CHAPTER 33

Society and Intelligence

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There are large between-country differences in measures of economic well-being and noneconomic well-being (democracy, rule of law, human rights, health) – but why? Many researchers from diverse disciplines view increasing the stock of human capital as the key to raising economic development, promoting democratization, and improving health, and hence improving overall societal well-being. The single most studied aspect of human capital concerns *cognitive competence* – the capacity to assess and solve problems by the use of thinking (intelligence), to acquire, to possess and use knowledge. Some have suggested that differences in population cognitive competence might explain these societal differences (e.g., Hanushek & Woessmann, 2008; Hart, 2007; Kanazawa, 2006; McDaniel, 2006). At the individual level, cognitive competence is broadly believed to increase productivity and quality in many realms (employment, child rearing, health and political decisions, to name a few). Substantial correlations between schooling attainment (i.e., highest completed school grade or level) and these societal and individual outcomes have been interpreted to support the proposition that cognitive competence, the best-known measures of which are psychometric intelligence tests, is influenced by schooling, and in turn drives international differences in health, wealth, and modernity. Understanding the processes by which cognitive dimensions of human capital are fostered represents a key issue of our time. Unsurprisingly, many researchers have toiled on this issue in recent years, focusing on the relationship between transnational gaps in cognitive competence and international differences in wealth, longevity, democratization, and so on.

For example, there are hundreds of empirical studies that are interpreted as showing the impact of cognitive and other skills obtained through education on wages or incomes; the vast majority of them use schooling attainment to represent these skills (see Psacharopolous & Patrinos, 2004). A small number instead use direct measures of adult cognitive skills (e.g., Alderman et al., 1996; Boissiere, Knight, & Sabot, 1985;

Glewwe, 1996; Murnane, Willet, & Levy, 1995). The many empirical studies of the effects of cognitive and other skills on outcomes such as health, nutrition, and fertility almost all use schooling attainment to represent these skills (see Strauss & Thomas, 1998).

What if genetic differences in intelligence of the populations of each country contributed to international gaps in economic growth and health? This hypothesis was advanced in *IQ and the Wealth of Nations*, by the British intelligence researcher Richard Lynn and the Finnish political scientist Tatu Vanhanen (2002). In it, these authors discussed the relationship between national IQ and national income for a sample of 81 countries, concluding that the results imply that since largely genetically driven IQ differences are the cause of differences in national income, it will be impossible to eradicate the gap between rich and poor nations and there is little hope for most poor nations ever to catch up with the rich nations (p. 184).

Using a similarly broad swath of nations, Rindermann (2008a) and Rindermann and Ceci (2009) also reported strong relationships between cognitive competence scores that are highly correlated with IQ, which they derived from a variety of international achievement tests (e.g., TIMSS, PISA, and PIRLS), and a host of outcomes that include gross domestic product (GDP), health, human rights, rule of law, and measures of modernity. However, these authors, while not ruling out genetic contributions to cognitive competence within individual countries, concluded that the biggest contributor of transnational gaps was within-country differences in educational attainment. They suggest that changes in national educational policies can be expected to close these international gaps in GDP, health, rule of law, and so on.

However, a correlation between cognitive competence and these measures of societal well-being does not imply causality. Indeed, both could be consequences of some other, third factor, or causality could be the other way round – that is, societal differences could cause differences in cognitive competence. For example, rich countries can afford better schools and better schools could lead to higher scores on measures of cognitive competence (whether directly school-related, such as achievement test scores, or indirectly school-related, such as measures of abstract reasoning embodied in IQ tests, e.g., Raven's matrices), without that higher cognitive competence necessarily leading back to greater national wealth. The direction of causality is important if the goal is to change the level of economic and noneconomic well-being of a country. If cognitive competence causes societal differences, then changing cognitive competence might be one solution to alleviating some of the problems some societies are facing. If, on the other hand, causality is the other way around, and cognitive differences are merely a consequence of societal differences, modifying cognitive competence cannot be the solution. If cognitive competence is deemed to be a cause of societal differences, the next question is, Can cognitive competence be changed? If cognitive competence is defined as intelligence, as measured by an IQ test, then the issue becomes, Can intelligence be altered? Some have argued that it cannot, pointing to the substantial heritability of IQ within societies as evidence. Others have pointed to the malleability of IQ and other measures of cognitive competence as a result of, for example, schooling, to suggest that providing more/better access to education could change cognitive competence and hence broad societal outcomes (Ceci & Williams, 1997). This chapter will discuss each of these issues in turn.

International Differences in Cognitive Competence

There are large international differences on measures of cognitive competence, whether measured by IQ tests or by tests designed to assess school-related achievement. We will discuss each of these types of measure in turn. Lynn and Vanhanen (2002) compiled results from myriad studies of intelligence throughout the world. They found wide variability in measures of national IQ. For example, even within Europe, national average IQ estimates range from 90 in Croatia to 102 in Austria, Germany, Italy, and the Netherlands. Outside Europe they found a much larger range. For example, the Hong Kong estimate is 107, while the estimate for India is 81 and for South Africa it is 72. The lowest IQ estimate in their 81-nation sample is Ethiopia, at 63.[1] These authors note, in particular, the low scores shown by black, sub-Saharan African samples, which they calculate to have a median score of 69. As we will see, results of different tests, including culture-reduced figural relations as well as achievement tests, depend on school quantity and quality.

