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The Role of Elite Education and Inferred Cognitive Ability in Eminent Creative Expertise: An Historical Analysis of the TIME 100

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Abstract

Some areas of human performance have clear outcome metrics—such as chess or running—which ease the testing of expertise models. However, there are areas of expertise (which may lead to eminence) where cultural context and other factors may have varying levels of importance, but where expertise models should still be tested to inform more comprehensive theoretical models of development. In this study, we examine the presence of elite education and inferred cognitive ability for the development of eminent creative expertise as determined by the gatekeepers who have historically identified the TIME 100—arguably a set of individuals who are highly influential in the cultural context of their time. Overall, we uncover that top 1% in IQ people are overrepresented in the TIME 100 by an effect size, or relative risk, of about 42. This ranged at the low end with Artists/Entertainers being overrepresented by a factor of about 19 and at the high end with Scientists/Thinkers overrepresented by a factor of about 70. These findings inform our understanding of the presence of highly selective educational institutions, as well as cognitive abilities, in the development of eminence across the domains included in the TIME 100. These findings also simultaneously inform the literatures on the relationship between cognitive abilities and creative expertise, and how these elements contribute to our understanding of the development of expertise in traditionally understudied domains.

Keywords

Eminence, creativity, influential and powerful, elite education, cognitive ability, gifted

Introduction

The study of expertise has recently moved toward more comprehensive theoretical models of development (e.g., Hambrick, Macnamara, Campitelli, Ullen, & Mosing, 2016) with a multi-disciplinary approach (e.g., Gobet, 2016). This suggests that to better determine the generality of expertise models, more research is needed outside the traditional domains of expertise research—such as music, sports, and chess (e.g., Ericsson, 2014; Ericsson, Krampe, & Tesch-Romer, 1993). One class of domains which expertise research is now entering is elite occupations or eminent accomplishment in society, including top editors and writers, politicians, CEOs, and the wealthy, among other groups (e.g., Volden, Wiseman, & Wai, 2016; Wai, 2013, 2014; Wai & Perina, 2018).

Expertise models typically find that general cognitive ability plays an important role (e.g., for a review see Subotnik, Olszewski-Kubilius, and

Worrell, 2011). However, the degree to which cognitive ability matters appears to vary widely by expertise discipline. For example, Wai and Rindermann (2015) argued that the path to becoming an expert in a discipline, as well as performance within that discipline, essentially functioned as a mental test battery or cognitive challenge (e.g., Gottfredson, 2003), and illustrated that cognitive ability—as inferred through elite education—appeared to be much less important for becoming a House member but much more important for being selected as one of the most powerful people in the world according to *Forbes* magazine. Even within billionaires and attendees at the World Economic Forum, different industries or sectors in which people came from varied greatly in the extent to which general cognitive ability appeared to be a limiting factor (e.g., Wai, 2014). This suggests that it is worthwhile to test the degree to which general cognitive ability matters (and indirectly assessing the extent to which other factors may be more important), by studying more domains of eminent achievement in society.

The TIME 100 is a novel sample to examine further the role of cognitive ability (as well as the presence of educational selectivity) in the development of expertise because it includes about 100 individuals each year identified by TIME editors as some of the most influential and powerful people in society (see Table 1 for detail in the editors' own words on how the yearly 100 are selected) which span 1999 through 2019. The sample reflects eminent creative expertise overall and includes influential and powerful people across numerous domains, namely Artists and Entertainers, Builders and Titans, Heroes and Icons, Leaders and Revolutionaries, and Scientists and Thinkers. Thus, the influence of general cognitive ability and elite education can be directly compared across these different domains of expertise within the broader creative expertise category.

Cognitive Abilities, Creativity, and Creative Enterprise

There is a longstanding debate surrounding the connection between cognitive abilities and creativity. Nusbaum and Silvia (2011) studied fluid intelligence, executive processes, and strategy use in divergent thinking, and concluded that intelligence and creativity may not be all that different. On the other hand, Karwowski et al (2016) found that intelligence is necessary, but not sufficient, for creativity. Cognitive abilities tested early in life also predict what might be considered "creative accomplishments" including earning doctorates, patents, publications, higher incomes, university tenure, as well as other outcomes (e.g., Kell, Lubinski, Benbow, & Steiger, 2013; Park, Lubinski, & Benbow, 2007; Wai, Lubinski, & Benbow, 2005). Creativity researchers Plucker, Beghetto, and Dow (2004, p. 90) note: "Our proposed definition is: Creativity is the interaction among *aptitude, process and environment* by which an individual or group produces a *perceptible product* that is both *novel and useful* as defined within a *social context*." The TIME 100 is a group of people who arguably have created a perceptible product that is both novel and useful as defined within the current social context, and thus analysis of this group provides a unique way to examine the extent to which cognitive ability and elite education may be related to creativity and creative accomplishment. Comparisons across scientific creativity to artistic creativity can also be made. Our focus in this study is on creative expertise, and not all forms of creativity.

Historical Trends

An added dimension to studying a sample such as the TIME 100 across the complete and entire period in 1999 and then from 2004 to 2019 is that one can determine the extent to which elite education and inferred cognitive ability may matter for eminent creative expertise. Prior work focused on Fortune 500 CEOs from 1996 to 2014 (Wai & Rindermann, 2015) and on billionaires from 2002 to 2016 (Wai & Kanaya, 2019) showed that overall the role of elite education and inferred cognitive ability remained rather stable across the time periods studied across roughly two decades. It is possible that the influence of cognitive ability for the development of expertise may not only vary across discipline but also across time, so more studies investigating historical trends in the expertise literature seem called for.

Studying Eminent Creative Expertise

The development of expertise and eminence are not the same thing but are connected in that they are on the same continuum, with eminence being further in the right tail of achievement (e.g., Subotnik et al. 2011). This study broadly adds to the expertise literature by expanding the study of the role of both cognitive abilities and education in expertise development by focusing on the TIME 100—a group of eminent creative achievers recognized by society as highly influential and powerful—across different subdomains of achievement and creative expertise ranging from science to art but also across time and by sex. Simonton (2014, p. 11) noted that "A sample is significant when it represents the population of cases that have immense theoretical or empirical interest in their own right." This study uses historiometric methods, essentially examining the full population of a set of cases of eminent creative achievers—determined by different editors across time—and estimating their cognitive abilities retrospectively by proxy through educational selectivity (e.g., Cox, 1959; Simonton, 2009).

Samples

The TIME 100 data used in this study starts in 1999; then there is a gap until the list was reinitiated by the magazine in 2004 with data available each individual year up through 2019. The total N = 1,742 (Males = 1,182, Females = 559, Non-Binary Gender = 1). Official lists came from TIME magazine and the first author collected information about each category within the TIME 100, sex, and education through internet searches for each person who could be individually and publicly identified.

