65	1.02	1.98	3.38	4.45
ACT	ACT M is 12 (or more) points lower than ACT V			ACT M and ACT V are within 4 points of each other			ACT M is 12 (or more) points higher than ACT V
	≤ -12	≤ -8	≤ -4	0	≥ 4	≥ 8	≥ 12
1990-1995	0.44	0.53	0.63	1.25	2.53	5.74	4.00
1996-2000	0.38	0.52	0.65	1.31	2.79	4.40	3.75
2001-2005	0.33	0.51	0.67	1.28	2.76	6.22	6.50
2006-2010	0.38	0.53	0.67	1.24	2.68	4.30	4.36
2011-2015	0.38	0.56	0.70	1.22	2.51	4.62	4.17
Total	0.38	0.53	0.67	1.25	2.64	4.67	4.31
EXPLORE	Explore M is 6 (or more) points lower than Explore V			Explore M and Explore V are within 2 points of each other			Explore M is 6 (or more) points higher than Explore V
	≤ -6	≤ -4	≤ -2	0	≥ 2	≥ 4	≥ 6
1996-2000	0.64	0.74	0.85	1.43	2.13	2.40	2.48

2001-2005	0.60	0.69	0.79	1.32	2.07	2.66	4.03
2006-2010	0.47	0.59	0.72	1.34	2.36	3.27	4.85
2011-2015	0.46	0.56	0.69	1.27	2.49	3.47	6.18
Total	0.55	0.65	0.76	1.33	2.27	2.98	4.29
ASSET	ASSET M is 2.25 (or more) SDs below ASSET V			ASSET M and ASSET V are within 0.75 SDs of each other			ASSET M is 2.25 (or more) SDs above ASSET V
	≤ -2.25	≤ -1.5	≤ -0.75	0	≥ 0.75	≥ 1.5	≥ 2.25
2011-2015	0.14	0.44	0.82	2.10	5.34	7.04	11.50

Note. "M" stands for mathematics. "V" stands for a verbal test or composite formed for this study. For example, ACT V and EXPLORE V are composites of the respective English and Reading subtests.

Table 3. Top 0.01% male/female ratios.

SAT	SAT M is 300 (or more) points lower than SAT V			SAT V and SAT M are within 100 points of each other			SAT M is 300 (or more) points higher than SAT V
	≤ -300	≤ -200	≤ -100	0	≥ 100	≥ 200	≥ 300
1981-1985		0.73	1.00		14.50	13.00	
1986-1990	0.33	0.71	0.67	3.46	10.50	21.50	6.00
1991-1995	0.50	1.21	0.87	2.10	4.47	5.38	6.50
1996-2000	0.80	0.63	0.81	2.07	4.51	4.58	9.00
2001-2005	2.00	0.73	0.91	2.12	3.86	3.91	5.14
2006-2010	2.00	0.57	0.77	1.56	4.68	7.59	7.40
2011-2015		0.33	0.50	1.35	2.79	3.07	3.16
Total	0.61	0.62	0.74	1.79	3.74	4.27	4.78
ACT	ACT M is 12 (or more) points lower than ACT V			ACT M and ACT V are within 4 points of each other			ACT M is 12 (or more) points higher than ACT V
	≤ -12	≤ -8	≤ -4	0	≥ 4	≥ 8	≥ 12
1990-1995	0.39	0.50	0.61	3.40	13.00		
1996-2000	0.37	0.61	0.70	3.94	19.00		
2001-2005	0.24	0.45	0.56	3.83	5.57	15.00	
2006-2010	0.38	0.47	0.56	2.71	5.76	27.33	17.00
2011-2015	0.38	0.62	0.74	2.58	4.72	6.61	6.00
Total	0.35	0.55	0.66	2.80	5.46	10.64	9.43
EXPLORE	Explore M is 6 (or more) points lower than Explore V			Explore M and Explore V are within 2 points of each other			Explore M is 6 (or more) points higher than Explore V
	≤ -6	≤ -4	≤ -2	0	≥ 2	≥ 4	≥ 6
1996-2000	2.00	1.25	1.25	2.33	3.36	2.76	2.43
2001-2005	0.70	0.49	0.57	1.44	2.29	3.16	3.30