However, as we discuss later, some authors have questioned the validity (both internal and external) of Lynn and Vanhanen's results, particularly pointing to the unrepresentativeness of some of their samples and the meaningfulness of applying generally U.S./UK-oriented paper-and-pencil tests to people growing up in very different cultures (Barnett & Williams, 2004, 2005; Hunt & Carlson, 2007). Wicherts and colleagues (Wicherts, Dolan, & van der Maas, 2010; Wicherts, Dolan, Carlson & van der Maas, in press) also reviewed evidence of differences in national IQ. Disagreeing with Lynn and Vanhanen's claim that the IQ of black sub-Saharan African nations averaged below 70, their systematic review suggested a figure of approximately 80 IQ points, the discrepancy between the two due mainly to different choices regarding sample inclusion. Wicherts and colleagues also share some of Barnett and Williams's concerns regarding the meaning of these tests for individuals in undeveloped countries.

[1] The mean of IQ tests is set at 100 for the UK, with the standard deviation at 15 ("Greenwich IQ"). We do not mention Equatorial Guinea with IQ 59 (was a mistake in Lynn and Vanhanen's book).

What Do International Differences in IQ/Assessment Test Performance Mean?

To make international comparisons meaningful as indicators of some underlying, culture-independent ability, tests must be measuring the same thing – with equal difficulty – in all countries. But intelligence tests were developed in Western countries, and because of this they are sometimes suspected to measure only an adaptation to a particular culture ("How well can they do our tricks?" Wober, 1969, p. 488). Intelligence should be defined as thinking ability independent of culture, but numerous examples can be cited of cultural variability on cognitive tasks, even very basic perceptual processes involved in spatial cognition (Henrich, Heine, & Norenzayan, 2010). This issue of cross-cultural validity is not a simple matter, due to differences in language, culture, and knowledge, and it seems fair to say that no test, no matter how "culture-free" it is claimed to be, is impervious to the effects of culture and schooling. Having stated this, it also seems evident that some tests are far more influenced by culture than others.

Tests include items of many different types, including explicit tests of vocabulary and figural problems. For example, the Draw-a-Man test (DAM; Goodenough, 1926; Harris, 1963) is a nonverbal intelligence test in which children are required to draw a man. It is often used in African samples, even though it is not generally considered as good an indicator of general intelligence as regular IQ tests (Wicherts, Dolan, & van der Maas, 2010). Lynn and Vanhanen (2002, 2006) included some samples using the Draw-a-Man test. Wicherts et al. suggest that the use of such samples is fraught with difficulties (e.g., in some cases the children completing the test had never used a pencil, had no schooling, and were unfamiliar with two-dimensional pictures). The tests were also being scored according to culturally loaded criteria including whether or not the children correctly drew Western clothes on their figures, despite being naked themselves. Other culture-dependent tests include the Kaufmann Assessment Battery for Children, which includes items that are likely to be unfamiliar to many test takers in less developed countries, such as telephones (Wicherts et al., 2010). Other well-known tests are also culture dependent, for example, the WISC-III: "Questions referring to, for example, 'advantages of getting news from a newspaper rather than from a television news program' (Wechsler, 1991, WISC-III Manual Comprehension subtest, p. 138), 'why it is important for cars to have license plates' (Wechsler, 1991, WISC-III Manual Comprehension subtest, p. 137), 'why you should turn off lights when no one is using them' (Wechsler, 1991, WISC-III, Manual Comprehension subtest, p. 134), 'what is an umbrella?' (Wechsler, 1991, WISC-III Manual Vocabulary subtest, p. 108), and 'in what way are a telephone and a radio alike?' (Wechsler, 1991, WISC-III Manual Similarities subtest, p. 78), would not be equally difficult, even when translated, for individuals from more and less developed countries" (Barnett & Williams, 2004, p. 390). Wicherts and colleagues noted that small alterations to the WISC-R, to reduce language and other difficulties, made a large difference in scores of Zimbabwean children, which again raises the question of what these tests are measuring.

Even tests that appear to be less culturally loaded, such as the Raven's matrices tests, are considered to have questionable psychometric meaning (Wicherts, Dolan, Carlson, & van der Maas, in press) due to test takers' lack of familiarity with stimulus materials (colored geometric shapes, multiple choice format, etc.). Wicherts and his colleagues stated, "Factor analyses show that the *g* loading of the Raven's tests is considerably smaller in African than in western samples" (p. 145) and "it is unclear whether Raven's tests afford an adequate comparison of western and African samples in terms of the construct of *g*" (p. 145).