The year 1999 is unique in that it is the list of the 100 most influential people of the 20th century. The years 2004 through 2019 reflect the 100 most influential people during that particular year of selection. There have been five managing editors across the entire span of the Time 100 data, as well as shifting teams of editors who were involved in the selection process. Though in general the magazine has stressed that the TIME 100 is about influence, each group of editors had different definitions of what this meant. Table 1 presents different editors and their explanations of how the lists were compiled, along with examples of the types of well-known individuals who were selected. Table 1 illustrates that some of the findings using the TIME 100 data may be due to differences in editor selection preferences but also that the diversity of these editor selection preferences may provide different perspectives on measuring power, influence, or however each TIME 100 list was selected. Csikszentmihalyi (1996) has noted that gatekeepers—such as reviewers and editors in academic research, or art critics in the art world—serve as arbiters for what is deemed a creative contribution to a particular domain. The editors in Table 1 thus constitute the gatekeepers of what is deemed eminence in the TIME 100.

Table 1. Selection criteria for inclusion in the TIME 100 across time and examples by category

2004
Summary of selection criteria: "How did we choose them? Given that no objective measure is possible when it comes to human beings, we identified three rather distinct qualities among those who shape our lives. First there were those who came to their status by means of a very public possession of power. President George W. Bush is the pre-eminent example. Others, though they are rarely heard from in public, nonetheless have a real influence on the great events of our time. Think of Ali Husaini Sistani, the Grand Ayatullah of Iraq's Shi'ites, who in effect has a veto on plans to transfer power from those who occupy his country to its people. Still others affect our lives through their moral example. Consider Nelson Mandela's forgiveness of his captors and his willingness to walk away from the South African presidency after a single term" (Elliott, 2004).
Leaders/Revolutionaries: Kofi Annan, Condoleezza Rice, Pope John Paul II
Builders/Titans: Carly Fiorina, Howard Schultz, Meg Whitman
Artists/Entertainers: Simon Cowell, J. K. Rowling, Katie Couric
Heroes/Icons: Nelson Mandela, Aung San Suu Kyi, Arnold Schwarzenegger
Scientists/Thinkers: Steven Pinker, Linus Torvalds, Sandra Day O'Connor

2010
Summary of selection criteria: "The TIME 100 is not about the influence of power but the power of influence. Some of the people you'll encounter on this list are influential in the traditional sense—heads of state like Barack Obama, corporate leaders like Robin Li, CEO of the Chinese search-engine company Baidu. But we also seek out people whose ideas and actions are revolutionizing their fields and transforming lives—like Matt Berg, who is using text-messaging technology to improve community health monitoring in Africa, and Rahul Singh, whose organization GlobalMedic was among the first on the ground after January's Haiti earthquake, providing millions of gallons of water to those most in need. You might not have heard their names before, but their innovations and efforts will help change the world for years to come" (Stengel, 2010).
Leaders: Barack Obama, Christine Lagarde, Sarah Palin
Heroes: Temple Grandin, Serena Williams, Ben Stiller
Artists: Lady Gaga, Conan O'Brien, Elton John
Thinkers: Elizabeth Warren, Atul Gawande, Sonia Sotomayor
2014
Summary of selection criteria: "The TIME 100 is a list of the world's most influential men and women, not its most powerful, though those are not mutually exclusive terms. Power, as we've seen this year, can be crude and implacable, from Vladimir Putin's mugging of Crimea to North Korean dictator Kim Jong Un's summary execution of his uncle and mentor Jang Song Thaek. Those men made our list, but they are the outliers, and not just because we generally seek to celebrate the best work of the human spirit. The vast majority of this year's roster reveals that while power is certain, influence is subtle. Power is a tool, influence is a skill; one is a fist, the other a fingertip. You don't lead by hitting people over the head, Dwight Eisenhower used to say. That's "assault, not leadership" (Gibbs, 2014).
Arts: Matthew McConaughey, Benedict Cumberbatch, Beyonce
Business: Jack Ma, Megyn Kelly, Aliko Dangote
Government: Narendra Modi, Janet Yellen, Shinzo Abe
Science: John Kovac, Kathryn Sullivan, Katharine Hayhoe
2018
Summary of selection criteria: "TIME's annual list of the world's most influential people is a designation of individuals whose time, in our estimation, is now. The TIME 100 isn't a measure of power, though many on the list wield it. Nor is it a collection of milestones accumulated. As our staff considers candidates, we often find ourselves wowed by those with stunning lifetime achievements. But editorial director Dan Macsai, maestro of the TIME 100, brings us back to the key question: Was *this* their year?" (Felsenthal, 2018).
Artists: Gal Gadot, Guillermo Del Toro, Judy Chicago
Leaders: Meghan Markle, Nancy Pelosi, Emmanuel Macron
Icons: Jennifer Lopez, Chadwick Boseman, Christopher Wylie
Titans: Oprah Winfrey, Elon Musk, Masayoshi Son

Note. The four time points were chosen to span the period the TIME 100 have been named, and 2004, 2010, 2014, and 2018 were each in periods with different editorial leadership. 2004 was the first year the list was initiated based on current influential people of that year, and those initial categories set the stage for categories that came after. The categories "Leaders/Revolutionaries," "Builders/Titans," "Artists/Entertainers," Heroes/Icons," and "Scientists/Thinkers," were created to encompass individual category names in specific years so across time comparisons could be possible. In this table, the selection criteria are given across these time points in the words of the editors themselves, and a few examples of people chosen in each subcategory are provided to give context to who made the list for that year.

Method

The method used to determine an "elite school" comprised one method for schools within the U.S. combined with another method for schools outside the U.S. If an individual attended an elite school according to either method, for the purposes of this study it was determined they had attended an elite school. This exact method has been used in prior work (e.g., Wai, 2014; Wai & Kanaya, 2019; Wai & Perina, 2018).

The method for schools within the U.S. determined elite school status as a highly selective college or university in the U.S. based on average standardized test scores (reported to *U.S. News & World Report*; America's Best Colleges, 2013) that placed the average student or above in the top 1% of scorers relative to the general population. Thus, elite school status was used as a proxy for being in the top 1% of general cognitive ability. The Scholastic Assessment Test (SAT) or American College Test (ACT) have been shown to measure general intelligence or IQ to a large degree (e.g., Frey & Detterman, 2004; Koenig, Frey & Detterman, 2008).