2006-2010	0.56	0.59	0.62	1.21	2.92	3.30	4.57
2011-2015	0.46	0.53	0.59	1.67	3.62	4.60	6.26
Total	0.57	0.55	0.62	1.54	3.05	3.66	4.45
ASSET	ASSET M is 2.25 (or more) SDs below ASSET V			ASSET M and ASSET V are within 0.75 SDs of each other			ASSET M is 2.25 (or more) SDs above ASSET V
	≤ -2.25	≤ -1.5	≤ -0.75	0	≥ 0.75	≥ 1.5	≥ 2.25
2011-2015							

Note. "M" stands for mathematics. "V" stands for a verbal test or composite formed for this study. For example, ACT V and EXPLORE V are composites of the respective English and Reading subtests.

Table 4. Full sample and top 1% tilt ratios equating participation 2011-2015.

SAT	SAT M is 300 (or more) points lower than SAT V			SAT V and SAT M are within 100 points of each other			SAT M is 300 (or more) points higher than SAT V
	≤ -300	≤ -200	≤ -100	0	≥ 100	≥ 200	≥ 300
Full sample	0.73	0.53	0.62	0.95	1.91	3.07	3.28
Top 1%	0.73	0.52	0.60	0.98	2.03	3.22	3.28
ACT	ACT M is 12 (or more) points lower than ACT V			ACT M and ACT V are within 4 points of each other			ACT M is 12 (or more) points higher than ACT V
	≤ -12	≤ -8	≤ -4	0	≥ 4	≥ 8	≥ 12
Full sample	0.34	0.50	0.63	1.05	2.09	3.93	3.89
Top 1%	0.34	0.50	0.63	1.10	2.26	4.16	3.76
EXPLORE	Explore M is 6 (or more) points lower than Explore V			Explore M and Explore V are within 2 points of each other			Explore M is 6 (or more) points higher than Explore V
	≤ -6	≤ -4	≤ -2	0	≥ 2	≥ 4	≥ 6
Full sample	0.43	0.53	0.63	1.05	2.06	3.06	5.34
Top 1%	0.42	0.51	0.63	1.17	2.28	3.18	5.67
ASSET	ASSET M is 2.25 (or more) SDs below ASSET V			ASSET M and ASSET V are within 0.75 SDs of each other			ASSET M is 2.25 (or more) SDs above ASSET V
	≤ -2.25	≤ -1.5	≤ -0.75	0	≥ 0.75	≥ 1.5	≥ 2.25
Full sample	0.08	0.25	0.47	1.05	2.57	3.49	5.33
Top 1%	0.08	0.25	0.47	1.21	3.07	4.05	6.61

Note. *Samples were equated for participation using baseline male-female participation in 2011-2015 for each measure. "M" stands for mathematics. "V" stands for a verbal test or composite formed for this study. For example, ACT V and EXPLORE V are composites of the respective English and Reading subtests.*

Table 5. Significance tests for corresponding research questions.