Some have gone so far as to claim that "intelligence cannot be fully or even meaningfully understood outside its cultural context" (Sternberg, 2004, p. 325). Sternberg uses the term "successful intelligence" to refer to the practical utility of understanding behaviors within the individual's own particular environment and suggests that if tests are used cross-culturally, " the psychological meanings to be assigned to the scores will differ from one culture to another" (p. 327). The successful intelligence approach is based on the idea that "components of intelligence and the mental representations on which they act are universal" (p. 327) but "the mental contents (i.e., types and items of knowledge) to which processes such as these are applied and the judgments as to what are considered 'intelligent' applications of the processes to these contents" (p. 327) vary across cultures. Aspects of a test that are familiar in one situation or culture might be less familiar, and therefore potentially more difficult, in another situation or culture, both for individuals from different cultures in the same test situation and for the same individual in different situations (at home in a village while tracking livestock versus sitting at a desk in a school building surrounded by strangers).

The latter is an example of the context or domain specificity of expertise, knowledge, and understanding. An extensive body of research over the last century has shown that learning does not always readily transfer to novel contexts (see Barnett & Ceci, 2002, for an overview). An individual may behave intelligently in a familiar context but not successfully apply that intelligence to an unfamiliar context.

Thus, even if an intelligence test is capable of making meaningful distinctions between individuals who have similar life experiences (whether that distinction is phrased in terms of a latent construct such as "*g*," or in terms of motivational or other causes of differential learning from the same experiences, or in terms of attentional or other constraints on demonstrated performance) it may not have the same meaning when comparing individuals with different life experiences. For example, if individuals in one group have spent several hours a day for several years sitting at a desk in a school listening to a teacher and working with paper and pencil on writing and mathematics, and another group has never set foot in such a place and never worked with a paper and pencil, any difference in performance is a confound of what that difference would have been had they had the same experience, and the differences caused by the differential experience.

So, in light of this, what do international differences in IQ test performance mean?[2] Researchers do not want to unjustifiably disparage the abilities of people from other cultures (Ceci & Williams, 2009). Culture has a strong impact on forms of education, on the esteem a given culture assigns to abstract thinking and knowledge, on diligence and effort (Flynn, 2007), on thinking styles and worldviews. However, this acknowledgment does not obviate the possibility of making cross-cultural comparisons. Cross-cultural research provides a means of identifying both large background factors and the many small ideological, institutional, and behavioral mechanisms through which the worldviews of cultures work to shape cognitive competencies.

Although some (e.g., Lynn & Vanhanen, 2002) would argue that differences are indicative of underlying general intelligence, the latent construct "*g*," the foregoing suggests they are, at best, a not error-free measure. The relative magnitude of the signal (*g*) and noise (experientially driven differences) is open to debate. Resolving this debate rests, in part, on the issue of malleability (sensitivity to education and other experiential differences) of IQ, which we discuss later in this chapter. However, even if they do not measure pure "*g*," IQ tests measure something, and if that "something" can be used to make useful predictions, it may be worth understanding. For example, if national IQ measurements (from appropriately representative samples, etc.) are an indicator of national absorption of formal education, and if the effect of widespread formal education is beneficial for society, then the factors that boost national IQ may be worth investment.

An alternative way to measure the effects of formal education is to do so directly, with tests of academic achievement. Using more knowledge-based student achievement tests, which had been applied in a few sub-Saharan countries (where IQ scores are also low), Rindermann, Sailer, and Thompson (2009) and Lynn and Meisenberg (2009) have demonstrated, with measures transformed into IQ equivalent scores, averages of around 66 for these countries (e.g., South Africa, Botswana, and Ghana). Measures of cognitive competence other than IQ show large ranges similar to less knowledge-based figural tests such as mazes (e.g., CPM, SPM, and APM).[3] For example, the Trends in International Mathematics and Science Study (TIMSS), a series of international assessments carried out in 59 participating countries and 8 benchmarking locations around the world to assess mathematics and science learning in the fourth and eighth grades, found large differences in mathematical performance at both age levels (Mullis, Martin, et al., 2009). In the eighth-grade sample, Taiwan and South Korea recorded the highest average scaled scores, at 598 and 597, respectively, while Qatar and Ghana scored the lowest, at 307 and 309, respectively. (The mean is 500, the standard deviation, 100.) In the younger age group, the top scorers were Hong Kong and Singapore, at 607 and 599, while the lowest were Yemen and Qatar, at 224 and 296 – a difference of nearly three standard deviations! Findings were similar in the 2003 version of the study (Mullis, Martin, et al., 2005). In the

[2] There is considerable debate about the meaning of intelligence and whether IQ tests really measure it (Ceci, 1996). However, we will not discuss this wider debate here, except to address issues particular to the interpretation of international comparisons of IQ.