Appendix 1a shows that this includes a total of 29 U.S. schools (21 national universities and 8 liberal arts colleges). Appendix 1a lists the schools with SAT (M + V) scores or the ACT equivalent of 1400 or greater. This is roughly the cut for the top 3% of all test takers and the top 1% in ability relative to the entire population. According to Murray (2012, p. 366): "In 2010, a combined score of 1400 put a student at about the 97th percentile of all students who took the SAT (based on the distribution produced by the known means and standard deviations for the two tests and a correlation of +0.7 between them). But the number of test-takers in 2010 represented only 36% of the seventeen-year-olds in the country. Any plausible assumptions about the proportion of the 62% of seventeen-year-olds who didn't take the SAT who could have gotten a combined score of 1400 or more puts a student who actually does score 1400 well into the 99th [per]centile of the seventeen-year-old population."

Because some students, as one example, may have attended an "honors college" at a large public institution with lower average test scores but had individually scored above this cut, the method was expanded to include being admitted to a selective graduate school, in three different ways. Appendix 1b and 1c show the list of schools that had the highest average scorers on the Law School Admission Test (LSAT) and Graduate Management Admission Test (GMAT). An LSAT score of 168 or higher and a GMAT score of 700 or higher is roughly the cut for the top 10% of test takers within the respective pools (GMAT, 2013; LSAC, 2007). Finally, because *U.S. News* only ranks other graduate schools according to specific discipline, the list of schools in Appendix 1a was used as a reasonable indication that if an individual had attended that school for graduate school in some capacity, they also had to score very highly on the Graduate Record Examination. The population that chooses to take one of these graduate admissions exams is very select, suggesting that students being admitted to graduate school at one of these schools are very likely in the top 1% of ability.

The method for schools outside the U.S. that determined elite school status was developed to cast a wider net based on the idea that highly cognitively able and select students, for example, may have attended one of the top schools for undergraduate or graduate education within their home country, which means they are very likely to be highly able, but would have been missed should we use only U.S. schools. Thus, an elite school outside the U.S. was defined by a high—within the top 10 in a country—international rank in the *QS World University Rankings* (2012). Admission to one of these schools is a direct measure of attending an elite school, and an indirect measure of high general cognitive ability relative to the selection pool within each country, yet still likely within the top 1% of ability. For example, to gain admission to China's elite schools, students must take the CEE or *gaokao*, and the total score is the main criteria for admission. Li, Meng, Shi and Wu (2012, p. 80) note that "CEE scores are essentially good measures of student ability or IQ. In Chinese society, CEE scores are well accepted as direct measures of intelligence."

Our approach is an observational, largely exploratory descriptive study, where our research questions are broadly the following:

1. Prior literature examining the representation of females among elite occupations or prizewinners indicates they are typically historically underrepresented (e.g., Wai, 2013). Thus our first research question is to examine whether females are underrepresented in the TIME 100, to what extent, and whether this representation has changed or stayed the same across time.
2. Prior literature examining the elite education percentage of individuals in a wide array of elite occupational and leadership groups indicates a high level of elite education and ability that varies widely across different groups. Additionally, across time analyses have indicated stability rather than change (e.g., Wai & Kanaya, 2019; Wai & Rindermann, 2015). Thus our second set of research questions examines whether (1) the TIME 100 overall, as well as individual categories, are different in elite school percentage from one another, (2) whether the TIME 100 groups are different from other already studied highly select expertise groups, including House members, Senators, federal judges, Fortune 500 CEOs, billionaires, 30-millionaires, World Economic Forum attendees, *Forbes* most powerful men and women, and elite journalists, and (3) whether this elite school percentage has changed across time for the TIME 100 overall and as a function of area of achievement.

Results

Figure 1 shows the male-female ratio in 1999, when the TIME 100 reflected the most important people of the century. Then from 2004 to 2019 the male-female ratio reflects the cultural, historical, and other aspects of the choice of editors (refer to Table 1) in selecting the most influential people for the list. The male-female ratio has steadily decreased over time and has almost reached parity by 2018 and 2019.