	Ratio comparison	Z-test	p-value
RQ1: Are there sex differences in ability tilt in the right tail of cognitive abilities?			
Full sample: SAT M – V ≥ 300 vs. SAT M – V ≤ -300	4.41 vs. 0.80	Z = 11.11	***p* < 0.0002**
Full sample: ACT M – V ≥ 12 vs. ACT M – V ≤ -12	4.37 vs. 0.39	Z = 16.059	***p* < 0.0002**
Full sample: EXPLORE M – V ≥ 6 vs. EXPLORE M – V ≤ -6	4.07 vs. 0.55	Z = 34.548	***p* < 0.0002**
Full sample: ASSET M – V ≥ 1.5 vs. ASSET M – V ≤ -1.5	6.07 vs. 0.44	Z = 16.274	***p* < 0.0002**
RQ2: Do sex differences increase as ability tilt increases?			
Full sample: SAT M – V ≥ 100 vs. SAT M – V ≥ 300	1.83 vs. 4.41	Z = 9.512	***p* < 0.0002**
Full sample: ACT M – V ≥ 4 vs. ACT M – V ≥ 12	2.37 vs. 4.37	Z = 3.444	***p* = 0.0006**
Full sample: EXPLORE M – V ≥ 2 vs. EXPLORE M – V ≥ 6	2.07 vs. 4.07	Z = 11.508	***p* < 0.0002**
Full sample: ASSET M – V ≥ 0.75 vs. ASSET M – V ≥ 2.25	4.47 vs. 9.27	Z = 2.299	***p* = 0.0215**
Full sample: SAT M – V ≤ -100 vs. SAT M – V ≤ -300	0.66 vs. 0.80	Z = 1.481	*p* = 0.1386
Full sample: ACT M – V ≤ -4 vs. ACT M – V ≤ -12	0.66 vs. 0.39	Z = -13.978	***p* < 0.0002**
Full sample: EXPLORE M – V ≤ -2 vs. EXPLORE M – V ≤ -6	0.76 vs. 0.55	Z = -11.947	***p* < 0.0002**
Full sample: ASSET M – V ≤ -0.75 vs. ASSET M – V ≤ -1.5	0.81 vs. 0.44	Z = -4.638	***p* < 0.0002**
RQ3: Do sex differences in ability tilt increase as ability selectivity increases?			
Full sample vs. Top 0.01%: SAT M – V ≥ 300	4.41 vs. 4.78	Z = 0.383	*p* = 0.7017
Full sample vs. Top 1%: ACT M – V ≥ 12	4.37 vs. 4.31	Z = -0.056	*p* = 0.9553
Full sample vs. Top 0.01%: EXPLORE M – V ≥ 6	4.07 vs. 4.45	Z = 0.597	*p* = 0.5505
Full sample vs. Top 1%: ASSET M – V ≥ 2.25	9.27 vs. 11.50	Z = 0.443	*p* = 0.6578
Full sample vs. Top 0.01%: SAT M – V ≤ -300	0.80 vs. 0.61	Z = -0.682	*p* = 0.4952
Full sample vs. Top 0.01%: ACT M – V ≤ -12	0.39 vs. 0.44	Z = 1.238	*p* = 0.2157
Full sample vs. Top 0.01%: EXPLORE M – V ≤ -6	0.55 vs. 0.57	Z = 0.16	*p* = 0.8729
Full sample vs. Top 1%: ASSET (insufficient N)			
RQ4: Have sex differences in ability tilt changed over time?			
Full sample: SAT M – V ≤ -200 (1981-1990 vs. 2006-2015)	0.75 vs. 0.53	Z = 5.621	***p* < 0.0002**
Full sample: SAT M – V ≥ 200 (1981-1990 vs. 2006-2015)	3.47 vs. 3.09	Z = 1.511	*p* = 0.1308
Full sample: ACT M – V ≤ -8 (1990-2000 vs. 2006-2015)	0.53 vs. 0.55	Z = -1.648	*p* = 0.0994
Full sample: ACT M – V ≥ 8 (1990-2000 vs. 2006-2015)	4.49 vs. 4.09	Z = 0.73	*p* = 0.4654