[3] CPM, SPM and APM – psychometric paper-and-pencil tests using only abstract figures (similar nonverbal-figural scales of CogAT) – are less overtly related to explicitly, school-taught knowledge than intelligence tests using verbal and math tasks or student assessment tests (using verbal and math tasks and knowledge questions). But performance on these tests and intelligence underlying the performance on them are not independent of school attendance and instructional quality (Becker, Lüdtke, Trautwein, Köller, & Baumert, 2007; Cahan & Cohen, 1989; Ceci, 1991; Stelzl, Merz, Remer, & Ehlers, 1995).

eighth-grade sample, Singapore and South Korea recorded the highest average scaled scores, at 605 and 589, respectively, while South Africa and Ghana scored the lowest, at 264 and 276, respectively. In the younger age group, the top scorers were Singapore and Hong Kong, at 594 and 575, and the lowest were Tunisia and Morocco, at 339 and 347. In summary, the well-known large-scale student assessment studies also demonstrate very large transnational differences in cognitive competence.

The relationship between these two measures of cognitive competence – intelligence and achievement – is a contentious topic. Some psychometricians argue that intelligence tests, particularly those assessing fluid intelligence (Cattell, 1987), are tapping an innate ability driven by brain differences related to neuronal processing time and working memory capacity, and as such are measuring something completely different from more knowledge-based performance on school-related assessment tests (for a review, see Neisser et al., 1996). However, high correlations between aptitude and achievement test scores in intranational samples (Ceci, 1991), coupled with similar cognitive demands and very high correlations at the between-country level (Rindermann, 2007), lead to the conclusion that the various measures of cognitive competence are largely tapping the same characteristic. Translating international score differences into an easy to understand metric, "years-behind-at-school," suggests that the larger transnational gaps are equivalent to about 5–10 years of schooling among children, adolescents, and young adults between 10 and 30 (Rindermann & Ceci, 2009).

Cognitive Competence and Societal Measures

Many have noted that cognitive competence appears to be related to societal measures of economic and noneconomic wellbeing. Lynn and Vanhanen (2002) assessed the correlation between national IQ estimates and national per capita income (GDP per capita), and found a correlation of $r = .62$, for 199/8, with higher IQ countries showing higher per capita income. Whetzel and McDaniel (2006) reached a similar conclusion using updated data. They avoided some of the methodological issues raised concerning Lynn and Vanhanen's study by truncating all IQ scores below 90 to equal 90; the relationship between IQ and GDP remained strong. Other researchers using student achievement studies or further control variables and different statistical methods found supporting positive relationships (Hanushek & Woessmann, 2008; Jones & Schneider, 2006; Weede & Kämpf, 2002).[4]

Additionally, there are positive correlations between measures of cognitive abilities and noneconomic aspects of national wellbeing such as democracy, the rule of law, and political liberty. For example, Glaeser, Ponzetto, and Shleifer (2007) have argued that the causal path runs from increased education to increased democracy. Positive effects remain significant when income is controlled (Rindermann, 2008b): Cognitive ability correlates with democracy ($N = 183$) at $r = .56$ (partial correlation with GDP controlled $= .23$); cognitive ability correlates with the rule of law ($N = 131$) at $r = .64$ ($r_p = .27$). The level of democracy was measured by two indices: one combining variables such as the fragmentation of the vote between political parties and the level of voter turnout, the second aggregating essential political indicators such as guarantees of civil liberties (Rindermann, 2008b). The rule of law was measured by indices focusing on protection of property rights and judicial independence (Rindermann, 2008b). The correlations are not extremely high, thus leaving space for exceptions like high levels of intelligence and knowledge in Singapore or China and only low or zero levels of democracy. At the individual data

4 Describing the positive impact of one variable on the other does not imply that other variables have no influence. Intelligence is not the only determinant for wealth, for example. There are additional factors behind intelligence (e.g., culture) and between intelligence and positive outcomes (like the quality and functionality of institutions).

level (Cunha, Heckman, Lochner, & Masterov, 2006; Ellis & Walsh, 2003; Thomson, 1937) cognitive ability is negatively correlated with violent crime. Rushton and Templer (Rushton &Templer, 2009) also report noneconomic national well-being correlates, using Lynn and Vanhanen's national IQ data: "Cross-national differences in rate of violent crime (murder, rape, and serious assault) were significantly correlated with a country's IQ scores (mean r = −.25, such that the higher the IQ, the lower the rate of crime)" (p. 345). The relationship remains robust excluding sub-Saharan African countries for which IQ estimates may be less valid ($r = -.35$). These same authors also investigated the relationship between national IQ and health measures, reporting correlations between IQ and the rate of HIV/AIDS ($r = -.52$), infant mortality ($r = -.67$), and life expectancy ($r = .74$). Thus, measures of cognitive competence and indicators of economic and noneconomic national well-being have been shown to be significantly correlated. Even if these cognitive measures are not assessing potential but merely some form of realized potential in academic-style tasks, their relationship with measures of national well-being merit further investigation.

Direction of Causality

Given a correlation between higher national cognitive competence and positive societal outcomes, the question remains: Does higher cognitive competence (howsoever derived) cause the positive outcomes (i.e., smarter people make better decisions and end up richer and healthier), do the positive "outcomes" cause higher cognitive competence scores (i.e., rich, healthy people have time and energy to devote to learning and so end up smarter), or could the relationship go in both directions? It may be easier to study, learn, and score high on cognitive tests if you are healthy and live in a law-abiding democracy that allows all children to attend, and afford, good schools, and studying and learning may lead to better lifestyle decisions. It is also possible that some of the correlations mentioned above are not causal in either direction but are both the consequence of some other factor, such as culture.