Figure 1. Male-female ratio in 1999 and from 2004 to 2019

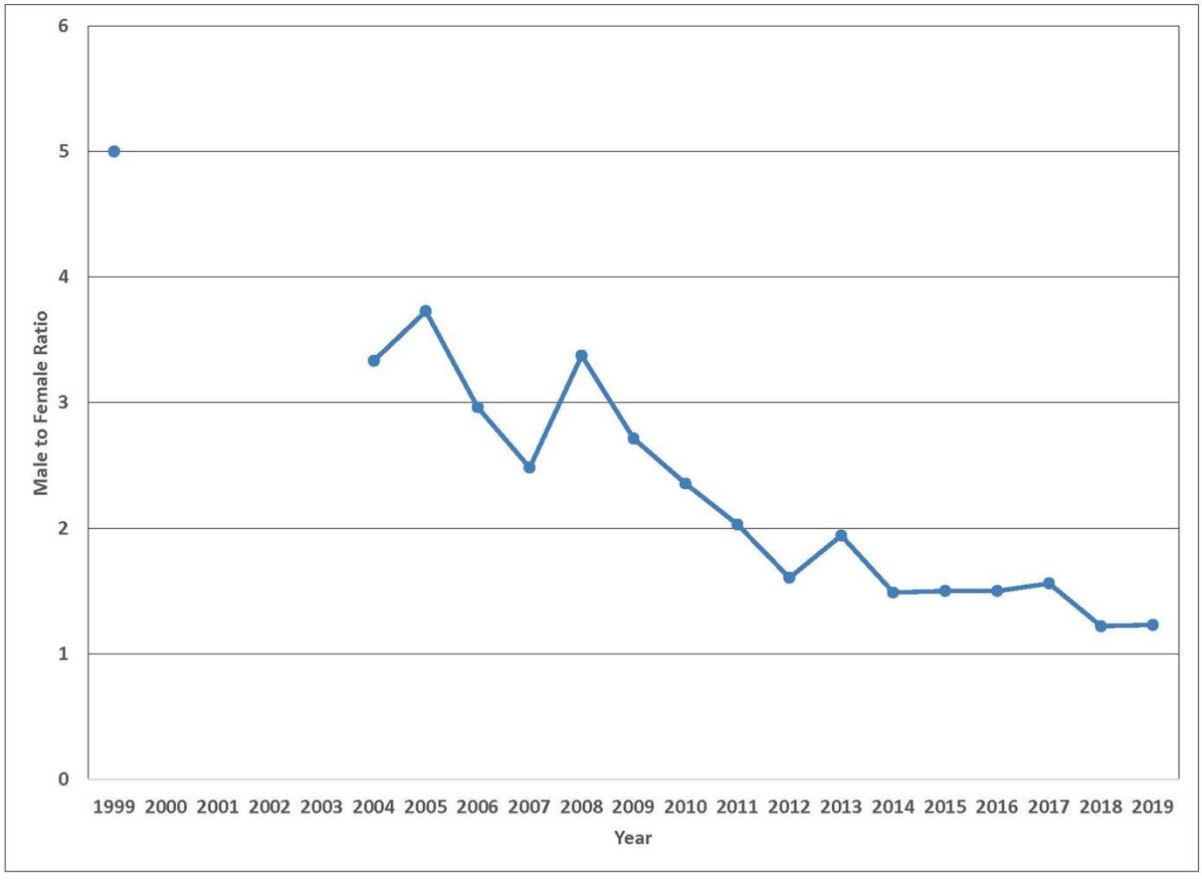

Figure 2 illustrates that overall, the percentage of the TIME 100 with an elite education and by inference in the top 1% of cognitive ability has remained relatively stable at about 40% to 50% from 1999 to 2015, with a drop in 2016 and 2018 (black line). Of those selected, females (red line) and males (blue line) have converged over time to be similar in elite education and inferred ability. Overall, throughout history, males selected for the TIME 100 tend to be more educationally select and cognitively able than the females selected for the TIME 100. An unweighted average across all years showed the elite school percentage for the entire sample was 42.2%, for males 44.2%, and for females 35.4%. To examine historical trends overall, the two oldest time points (1999 = 40.7%; 2004 = 51.0%) compared to the two most recent time points (2018 = 33.0%; 2019 = 37.7%) shows that at least in recent years there has been a drop in the educational selectivity of the list, though most of the intervening years showed general stability.

Figure 2. Percentage with elite education and by inference in the top 1% of cognitive ability overall and by sex

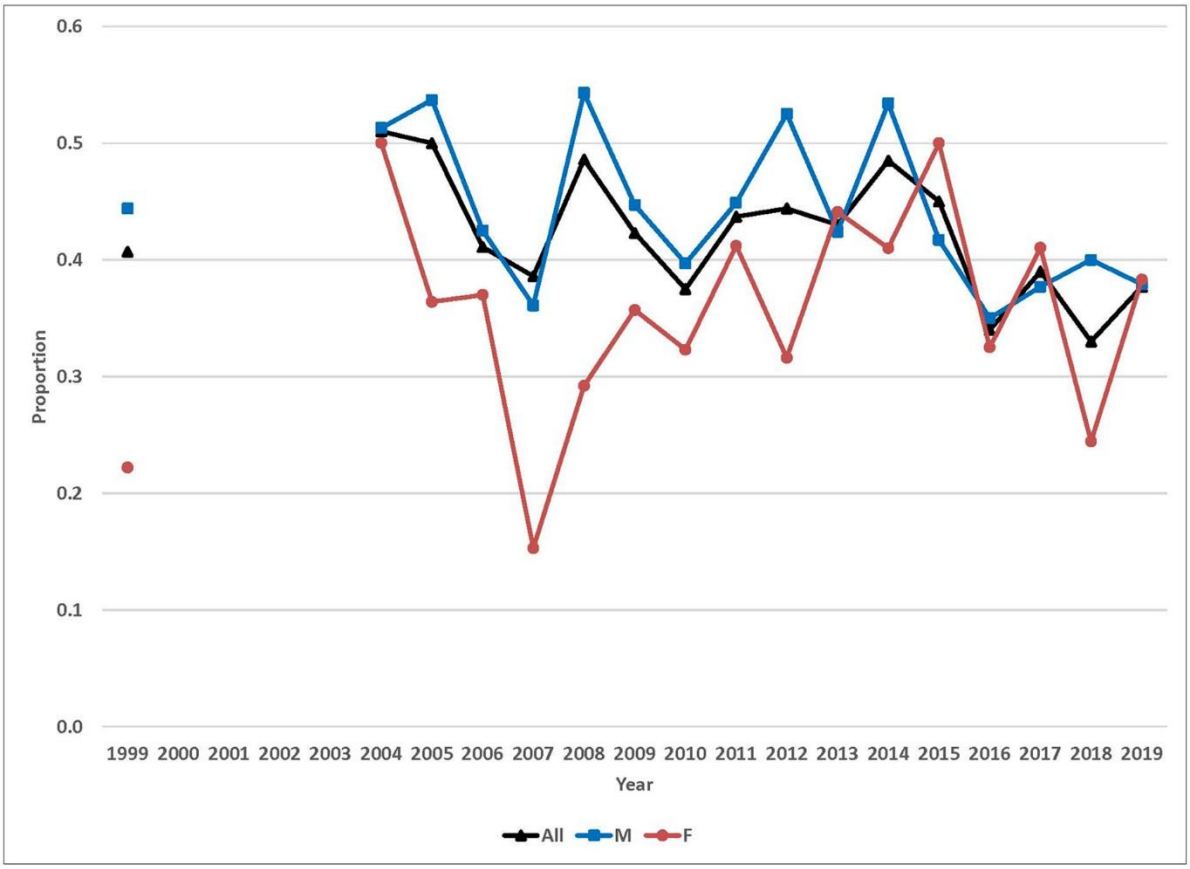

Figure 3 shows that overall elite education and inferred cognitive ability followed the following hierarchy that has shown some variation but generally has remained rather stable across time: Scientists/Thinkers > Leaders/Revolutionaries and Builders/Titans > Heroes/Icons and Artists/Entertainers. An unweighted average across all years (where data could be classified into one of the five broad categories) showed the most robust overall trend, where the elite school percentage for Scientists/Thinkers was 70.4%, for Leaders/Revolutionaries was 52.8%, for Builders/Titans was 48.6%, for Heroes/Icons was 26.6%, and for Artists/Entertainers was 19.1%. Even at the "lowest" levels, Top 1% in ability people are overrepresented among Artists/Entertainers at about 0 to 30 times

relative to the general population. At the "highest" levels, Scientists/Thinkers are overrepresented at about 60 to 80 times relative to the general population. To examine historical trends by category, comparisons were made for the two oldest and two most recent periods available. This included the following descriptive results: Leaders/Revolutionaries (1999 = 42.1%; 2004 = 57.1%; 2018 = 53.6%; 2019 = 50.0%), Builders/Titans (1999 = 30.0%; 2004 = 66.7%; 2018 = 28.6%; 2019 = 43.8%), Artists/Entertainers (1999 = 20.8%; 2004 = 14.3%; 2018 = 27.8%; 2019 = 0%), Heroes/Icons (1999 = 21.1%; 2004 = 30.0%; 2018 = 11.1%; 2019 = 43.8%), Scientists/Thinkers (1999 = 80.8%; 2004 = 85.7%; 2010 = 66.7%; 2014 = 80.0%). Note that sample sizes for individual years were very small (< 25 in some cases), so variation may be largely about lack of sample stability.