Full sample: EXPLORE M – V ≤ -4 (1996-2005 vs. 2006-2015)	0.71 vs. 0.57	Z = 7.806	***p* < 0.0002**
Full sample: EXPLORE M – V ≥ 4 (1996-2005 vs. 2006-2015)	2.47 vs. 3.28	Z = -5.374	***p* < 0.0002**
Top 1%: SAT M – V ≤ -200 (1981-1990 vs. 2006-2015)	0.75 vs. 0.50	Z = 5.937	***p* < 0.0002**
Top 1%: SAT M – V ≥ 200 (1981-1990 vs. 2006-2015)	3.49 vs. 3.22	Z = 1.019	*p* = 0.3082
Top 1%: ACT M – V ≤ -8 (1990-2000 vs. 2006-2015)	0.52 vs. 0.55	Z = -1.581	*p* = 0.1139
Top 1%: ACT M – V ≥ 8 (1990-2000 vs. 2006-2015)	4.80 vs. 4.47	Z = 0.52	*p* = 0.6031
Top 1%: EXPLORE M – V ≤ -4 (1996-2005 vs. 2006-2015)	0.71 vs. 0.57	Z = 6.758	***p* < 0.0002**
Top 1%: EXPLORE M – V ≥ 4 (1996-2005 vs. 2006-2015)	2.57 vs. 3.38	Z = -4.749	***p* < 0.0002**
Top 0.01%: SAT M – V ≤ -200 (1981-1990 vs. 2006-2015)	0.71 vs. 0.43	Z = 1.4	*p* = 0.1615
Top 0.01%: SAT M – V ≥ 100 (1981-1990 vs. 2006-2015)	11.17 vs. 3.31	Z = 4.198	***p* < 0.0002**
Top 0.01%: ACT M – V ≤ -8 (1990-2000 vs. 2006-2015)	0.56 vs. 0.57	Z = -0.099	*p* = 0.9211
Top 0.01%: ACT M – V ≥ 4 (insufficient N)			
Top 0.01%: EXPLORE M – V ≤ -4 (1996-2005 vs. 2006-2015)	0.56 vs. 0.55	Z = 0.054	*p* = 0.9569
Top 0.01%: EXPLORE M – V ≥ 4 (1996-2005 vs. 2006-2015)	3.03 vs. 3.99	Z = -1.559	*p* = 0.119
RQ5: Do sex differences in ability tilt vary as a function of measure and cultural context?			
Top 1%: SAT M – V ≥ 300 vs. ASSET M – V ≥ 2.25	4.45 vs. 11.50	Z = -2.579	***p* = 0.0099**
Top 1%: ACT M – V ≥ 12 vs. ASSET M – V ≥ 2.25	4.31 vs. 11.50	Z = -2.453	***p* = 0.0142**
Top 1%: EXPLORE M – V ≥ 6 vs. ASSET M – V ≥ 2.25	4.29 vs. 11.50	Z = -2.738	***p* = 0.0062**
Top 1%: SAT M – V ≤ -200 vs. ASSET M – V ≤ -1.5	0.63 vs. 0.44	Z = 2.877	***p* = 0.004**
Top 1%: ACT M – V ≤ -8 vs. ASSET M – V ≤ -1.5	0.53 vs. 0.44	Z = 1.566	*p* = 0.1173
Top 1%: EXPLORE M – V ≤ -4 vs. ASSET M – V ≤ -1.5	0.65 vs. 0.44	Z = 3.153	***p* = 0.0016**

Note: Comparisons significant at p < 0.05 are bolded. "Insufficient N" indicates that the sample size was not sufficient to compute a significance test (i.e., the standard binomial requirement that for each sample n(p) and n(1-p) must both be equal to or greater than 5 was not met). "M" stands for mathematics. "V" stands for a verbal test or composite formed for this study. For example, ACT V and EXPLORE V are composites of the respective English and Reading subtests.

Appendix A. Full sample Ns.

SAT	SAT M is 300 (or more) points lower than SAT V						SAT V and SAT M are within 100 points of each other						SAT M is 300 (or more) points higher than SAT V	
	≤ -300		≤ -200		≤ -100		0		≥ 100		≥ 200		≥ 300	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1981-1985	14	17	422	574	4979	6916	31413	34399	3651	1858	179	50	11	2
1986-1990	22	25	595	778	7175	9920	57332	63665	9653	5739	745	216	36	7
1991-1995	18	30	537	755	7473	10165	69375	74435	16470	8930	1575	424	96	13
1996-2000	16	16	452	738	7932	11904	99948	101390	25076	14041	2475	821	100	19
2001-2005	14	10	370	643	7025	11188	105297	110964	29482	15518	2773	810	119	28
2006-2010	14	22	361	660	6222	10215	76941	82191	21123	11339	2326	714	123	30
2011-2015	9	13	286	571	5295	9137	63574	71690	14698	8152	1653	572	111	36
Total	107	133	3023	4719	46101	69445	503880	538734	120153	65577	11726	3607	596	135
ACT	ACT M is 12 (or more) points lower than ACT V						ACT M and ACT V are within 4 points of each other						ACT M is 12 (or more) points higher than ACT V	
	≤ -12		≤ -8		≤ -4		0		≥ 4		≥ 8		≥ 12	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1990-1995	238	536	2119	4002	10123	16131	29100	26696	3284	1370	139	23	5	1
1996-2000	182	477	2011	3852	10555	16421	37257	32750	5457	2223	256	65	15	4
2001-2005	144	436	1841	3591	10694	16325	43071	38686	5508	2243	297	55	14	2
2006-2010	144	377	1749	3257	10840	16173	48113	42592	10645	4555	844	222	50	12
2011-2015	230	603	2478	4430	13682	19582	53667	46045	10915	4706	1015	233	82	19
Total	938	2429	10198	19132	55894	84632	211208	186769	35809	15097	2551	598	166	38
EXPLORE	Explore M is 6 (or more) points lower than Explore V						Explore M and Explore V are within 2 points of each other						Explore M is 6 (or more) points higher than Explore V	
	≤ -6		≤ -4		≤ -2		0		≥ 2		≥ 4		≥ 6	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F