Although random assignment, experimental studies are impractical, individual, within country, quasi-experimental data do provide some evidence for a causal link between education and earnings. For example, Angrist and Krueger (1991) investigated the way that compulsory schooling age rules affect the amount of education children receive – depending on whether they are born earlier or later compared to the age cutoff – and the subsequent effect this exerts on earnings. Those students "who are compelled to attend school longer by compulsory schooling laws earn higher wages as a result of their extra schooling" (p. 1010). Unfortunately, investigation of the relationship between education and earnings *between* countries is even more difficult, due to the many potential confounded variables.

One way to examine such relationships is to look at the correlation between potentially causal factors at some point in history with potential dependent variables at a later time, controlling for the level of likely confounds. Rindermann (2008a, 2008b) adopted this approach. A longitudinal cross-lagged analysis on a sample of 17 (largely developed) nations was used to assess the possible direction of causality between cognitive ability (measured by student assessments) and national income (Rindermann, 2008a). Longitudinally, the standardized path coefficient for the impact of cognitive abilities on gross domestic product was .29 while the coefficient for the impact of gross domestic product on cognitive abilities was .21. So there may be effects of cognitive ability on wealth (e.g., through increased efficiency at the job and increased efficiency of institutions) and vice versa (e.g., by higher quality of nutrition and health services). Overall model fit was good. The impact of cognitive ability on GDP was similar when a larger sample of 88 nations' educational measures (average years of school attendance) were used as proxies or causal factors of cognitive competence ($\beta_{\text{Edu1}\rightarrow\text{GDP2}} = .40$).

However, the reverse effect was not found ($\beta_{GDP1 \rightarrow Edu2} = -.06$). The finding of an effect of cognitive ability and education on GDP, in both samples, provides support for claims of generalizability. There is also a suggestion of the effects of the "classical" factor economic freedom on GDP (cognitive ability model, $\beta_{EF1 \rightarrow GDP2} = .10$; education model, $\beta_{EF1 \rightarrow GDP2} = .23$). In turn, cognitive competence and education also seem to have positive impacts on economic freedom ($\beta_{CA1 \rightarrow EFP2} = .25$; $\beta_{ED1 \rightarrow EF2} = .54$): Cognitive competence and education enable individuals and societies to act successfully to establish a liberal economy. The coefficients for the effect of economic freedom on cognitive competence and education are smaller (cognitive ability model, $\beta_{EF1 \rightarrow CA2} = .17$; education model, $\beta_{EF1 \rightarrow Edu2} = .09$).

Unconfounded data to further elucidate the relationship between wealth and cognition are difficult to find, but Rindermann and Ceci (2009, p. 554) described one natural experiment by comparing cognitive assessments for Arab countries with varying levels of mineral wealth. Results suggest no effects of such independently generated affluence on cognitive ability, at least for the way that influx of wealth was spent. In an update of these results using only student assessment results (Rindermann, Sailer, & Thompson, 2009), a similar outcome appears: Oil-rich countries (Bahrain, Kuwait, Qatar, Saudi Arabia, Emirates) reach a mean of 80 (result of Program of International Student Assessment – PISA, Third International Mathematics and Science Study – TIMSS and Progress in International Reading Literacy Study – PIRLS averaged and renormed on an IQ-scale with UK = 100) with a GDP per capita of U.S.$18,203 in purchasing power parity. But 10 poorer Arab countries without such large per capita oil resources (Algeria, Egypt, Iran, Jordan, Lebanon, Morocco, Oman, Syria, Tunisia, and Yemen) had similar average IQ (79) but a GDP of only U.S.$5,566. A similar pattern is seen within Scandinavia if oil-rich Norway (IQ 96, GDP U.S.$37,670) is compared with Finland, Denmark, Sweden, and Iceland (mean IQ 99, GDP U.S.$29,269). In sum, in these cases, money appears to neither foster intelligence nor increase knowledge – maybe because the additional affluence was not spent for the improvement of environmental conditions furthering cognitive development.

The impact of pure economic factors has also been found to be weak at the individual data level, if the socioeconomic status variable (SES) is divided into two of its components: educational attainment and wealth (Rindermann & Thompson, 2009). Using datasets from Austria, Germany, the United States (the latter from Hart & Risley, 1995), Costa Rica, and Ecuador (indigenous people), the educational level of parents was always more important for explaining (at least statistically) the cognitive ability level of children than the parental level of financial affluence. (Similar findings have been reported by Melhuish et al., 2008.) Rindermann and Ceci (2009) suggested that income at the national level could be more important indirectly, depending on the distribution and use of wealth within a country. Economic resources spent for sufficient and high-quality nutrition (proteins, vitamins, minerals; Eysenck & Schoenthaler, 1997; Lynn, 2009) and health care (from pregnancy on to anti-worm treatment and to vaccinations such as against measles; Glewwe & Kremer, 2006) reaching the whole population (including the poor, orphans, and children of poorly educated parents) provide a basis for a healthy cognitive (and physical) development.