Figure 3. Percentage with elite education and by inference in the top 1% of cognitive ability by TIME 100 category

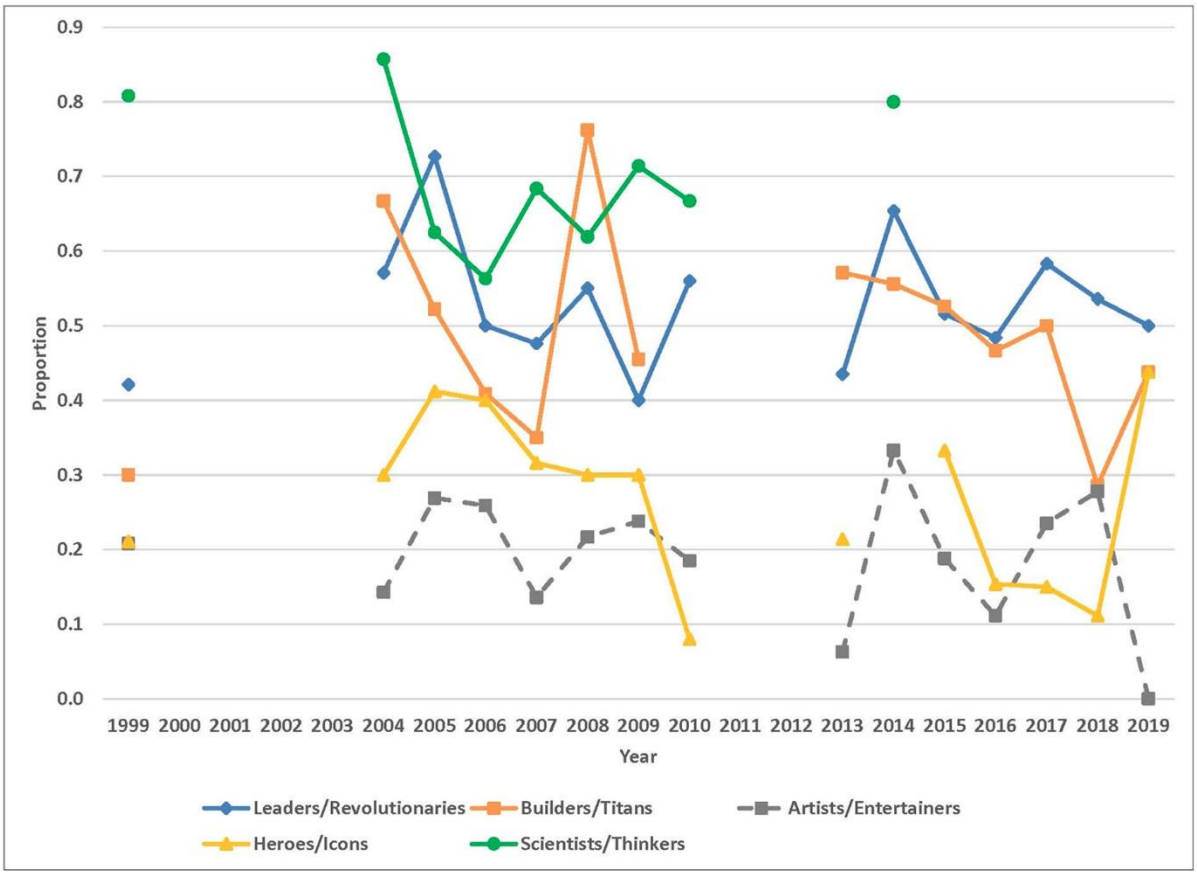

Table 2 shows the percentage of individuals attending an elite school for their undergraduate or graduate education (Elite School), a graduate school independent of the Elite School category (Grad School), a college independent of the Elite School and Grad School categories (College), and essentially the missing data NR/NC = Not Reported or No College. Table 2 is sorted by the Elite School category from lowest to highest with the TIME 100 groups together up top. The TIME 100 groups are shown for overall as well as within each category to illustrate in particular how the elite school percentage compares to other areas of achievement and eminence. Below the TIME 100 are the other categories for comparison. Overall, about 31.7% of the TIME 100 attended an elite school (8.7% attended Harvard), placing these individuals in the bottom third of groups in terms of the percentage of the group having attended an elite school. The TIME 100 Scientists/Thinkers were among the most select educationally and cognitively relative to the other groups (47.6% attended an elite school; 19.0% attended Harvard), and

secondarily the TIME 100 Builders/Titans (40.9% elite school; 9.1% Harvard). This makes sense given that scientists and thinkers most likely required a high level of education and ability and the builders and titans included many CEOs, entrepreneurs and others, hence having an elite school percentage roughly the same as the Fortune 500 CEOs (41.0% elite school; 11.6% Harvard). Compared to all other groups included in this analysis, the TIME 100 Artists/Entertainers and Leaders/Revolutionaries had the lowest elite school education at about 20%.

Table 2. Education and inferred cognitive ability range among experts across various fields of achievement and expertise in the U.S.

	Elite School	Grad School	College	NR/NC	Harvard
TIME 100 Artists/Entertainers	0.190	0.048	0.667	0.095	0.000
TIME 100 Leaders/Revolutionaries	0.200	0.500	0.150	0.150	0.100
TIME 100 Heroes/Icons	0.300	0.200	0.300	0.200	0.050
TIME 100 Overall	0.317	0.221	0.365	0.096	0.087
TIME 100 Builders/Titans	0.409	0.136	0.455	0.000	0.091
TIME 100 Scientists/Thinkers	0.476	0.238	0.238	0.048	0.190
House members	0.206	0.475	0.308	0.009	0.066
Wealth-X President	0.277	0.170	0.313	0.238	0.070
Wealth-X CEOs	0.309	0.196	0.319	0.175	0.076
Wealth-X 30 millionaires	0.338	0.183	0.278	0.200	0.090
Wealth-X Founders	0.338	0.183	0.274	0.203	0.082
Wealth-X Chairman	0.348	0.192	0.309	0.150	0.095
Wealth-X self-made 30 millionaires	0.359	0.200	0.266	0.175	0.099
Federal judges	0.409	0.591	0.000	0.000	0.119
Fortune 500 CEOs	0.410	0.262	0.268	0.058	0.116
Senators	0.410	0.420	0.160	0.010	0.120
Forbes self-made billionaires	0.426	0.155	0.314	0.105	0.123
Wealth-X billionaires	0.434	0.129	0.338	0.099	0.122
Wealth-X self-made billionaires	0.437	0.161	0.316	0.086	0.134
New York Times Editors/Writers	0.439	0.129	0.376	0.056	0.044
Forbes billionaires	0.448	0.122	0.321	0.109	0.113
Wall Street Journal Editors/Writers	0.498	0.121	0.344	0.037	0.037
Davos overall	0.546	0.176	0.181	0.095	0.185
Davos media	0.556	0.111	0.256	0.078	0.133
Forbes Powerful women	0.559	0.085	0.288	0.068	0.186
Davos CEOs	0.599	0.194	0.171	0.036	0.153
The New Republic	0.642	0.000	0.316	0.042	0.189
Davos government & policy	0.742	0.194	0.032	0.032	0.355
Forbes Powerful men	0.852	0.037	0.111	0.000	0.407
Davos academia	0.901	0.088	0.011	0.000	0.275

Note. TIME 100 data in 2009 only were used for comparison purposes because representative matching categories were systematically available. Analyses were conducted using only U.S. elite schools rather than globally elite schools to ensure U.S. comparisons could be made across all groups. This dropped the percentages attending elite schools and by inference in the top 1% of ability for the TIME 100. "Wealth-X" is a company that tracks 30-millionaires and above (Wai & Lincoln, 2016). "Wealth-X CEOs" indicates people among 30-millionaires who were also CEOs. "Davos" indicates people who attended the World Economic Forum in Davos, Switzerland (Wai, 2014). "Davos CEOs" indicates people who attended Davos who were also CEOs. "TIME 100 Builders/Titans" indicates TIME 100 people in 2009 who were placed by editors in that category.