1996-2000	888	1366	2522	3335	5123	5918	4678	3513	2551	1250	948	400	265	103
2001-2005	751	1307	2547	3798	6271	8120	9136	8025	4827	2605	1574	622	392	106
2006-2010	379	810	1391	2439	3698	5238	6132	5194	3738	1691	1322	414	361	76
2011-2015	544	1148	1865	3289	4734	6902	7431	6490	4601	2056	1699	508	477	82
Total	2562	4631	8325	12861	19826	26178	27377	23222	15717	7602	5543	1944	1495	367
ASSET	ASSET M is 2.25 (or more) SDs below ASSET V						ASSET M and ASSET V are within 0.75 SDs of each other						ASSET M is 2.25 (or more) SDs above ASSET V	
	≤ -2.25		≤ -1.5		≤ -0.75		0		≥ 0.75		≥ 1.5		≥ 2.25	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
2011-2015	2	14	97	220	749	929	2522	1387	1251	280	449	74	102	11

Note. "M" stands for mathematics. "V" stands for a verbal test or composite formed for this study. For example, ACT V and EXPLORE V are composites of the respective English and Reading subtests.

Appendix B. Top 1% Ns.

SAT	SAT M is 300 (or more) points lower than SAT V						SAT V and SAT M are within 100 points of each other						SAT M is 300 (or more) points higher than SAT V	
	≤ -300		≤ -200		≤ -100		0		≥ 100		≥ 200		≥ 300	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1981-1985	14	17	385	526	3877	5087	19249	16957	3249	1408	179	49	11	1
1986-1990	22	25	507	671	5101	6964	33566	31839	8297	4338	745	216	36	7
1991-1995	18	30	462	660	5504	7695	42636	42097	13957	7056	1575	424	96	13
1996-2000	16	16	401	654	6024	9177	62616	59532	20594	10722	2220	708	100	19
2001-2005	14	10	312	552	5055	8363	64723	63642	24724	12195	2576	710	119	28
2006-2010	14	22	313	612	4989	8400	49358	49282	17670	8779	2121	627	123	30
2011-2015	9	13	264	543	4304	7734	40671	44102	12623	6609	1575	520	111	36
Total	107	133	2644	4218	34854	53420	312819	307451	101114	51107	10991	3254	596	134
ACT	ACT M is 12 (or more) points lower than ACT V						ACT M and ACT V are within 4 points of each other						ACT M is 12 (or more) points higher than ACT V	
	≤ -12		≤ -8		≤ -4		0		≥ 4		≥ 8		≥ 12	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1990-1995	234	533	2078	3948	8651	13732	15694	12549	2627	1037	132	23	4	1
1996-2000	180	475	2001	3833	9594	14751	23173	17625	4432	1590	233	53	15	4
2001-2005	144	433	1832	3575	9669	14505	25123	19629	4185	1517	255	41	13	2
2006-2010	142	369	1733	3242	10349	15377	35307	28492	8603	3216	753	175	48	11
2011-2015	226	598	2454	4408	13210	18958	40490	33197	8930	3561	905	196	75	18
Total	926	2408	10098	19006	51473	77323	139787	111492	28777	10921	2278	488	155	36
EXPLORE	Explore M is 6 (or more) points lower than Explore V						Explore M and Explore V are within 2 points of each other						Explore M is 6 (or more) points higher than Explore V	
	≤ -6		≤ -4		≤ -2		0		≥ 2		≥ 4		≥ 6	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F