There is some evidence that measures of noneconomic well-being can also be affected by cognitive competence. Within-country evidence shows a statistical relationship between individual differences in childhood cognitive ability and adult health, even after controlling for SES (Gottfredson & Deary, 2004). Although these researchers' methodology was not experimental, the longitudinal nature of their study suggests that cognitive ability differences may be causal. However, in the absence of intervention studies, evaluating causality from between-country cognitive competence differences to between-country health differences is more difficult due to the necessity of more extensive controls for other variables, such as access to health care. Nevertheless, different authors using different data sources (educational or competence measures) have come to the conclusion that human capital is more important than wealth even for health factors such as a reduction in the spread of HIV (Lakhanpal & Ram, 2008; Rindermann & Meisenberg, 2009).

As mentioned earlier, correlational analyses also found statistical relationships between measures of cognitive competence and democracy. Within-country longitudinal evidence, which supports a causal interpretation, also exists for a relationship between childhood cognitive ability and adult voter turnout, after controlling for various personality and social variables (Denny & Doyle, 2008). Voting – engagement in the political process – could be viewed as an indicator of democratization in general. The same is true for attitudes of tolerance and liberty (Deary, Batty, & Gale, 2008).

Thus, cognitive competence and education may help improve societal well-being, including wealth, and evidence suggests a link between education and wealth, not purely a consequence of wealth buying education. However, generalizability of quasi-experimental data is limited. Perhaps, if oil-rich countries had spent their windfall differently, the consequences for cognitive development could also have been different.

Malleability of Ability

Even if there is a causal relationship between cognitive competence and desirable societal outcomes, there may be nothing that can be done to promote these desirable outcomes unless cognitive competence is malleable. Some have claimed that cognitive competence, as measured by IQ, is largely determined by genetics, and thus is not very malleable in response to policy interventions (see, e.g., Lynn & Vanhanen's comments regarding the impossibility of eradicating the difference between poor and rich countries, mentioned earlier). High heritability within a population does not, however, necessarily imply (or preclude) equivalent heritability for differences between populations. Given the obvious difficulty of conducting behavioral genetic twin and adoption studies between populations and countries (take two U.S. identical twins separated at birth, send one to live in a village in sub-Saharan Africa and one to live in Pittsburgh, then take two African identical twins separated at birth and . . .), Rushton, Bons, Vernon, and Cvorovic (2007) attempted to address these questions by comparing the patterns of item difficulty and heritability for IQ test items across populations. They used the Raven's Progressive Matrices test, which is often considered one of the least culture-bound tests, and compared groups from Canada, the United States, Serbia, and South Africa. Within the South African sample, they also compared different ethnic/racial groups. They found that population differences on item scores correlated with item heritability within the Canadian and U.S. twin samples, leading them to suggest that IQ differences *between* populations, as well as individual differences *within* populations, are highly genetically driven and hence nonmalleable. These data are also open to alternative explanations. For example, if heritability was driven by attention differences, with more heritable items being those requiring the most careful concentration, international differences due to lack of experience with schooling and sit down, paper-and-pencil tests might also correlate with this, but for environmental rather than genetic reasons. That is, test takers in a less developed country, where they did not have so much experience with concentrating for long periods of time on written materials, might do poorly on items requiring such careful concentration, compared to test takers in a more developed country where they have much more experience with such tasks. Admittedly, this is speculative and perhaps even far-fetched, but it illustrates the difficulty of making transnational inferences based on within-country heritability estimates obtained in developed nations.

Moreover, there is also considerable evidence that IQ, and other measures of cognitive competence, can be changed by education (see, e.g., Ceci, 1991; Hansen, Heckman, & Mullen, 2004; Nisbett, 2009), despite strong genetic effects (Neisser et al., 1996). It has been suggested that schooling and school-related activities foster the development of cognitive competencies that promote performance on most intelligence tests (Cahan & Cohen, 1989). Perfectly controlled experiments are impossible to conduct – children cannot be randomly assigned to be deprived of an education in the name of research – but researchers have provided several sources of evidence to support this claim. Some analyses are correlational, such as analyses of the relationship between IQ and number of years in school. However, many come from natural experiments. Ceci (1991) reviewed studies in which IQ has been shown to decline during summer vacations and among those who have been unable to reliably attend school due to their parents' occupation or the unavailability of schools. For example, children living in remote "hollows" in mountains west of Washington, D.C., early in the 20th century, had reduced exposure to school compared to those in less remote areas, presumably independent from genetic background. IQ scores were found to vary with availability of schooling. Further studies found that delayed onset of schooling depresses IQ scores, whether the delay was due to war, unavailability of teachers, closure due to racial desegregation, or school entry cutoff dates (Cahan & Cohen, 1989; Ceci, 1991; Stelzl, Merz, Remer, & Ehlers, 1995). School age cutoffs were used by Cahan and Cohen in their quasi-experimental study of the effect of amount of schooling on fifth- and sixth-graders' scores on various verbal and nonverbal intelligence tests, including the Cognitive Abilities Test and Raven's Matrices. They concluded, "The results unambiguously point to schooling as the major factor underlying the increase in intelligence test scores as a function of age" (p. 1239). Similar results were found by Stelzl et al. (1995). They also used a quasi-experimental design to separate schooling from age effects on intelligence test scores of 10-year-old children. Their results showed considerable schooling effects on all tests, including the tests of fluid intelligence.