Discussion

This study extends the historical analysis of elite education and inferred cognitive ability within Fortune 500 CEOs and billionaires (Wai & Kanaya, 2019; Wai & Rindermann, 2015) to the TIME 100, across five different domains of creative expertise. This study shows that, more or less, the effects of elite schools and cognitive ability probably has been similar within groups across time. Among other things, this shows that the educational filtering structure hasn't really changed for selection into the TIME 100, billionaires, or for the Fortune 500 in the last two decades, suggesting groups of people with eminent creative expertise in society continue to be as similarly educationally and cognitively select as they were nearly two decades ago.

How Important is Elite Education and Inferred Cognitive Ability for Developing Eminent Creative Expertise?

This study adds to the expertise literature by showing that elite education and corresponding general cognitive ability are often associated with developing creative expertise, and, arguably, eminence. Overall, the unweighted average of elite education for all years was 42.2%. This means roughly 42.2% of the TIME 100 attended an elite school and was likely in the top 1% in cognitive ability. Given that base rate expectations for the top 1% of ability is 1% of the population, this is roughly 42 times base rate expectations. This means that by category Artists/Entertainers and Heroes/Icons were overrepresented by a factor of about 19 to 27, Builders/Titans and Leaders/Revolutionaries by a factor of 49 to 53, and Scientists/Thinkers by a factor of 70. Thus elite education and inferred cognitive ability matter for expertise development, but there is variation across category or domain.

Set in the context of other highly select occupations or positions of achievement or perhaps even eminence, Table 2 shows that overall the TIME 100 was not as educationally or cognitively select relative to a wider range of previously reported select groups. Simonton (2016, p. 6) noted that "the historiometric research reviewed thus far has demonstrated that IQ plays a very minor role…differences in general intelligence explain little variance in achieved eminence." The finding that top 1% in IQ people are overrepresented in the TIME 100 by factor of about 42 and that there is wide variation across domains within the TIME 100 suggests that differences in general intelligence may play at least some role in explaining achieved eminence. Additionally, other findings have demonstrated that even within the top 1% in ability, more matters for real world creative accomplishments (e.g., Kell et al., 2013; Park et al., 2007; Wai et al., 2005).

Given that we examined eminent creative expertise across multiple domains within the TIME 100, it appears that elite education and inferred general cognitive ability matter more or less depending upon the domain of creative expertise and in what context. The individuals selected in the TIME 100 categories of Artists/Entertainers and Heroes/Icons in particular had top 1% and elite educated individuals overrepresented about 19 to 27 times, but relative to other groups in the TIME 100 these groups might be considered lower in the education/ability hierarchy. In particular, creativity in the arts and in becoming a societal icon may simply not require education or ability as much as other domains. Alternatively, these areas may not require the type of education offered at elite schools, but still may require substantial training, education, and cognitive ability. Builders/Titans and Leaders/Revolutionaries being similar to the Fortune 500 CEOs and Senators, for example, show similar levels of education and inferred ability as related groups outside the TIME 100. The finding that Scientists/Thinkers had the highest ability and education levels makes sense in that these individuals likely had to have graduate degrees, most likely from selective institutions, and that people from STEM fields tend to have higher abilities than other groups. For example, this finding holds within a stratified random U.S. sample of degree holders (Wai, Lubinski, Benbow, 2009), and within sectors of the World Economic Forum and billionaires (Wai, 2014).

General Cognitive Ability and Creative Expertise Outcomes

These findings address the ongoing discussion surrounding the role of cognitive abilities and creativity (e.g., Karwowski et al., 2016; Nusbaum & Silvia, 2011) by first specifically adding to the literature on the role of cognitive abilities prediction on creative outcomes with a focus on creative expertise. Prospective longitudinal studies have demonstrated cognitive abilities prediction for long-term creative outcomes, including patents and other educational/occupational aspects (e.g., Kell et al., 2013; Makel, Kell, Lubinski, Putallaz, & Benbow, 2016; Park et al., 2007), suggesting that intelligence is an important aspect in creativity or innovation in a pragmatic real world sense. Top 1% in general cognitive ability people being overrepresented among the TIME 100 by a factor of about 42 times base rate expectations (or a relative risk of 42, a very large effect size) suggests that cognitive abilities certainly are important for the development of creative expertise across the domains covered by the TIME 100. Given one definition of creativity from Plucker et al. (2004) that creativity involves a perceptible product that is novel and useful as defined within a social context, it is hard to argue that people in the TIME 100 have not been creative within these bounds. The findings in this study add to this literature, mainly in adding to the evidence that intelligence is likely necessary for creative expertise, but perhaps not sufficient (e.g., Karwowski et al., 2016). This suggests that perhaps other factors such as motivation and personality may play a useful role in the development of creative expertise as they do in explaining life outcomes (e.g., Möttus, Bates, Condon, Mroczek, & Revelle, 2019). In particular the role of motivation in the accumulation of crystallized knowledge (e.g., Cattell, 1987; Kanfer & Ackerman, 1989) may be a stepping-stone in creative expertise development.

Historical Trends: Overall and Within Creative Expertise Domain

The one notable historical trend decrease over time is shown in Figure 1, where the sex difference in TIME 100 representation favoring males has rapidly decreased over time from 5 to 1 in 1999 and almost at parity by 2018 and 2019. As noted in Table 1, editorial staff had to choose the people *whose time was now* for any given year. Editors have been increasingly more likely to choose more females over time, which may mean that females have had a more prominent role in U.S. culture in more recent years and/or the editors may have directly sought greater gender balance, among other factors.

The historical trends shown in Figure 2 and Figure 3 indicate that there is some variation across subcategories such as sex and area selected for the TIME 100. However, despite this variation, the overall trends tended to remain reasonably stable over time. Thus, even though more women have been identified to the TIME 100, overall, the educational selectivity and ability of various TIME 100 groups have remained rather similar across the last couple decades. However, in the most recent couple of years selectivity does seem to have dropped slightly.