1996-2000	746	1172	1775	2394	3117	3673	2760	1933	1733	813	690	287	218	88
2001-2005	666	1105	2009	2930	4015	5066	4847	3660	3494	1685	1321	496	371	92
2006-2010	340	730	1218	2082	2698	3738	3844	2876	3045	1289	1228	376	354	73
2011-2015	462	1009	1503	2673	3187	4631	4230	3334	3685	1482	1566	451	470	76
Total	2214	4016	6505	10079	13017	17108	15681	11803	11957	5269	4805	1610	1413	329
ASSET	ASSET M is 2.25 (or more) SDs below ASSET V						ASSET M and ASSET V are within 0.75 SDs of each other						ASSET M is 2.25 (or more) SDs above ASSET V	
	≤ -2.25		≤ -1.5		≤ -0.75		0		≥ 0.75		≥ 1.5		≥ 2.25	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
2011-2015	2	14	96	219	630	770	1594	758	956	179	359	51	92	8

Note. "M" stands for mathematics. "V" stands for a verbal test or composite formed for this study. For example, ACT V and EXPLORE V are composites of the respective English and Reading subtests.

Appendix C. Top 0.01% Ns.

SAT	SAT M is 300 (or more) points lower than SAT V						SAT V and SAT M are within 100 points of each other						SAT M is 300 (or more) points higher than SAT V	
	≤ -300		≤ -200		≤ -100		0		≥ 100		≥ 200		≥ 300	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1981-1985	1	0	8	11	21	21	14	0	29	2	13	1	2	0
1986-1990	1	3	12	17	28	42	45	13	105	10	43	2	6	1
1991-1995	1	2	17	14	39	45	61	29	161	36	70	13	13	2
1996-2000	4	5	22	35	64	79	91	44	293	65	142	31	18	2
2001-2005	2	1	16	22	60	66	146	69	482	125	211	54	36	7
2006-2010	2	1	17	30	59	77	139	89	538	115	243	32	37	5
2011-2015	0	6	14	42	55	110	179	133	842	302	393	128	60	19
Total	11	18	106	171	326	440	675	377	2450	655	1115	261	172	36
ACT	ACT M is 12 (or more) points lower than ACT V						ACT M and ACT V are within 4 points of each other						ACT M is 12 (or more) points higher than ACT V	
	≤ -12		≤ -8		≤ -4		0		≥ 4		≥ 8		≥ 12	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1990-1995	14	36	23	46	30	49	17	5	26	2	14	0	2	0
1996-2000	20	54	40	66	48	69	67	17	57	3	20	0	5	0
2001-2005	13	55	34	76	44	78	88	23	78	14	30	2	6	0
2006-2010	22	58	50	106	82	147	236	87	236	41	82	3	17	1
2011-2015	39	102	131	210	210	283	470	182	444	94	152	23	36	6
Total	108	305	278	504	414	626	878	314	841	154	298	28	66	7
EXPLORE	Explore M is 6 (or more) points lower than Explore V						Explore M and Explore V are within 2 points of each other						Explore M is 6 (or more) points higher than Explore V	
	≤ -6		≤ -4		≤ -2		0		≥ 2		≥ 4		≥ 6	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F

1996-2000	4	2	5	4	10	8	42	18	121	36	58	21	17	7
2001-2005	16	23	18	37	27	47	56	39	208	91	136	43	66	20
2006-2010	19	34	27	46	37	60	86	71	312	107	185	56	96	21
2011-2015	24	52	42	79	61	104	159	95	463	128	290	63	119	19
Total	63	111	92	166	135	219	343	223	1104	362	669	183	298	67
ASSET	ASSET M is 2.25 (or more) SDs below ASSET V						ASSET M and ASSET V are within 0.75 SDs of each other						ASSET M is 2.25 (or more) SDs above ASSET V	
	≤ -2.25		≤ -1.5		≤ -0.75		0		≥ 0.75		≥ 1.5		≥ 2.25	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
2011-2015														

Note. "M" stands for mathematics. "V" stands for a verbal test or composite formed for this study. For example, ACT V and EXPLORE V are composites of the respective English and Reading subtests.