And academic activities such as training on a task that exercises working memory have been shown to enhance so-called culture-reduced tests of fluid intelligence similar to Raven's Matrices. For example, Klauer and Phye (2008) have shown in a meta-analysis of 73 studies with 79 comparisons a mean effect of cognitive training on intelligence (mainly measures of fluid intelligence, using Cattell's Culture Fair Test) of $d = 0.52$.

Thus, at least within countries, there is considerable evidence that IQ is malleable and that education can lead to changes in cognitive competence, as assessed by measures such as IQ tests. Between-country evidence also shows a correlation between schooling and IQ.

In assessing the benefits of education, it is important to distinguish between the benefits in terms of increases in cognitive competence and the benefits in terms of gaining credentials the world might interpret as a signal of increased cognitive competence (or other related skills), whether actual or not. The latter has been termed the *signal theory* of educational effects (Spence, 1973). Signal theory argues that educational attainments *only* serve to signal the competence level of individuals. For example, college education does not further cognitive competence, but merely signals competence; persons intelligent enough to get through college and to receive a degree are assumed to possess a minimum level of intelligence and beneficial personality traits (e.g., conscientiousness), but college attendance or school education themselves do not increase abilities (e.g., Charlton, 2009; Murray, 2008). Signal theory is of course controversial and is not compatible with the results of much empirical research: Too many quasi-experimental studies have shown that the quantity of education alters cognitive competence (academic achievement and IQ; e.g., Cahan & Cohen, 1989; Stelzl et al. 1995). Thus, whether or not there may also be a signaling effect of educational credentials, signal theory cannot explain all of the benefits of education.

And at the cross-country level, signal theory is irrelevant – why should the overall economy develop better if people are absent from the labor market to spend their time on "learning" if it brings no real benefit? It seems unlikely that international investors or importers would invest in or buy from a country purely because of the educational credentials of its population.

Policy Implications

If schooling can change cognitive competence, and cognitive competence affects national economic and noneconomic well-being, then investment in raising the national level of schooling might be a good way to alleviate some of society's ills. Reviewing evidence of the interrelationship between schooling, intelligence, and income, several authors concluded, for different countries (including the United States, the UK, South Africa, Sweden, and Germany), that schooling increases individual income, both directly and via enhancement of intelligence (Bond & Saunders, 1999; Ceci & Williams, 1997). However, variations in individual IQ only explain a small amount of variance in individual income in the intranational samples.

Psacharopoulos and Patrinos (2004) reviewed studies of the return on investment in education in the tradition of the pioneering work of Angrist and Krueger (1991), based on human capital theory. Return on investment is measured by the increase in per capita income for each additional year of schooling. Their review encompasses studies from many countries, each evaluating intranational returns on investment, focusing only on individual income differences but considering both individual and social costs. (Note that the income benefit may include both increases due to increased competences, cognitive and other, and increases due to signaling effects.) Rates of return vary by geographic region and are higher for less well developed nations. Returns are also higher for primary education than for secondary or higher education, a finding consistent with Heckman and Masterov (2007). Private returns for primary education in sub-Saharan Africa are shown to be very high (37.6%), while social returns (including shared, "social" costs) are still high (25.4%).

An investigation by Rindermann and Ceci (2009) of the relationships between aspects of national educational systems and cognitive competencies aimed to determine the optimal educational policy choices to efficiently promote cognitive competence. The most important factor seems to be a general high educational level of society (high adult literacy rate, adults who have attended many years of school, adults who completed secondary or at least primary school). Cognitive competence is defined by Rindermann and Ceci as the mean cognitive competence level of students at school (measured using large-scale international student assessments such as TIMSS, PIRLS, and PISA), and the mean intelligence level in society, adapted from Lynn and Vanhanen (2006; see also Barber, 2005). Strong, positive relationships were found between kindergarten attendance and subsequent cognitive competence, even after controlling for other factors such as GDP, suggesting that early education provides a basis for subsequent successful ability development. Similar beneficial results of preschool education were found within different countries (e.g., W. S. Barnett & Boocock, 1998; Cunha et al., 2006). Number of instructional hours is also correlated with competence, leading to the conclusion that the more formal education students receive – and the younger they are when they begin to receive it – the higher their achieved cognitive competence levels are (at the individual data level, see also Ceci, 1991). However, just spending more money seems to be ineffective: Although educational expenditures are highly correlated with cognitive outcomes, the relationship disappears when GDP is partialed out.