Limitations

The core limitation of the method used in this paper for assessing general cognitive ability is that we are attempting to use the average scores of an institution as an indicator of individual ability. Given that we did not have individual test score data, however, this method is, by proxy, a reasonable approach to estimate aggregate ability for groups. This method cannot tease apart the potential differential effects of family background, school, or other factors from general cognitive ability. Some students may have had high individual test scores but simply attended the "honors college" of an institution with lower average test scores, thus may have been missed by this method. Or perhaps others with higher than typical test scores may have chosen not to attend an elite school (e.g., financial limitations, geographic limitations, or a scholarship). Other students may have attended one of these elite schools with lower than typical test scores (e.g., selected due to being an athlete, a legacy student, political connections, affirmative action; Espenshade & Radford, 2009; Golden, 2006; Sander, 2004). Overall, these limitations lower the reliability of using education as a proxy for ability, in particular for

individuals. However, factors in misclassifying students in both directions likely counterbalance one another, which makes the method a reasonable approach for estimating the ability of groups. Another limitation is that one could argue, for example, that the people selected for the TIME 100 in any given year may be well known and publicly influential at that time, but are not particularly important in history (e.g., individuals who would qualify as being eminent in the sense of great human accomplishment across time; Murray, 2003). In 1999 the list was deliberately meant to select influential people in history. Additionally, one strength of having different editors select influential people in any given year is the diversity of perspectives on what it means to be influential and powerful that year (e.g., see Table 1). However, perhaps the TIME 100 is more a reflection, overall, of public and social recognition, in large part. Thus, perhaps this study is about the development of expertise in public or social influence and less about eminence.

Conclusion

Performance in domains with clear performance metrics (e.g., chess, running) make for easy testing of models of expertise and perhaps even eminence. However, domains in which cultural context and other factors play varying levels of importance remain important both in terms of society and in testing of scientific models of expertise or even eminence. In societal terms, assessing models of expertise is important to help policymakers allocate resources to further their development. In scientific terms, model assessment and refinement are important to consider for both easy and edge cases. Although perhaps not extreme edge cases, the domains explored here in the TIME 100 force models of expertise to inch from the relatively easy to measure cases such as chess further toward the more complex.

Authors' Declarations

The authors declare that there are no personal or financial conflicts of interest regarding the research in this article.

The authors declare that they conducted the research reported in this article in accordance with the Ethical Principles of the Journal of Expertise.

The authors declare that they are not able to make the dataset publicly available but are able to provide it upon request.

References

America's Best Colleges (2013). Retrieved March, 2013 from www.usnews.com/rankings

Cattell, R. B. (1987). *Advances in psychology, No. 35. Intelligence: Its structure, growth and action*. New York, NY: North-Holland.

Cox, C. M. (1959). The early mental traits of three hundred geniuses. *Genetic studies of genius, Vol. II*, Stanford, CA: Stanford University Press.

Csikszentmihalyi, M. (1996). *Creativity: Flow and the psychology of discovery and invention*. New York, NY: HarperCollins Publishers.

Elliot, M. (2004). The people who shape our world. *TIME*. Retrieved from: http://content.time.com/time/specials/packages/article/0,28804,1970858_1970912,00.html

Ericsson, K. A. (2014). Why expert performance is special and cannot be extrapolated from studies of performance in the general population: A response to criticisms. *Intelligence, 45*, 81-103. doi: https://doi.org/10.1016/j.intell.2013.12.001

Ericsson, K. A., Krampe, R. T., & Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*, 363-406. doi: 10.1037//0033-295X.100.3.363

Espenshade, T. J., & Radford, A. W. (2009). *No longer separate, not yet equal: Race and class in elite college admission and campus life*. Princeton, NJ: Princeton University Press.

Felsenthal, E. (2018). How we chose the 2018 TIME 100 list of the world's most influential people. *TIME*. Retrieved from: http://time.com/5245849/time-100-2018-editor-letter/

Frey, M. C., & Detterman, D. K. (2004). Scholastic assessment or g? The relationship between the SAT and general cognitive ability. *Psychological Science, 14*, 373-378. doi: 10.1111/j.0956-7976.2004.00687.x

Gibbs, N. (2014). The ties that bind the 100. *TIME*. Retrieved from: http://time.com/75192/the-ties-that-bind-the-time-100/

GMAT (2013). What your percentile ranking means. Retrieved March, 2013 from

http://www.mba.com/ the-gmat/gmat-scores-and-score-reports/what-yourpercentile-ranking-means.aspx

Gobet, F. (2016). *Understanding expertise: A multidisciplinary approach*. London, UK: Palgrave.

Golden, D. (2006). *The price of admission*. New York, NY: Three Rivers Press.

Gottfredson, L. S. (2003). g, jobs, and life. In H. Nyborg (Ed.), *The scientific study of general intelligence: Tribute to Arthur R. Jensen* (pp. 293-342). New York, NY: Pergamon.

Hambrick, D. Z., Macnamara, B. N., Campitelli, G., Ullen, F., & Mosing, M. A. (2016). Beyond born versus made: A new look at expertise. *Psychology of Learning and Motivation, 64*, 1-55.

Kanfer, R., & Ackerman, P. L. (1989). Motivation and cognitive abilities: An integrative/aptitude-treatment interaction approach to skill acquisition. *Journal of Applied Psychology, 74,* 657-690. doi: http://dx.doi.org/10.1037/0021-9010.74.4.657

Karwowski, M., Dul, J., Gralewski, J., Jauk, E. Jankowska, D. M., Gajda, A., Chruszczewski, M. H., & Benedek, M. (2016). Is creativity without intelligence possible? A necessary condition analysis. *Intelligence, 57,* 105-117. doi: https://doi.org/10.1016/j.intell.2016.04.006

Kell, H.J., Lubinski, D., Benbow, C.P., & Steiger, J.H. (2013). Creativity and technical innovation: Spatial ability's unique role. *Psychological Science, 24,* 1831-1836. doi: 10.1177/0956797613478615

Koenig, K. A., Frey, M. C., & Detterman, D. K. (2008). ACT and general cognitive ability. *Intelligence, 36,* 153-160. doi: https://doi.org/10.1016/j.intell.2007.03.005

Li, H., Meng, L., Shi, X., & Wu, B. (2012). Does attending elite colleges pay in China? *Journal of Comparative Economics, 40*, 78-88. doi: https://doi.org/10.1016/j.jce.2011.10.001

LSAC (2007). The official LSAT prep test. Retrieved March, 2013 from http://www.lsac.org/ jd/pdfs/sampleptjune.pdf

Makel, M. C., Kell, H. J., Lubinski, D., Putallaz, M., & Benbow, C. P. (2016). When lightning strikes twice: Profoundly gifted, profoundly accomplished. *Psychological Science, 27*, 1004-1018. Doi: 10.1177/0956797616644735

Möttus, R., Bates, T. C., Condon, D. M., Mroczek, D. K., & Revelle, W. R. (2019). Leveraging a more nuanced view of personality: Narrow characteristics predict and explain variance in life outcomes. Preprint retrieved from: https://www.researchgate.net/publication/326116153_Leveraging_a_more_nuanced_view_of_personality_Narrow_characteristics_predict_and_explain_variance_in_life_outcomes

Murray, C. (2012). *Coming apart: The state of white America, 1960-2010*. New York, NY: Crown Forum.