Large class sizes were found to have a negative effect on cognitive competence, though this can be alleviated by cram school attendance, where available, and good discipline helps promote success, as do the use of achievement tests and central exit exams. Discipline and behavioral education seem to be especially important for pupils from families with low educational background (Woodworth, David, Guha, Wang, & Lopez-Torkos, 2008).[5] More time spent on homework has a negative effect on cognitive performance in poor school systems (but only at the cross-country level!). Overall, the results of Rindermann and Ceci's study suggest that increased gross and net learning *time* (from kindergarten and early school enrollment to adults' level of education) is important for the development of cognitive competence. However, as Hanushek and Woessmass (2008) note, quality of education is also important: "Knowledge rather than just time in school is what counts. . . . School attainment has a positive impact only if it raises the cognitive skills of students – something that does not happen with sufficient regularity in many developing countries" (p. 658). Discipline of students (e.g., attending school regularly, not coming late, not disturbing lessons), effective classroom management by teachers, and the use of high-stakes tests also lead to more net learning time.

Caveats

Education is not an isolated factor. Several studies have shown strong relationships between educational level and attributes of educational systems on the one hand and cognitive competence on the other. The obvious consequence would be to recommend the extension of education and the improvement of educational systems as described above. But the realization as well as outcomes of such reforms could be faced with several problems:

1. Educational attributes of societies do *not* exist *accidentally*. For instance, the existence of a large private school population in the United States and the absence of this sector in Scandinavia have their roots in cultural, historical, and social features of societies that cannot be neglected.
2. The same attributes of educational systems could have *differential impacts* depending on other educational and cultural features of societies. For example, late school enrollment in Finland is not detrimental because traditionally literacy education (at least the beginning of literacy education) occurs in families. Large class sizes in East-Asian countries do not impede achievement because the entire culture emphasizes personal effort and discipline and because regular instruction in school is accompanied by instruction in cram schools. So in these countries, reforms leading to earlier school onset or smaller classes would likely have rather small effects.
3. Educational attributes like kindergarten attendance, discipline, central exams, the use of tests, age at which students are first segregated into more versus less academic tracks, and instructional techniques cannot be easily manipulated. Educational traditions react sluggishly to attempts to change their direction. Additionally, pressure groups could oppose reforms, and there could be conflicts of interests between parties, trade unions, parental organizations, and media.
4. Educational reforms have *side effects*. For instance, if in less developed countries the educational level is raised, traditional aspects of societies from familial cohesion up to the influence of an old religious elite (e.g., mullahs and sangomas – healers in sub-Saharan Africa) may be weakened. A culture

[5] We use the term "low educational background" instead of the usually used term "minority" because the decisive variable seems to be not the status as a (quantitative) minority as opposed to a majority (e.g., Chinese or Jewish students in the United States versus Whites or Gentiles) but the educational background of the parents and their values and abilities.

might change when educational levels increase. Single modifications like earlier tracking could increase within-country differences or, like delaying tracking, the "bright flight" to private schools where a more tailored academic experience can be offered for those who can afford it.

Reciprocal causation. Neither at the level of individuals nor at the level of nations is education the single determinant of cognitive ability differences or of development processes. Numerous other factors (e.g., culture and genetics) have been empirically verified (for a list, see Rindermann & Ceci, 2009). And of course there are reciprocal effects: Education nurtures ability and ability promotes insight into the benefits of education and more generally into the advantages of a stimulating environment and lifestyle. Intelligence and knowledge enhance the ability to understand causal relationships, to anticipate future events, to act in a rational manner, and to modify environments – from their physical aspects to their social and cultural dimensions. So intelligent people may start with a higher probability of modifying their physical, social, and cultural world, and be able to construct this world in a more beneficial and more complex way. And such an environment will have an impact on ability.

Recommendation for Future Research

Psychological research and the economic sciences have done many statistical studies to research possible benefits of cognitive competences and education and why countries differed in economic and (relatively new) in cognitive development. In future research, this approach should be complemented by case studies of single countries and their educational policies and the possible effects of other social, economic and cultural conditions supporting or impeding ability development. Such studies should start with countries at the top of international competence studies, like the culturally very different Finland and Singapore. Possibly their experiences could not only increase our knowledge of determinants for cognitive enhancement but also assist other countries in their educational reforms.

Conclusion

Research on this topic is difficult due to the inappropriateness of experimental methods for many questions. Inferences must be derived from nonexperimental, correlational data whether cross-sectional, cross-lagged longitudinal, or quasi-experimental. Conclusions cannot be based on a single, watertight experiment but must be generated by converging weaker evidence from multiple sources. That being said, for some questions, enough such data exist to allow tentative conclusions. Evidence suggests that education does build cognitive competence, and education and cognitive competence promote better social outcomes, in terms of both economic and noneconomic factors. Cognitive competence here is used to refer to ability demonstrated in academic style, paper-and-pencil tasks of the sorts of skills schools seem to build. These studies do not assess practical abilities, creativity, and so on. Such skills are certainly useful and may or may not correlate (positively or negatively) with education, GDP, and other societal outcomes. However, within the limited sphere of the cognitive tests discussed here, cognitive competence appears malleable, education fruitful, and beneficial to society.

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