Murray, C. (2003). *Human accomplishment: The pursuit of excellence in the arts and sciences, 800 B.C. to 1950.* New York, NY: HarperCollins.

Nusbaum, E. C., & Silvia, P. J. (2011). Are intelligence and creativity really so different? Fluid intelligence, executive processes, and strategy use in divergent thinking. *Intelligence, 39*, 36-45.

Park, G., Lubinski, D., & Benbow, C.P. (2007). Contrasting intellectual patterns for creativity in the arts and sciences: Tracking intellectually precocious youth over 25 years. *Psychological Science, 18,* 948-952. doi: 10.1111/j.1467-9280.2007.02007.x

Plucker, J. A., Beghetto, R. A., & Dow, G. T. (2004). Why isn't creativity more important to educational psychologists? Potentials, pitfalls, and future directions in creativity research. *Educational Psychologist, 39,* 83-96. doi: 10.1207/s15326985ep3902_1

QS World University Rankings (2012). Retreived June, 2013 from http://www.topuniversities.com/ university-rankings/world-university-rankings/2012

Sander, R. H. (2004). A systemic analysis of affirmative action in American law schools. *Stanford Law Review, 57*, 367-483. doi: 10.2307/40040209.

Simonton, D. K. (2016). Reverse engineering genius: historiometric studies of superlative talent. *Annals of the New York Academy of Sciences, 1377,* 3-9. doi: 10.1111/nyas.13054

Simonton, D. K. (2014). Significant samples—not significant tests! The often overlooked solution to the replication problem. *Psychology of Aesthetics, Creativity, and the Arts, 8,* 11-12. doi: http://dx.doi.org/10.1037/a0035849

Simonton, D. K. (2009). The "other IQ": Historiometric assessments of intelligence and related constructs. *Review of General Psychology, 13,* 315. doi: 10.1037/a0017141

Stengel, R. (2010). Under the influence. *TIME*. Retrieved from: http://content.time.com/time/specials/packages/article/0,28804,1984685_1985638,00.html

Subotnik, R. F., Olszewski-Kubilius, P., & Worrell, F. C. (2011). Rethinking giftedness and gifted education: A proposed direction forward based on

psychological science. *Psychological Science in the Public Interest, 12*, 3-54. doi: 10.1177/1529100611418056

Volden, C., Wiseman, A. E., & Wai, J. (2016). Elite education, liberalism, and effective lawmaking in the U.S. congress. Paper presented at the 38th annual meeting of the Association for Public Policy Analysis and Management. Retrieved July, 2017 from: https://appam.confex.com/appam/2016/webprogram/Paper16275.html

Wai, J. (2013). Investigating America's elite: Cognitive ability, education, and sex differences. *Intelligence, 41*, 203-211. doi: https://doi.org/10.1016/j.intell.2013.03.005

Wai, J. (2014). Investigating the world's rich and powerful: Education, cognitive ability, and sex differences. *Intelligence, 46*, 54-72. doi: https://doi.org/10.1016/j.intell.2014.05.002

Wai, J., & Kanaya, T. (2019). Wealth generation as a form of expertise: An examination from 2002-2016 of elite education, cognitive ability, and the gender gap among billionaires. *Journal of Expertise, 2*, 59-76.

Wai, J., & Lincoln, D. (2016). Investigating the right tail of wealth: Education, cognitive ability, giving, network power, gender, ethnicity, leadership, and other characteristics. *Intelligence, 54*, 1-32. doi: 10.1016/j.intell.2015.11.002

Wai, J., Lubinski, D., & Benbow, C. P. (2005). Creativity and occupational accomplishments among intellectually precocious youths: An age 13 to age 33 longitudinal study. *Journal of Educational Psychology, 97*, 484-492. doi: http://dx.doi.org/10.1037/0022-0663.97.3.484

Wai, J., & Perina, K. (2018). Expertise in journalism: Factors shaping a cognitive and culturally elite profession. *Journal of Expertise, 1*, 57-78.

Wai, J., & Rindermann, H. R. (2015). The path and performance of a company leader: An historical examination of the education and cognitive ability of Fortune 500 CEOs. *Intelligence, 53*, 102-107. doi: https://doi.org/10.1016/j.intell.2015.10.001

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Appendix 1. Schools attended that indicate top one percent in ability status (ranked by test scores)

a. National Universities and Liberal Arts Colleges	**Average SAT (M + V) Scores**
1. California Institute of Technology	1525
2. Harvey Mudd College	1500
2. Princeton University	1500
4. Yale University	1495
5. Harvard University	1490
5. Massachusetts Institute of Technology	1490
7. University of Chicago	1485
8. Columbia University	1475
9. Washington University in St. Louis	1465
9. University of Notre Dame	1465
11. Pomona College	1460
12. Stanford University	1455
12. Dartmouth College	1455
14. Northwestern University	1445
14. Vanderbilt University	1445
16. Duke University	1440
16. University of Pennsylvania	1440
16. Swarthmore College	1440
19. Brown University	1430
19. Rice University	1430
19. Tufts University	1430
22. Amherst College	1425
23. Williams College	1420
24. Carleton College	1415
25. Johns Hopkins University	1410
25. Carnegie Mellon University	1410
25. Bowdoin College	1410
28. Cornell University	1400
28. Haverford College	1400
b. Law Schools	**Average LSAT Scores**
1. Yale University	173.5
1. Harvard University	173.5
3. Columbia University	172.5
4. New York University	172
5. University of Chicago	170
6. Stanford University	169.5
7. Duke University	169
7. Georgetown University	169
9. University of Pennsylvania	168.5
9. University of Michigan - Ann Arbor	168.5
11. University of Virginia	168
11. Northwestern University	168
c. Business Schools	**Average GMAT Scores**
1. Stanford University	730
2. Harvard University	724
3. University of Chicago	719
3. Yale University	719
3. New York University (Stern)	719
6. University of Pennsylvania (Wharton)	718
6. Dartmouth College (Tuck)	718
8. Columbia University	716
9. University of California Berkeley	715
10. Northwestern University	712
11. Massachusetts Institute of Technology	710
12. University of Michigan - Ann Arbor (Ross)	703