Talent Development & Excellence
Vol. 1, No. 1, 2009, 3-25

The impact of smart fractions, cognitive ability of politicians and average competence of peoples on social development

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Abstract: Smart fraction theory supposes that gifted and talented persons are especially relevant for societal development. Using results for the 95th percentile from TIMSS 1995-2007, PISA 2000-2006 and PIRLS 2001-2006 we calculated an ability sum value (N=90 countries) for the upper level group (equivalent to a within country IQ-threshold of 125 or a student assessment score of 667) and compared its influence with the mean ability and the 5th percentile ability on wealth (GDP), patent rates, Nobel Prizes, numbers of scientists, political variables (government effectiveness, democracy, rule of law, political liberty), HIV, AIDS and homicide. Additionally, using information on school and professional education, we estimated the cognitive competence of political leaders in N=90 countries. Results of correlations, regression and path analyses generally show a larger impact of the smart fractions' ability on positively valued outcomes than of the mean result or the 5th percentile fraction. The influence of the 5th percentile fraction on HIV, AIDS and homicide, however, was stronger. The intelligence of politicians was less important, a longitudinal cross-lagged analysis could show a positive influence on the cognitive development of nations.

Keywords:
high ability fraction, gifted portion, intelligence, patent rate, growth

A large amount of studies published in the last two decades has shown that cognitive ability levels of societies are relevant for the development of positively valued aspects of peoples and countries. Following an economic research tradition "human capital" is relevant for *economic growth and wealth* (Hanushek & Kimko, 2000; Lynn & Vanhanen, 2002, 2006; Jones & Schneider, 2006; Weede, 2006; Rindermann, 2008a). In addition, cognitive ability of nations has a positive impact on *political* development, in that it helps building up democracy, the rule of law and political liberty (Simpson, 1997; Rindermann, 2008b). Intelligence, knowledge and the intelligent use of knowledge also have beneficial effects on *health*, for instance they act as a brake on the spread of HIV (Oesterdiekhoff & Rindermann, 2007; Lakhanpal & Ram, 2008; Rindermann & Meisenberg, 2009). Finally, cognitive competence is relevant for the development of *modernity* as a societal and especially as a *cultural phenomenon* consisting of education, autonomy, liberty, morality and rationality (Habermas, 1985/1981; Meisenberg, 2004; Oesterdiekhoff, 2008; Lynn, Harvey & Nyborg, 2009). Societies at a higher ability level develop more complex, more evidence-based, more ethical and more rational world views. For some scholars like Georg Oesterdiekhoff (2000) or Michael Hart (2007) intelligence is the driving force of history.

These broad effects at the cross-national data level are backed in different societies by results at the individual level for *job performance* and *wealth* (Bacharach & Baumeister, 1998; Schmidt & Hunter, 2004; Irwing & Lynn, 2006; Rindermann & Thompson, 2009), for *tolerance, civic political attitudes* and *participation in elections* (Herrnstein & Murray, 1994; Denny & Doyle, 2008; Deary, Batty & Gale, 2008), for *health behavior* and *health* (Goldman & Smith, 2002; Gottfredson, 2004), *moral judgment* (Piaget, 1997/1932; Kohlberg, 1987) and more *rational world views* (Oesterdiekhoff, 2000; Nyborg, 2009).

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ISSN 1869-0459 (print)/ ISSN 1869-2885 (online)

The mentioned positive and global effects of cognitive competences are also the reason why international economic or educational organizations like OECD and UNESCO are conducting studies on education and competence. But the terms used vary, ranging from "*human capital*" by economists (also including personality factors relevant for productive behavior like self-discipline; e.g. Becker, 1993/1964), "*literacy*" by educationists (OECD, 2003) and psychometricians' and cognitive developmentalists' focus on the concept of "*intelligence*" (Cattell, 1987/1971; Piaget, 2001/1947). The measurement of cognitive abilities in these diverse research traditions is based on mental tasks that can be solved with thinking and (within the different approaches) with varying amounts of specific knowledge. Students' scores from all these different measurement approaches highly correlate at the individual level (Jensen, 1998; Ceci, 1991) and very highly at the national level (Rindermann, 2007a). Thus, the manifold of positive correlations among ostensibly dissimilar tests (e.g. verbal, math, science, figural and Piagetian tasks, psychometric and student assessments) is taken as an evidence that the same underlying latent factor is involved in all complex cognitive performance (Ceci, 1991). Formal education (years of schooling or degrees) often is used as a proxy or causal factor for cognitive ability. We use the term *cognitive ability* and *cognitive competence* interchangeably. They stand for *intelligence* (thinking ability), the disposal of true and important *knowledge* and the *intelligent use of that knowledge*.

In spite of various terms, research methods, disciplines and paradigms different researchers came to the same result: Cognitive ability of individuals and societies is important for positive outcomes. This causal assumption is especially backed by the use of longitudinal designs controlling for the influence of other factors and of backward effects e.g. of wealth or democracy (Rindermann, 2008a, 2008b). Of course, intelligence and knowledge are not the only and single determinants of the positive attributes described. There are additional factors *behind* (like education, culture and genes) and *beneath* (like neighbor effects, personality or chance factors) cognitive ability and *between* cognitive ability and the positive outcomes (like the quality of institutions or meritoric principles). There are positively valued attributes which may not depend (positively) on cognitive competence (like happiness and mating success). Therefore, high competence is no guarantee for positive outcomes. Finally, intelligence not guided by ethics and rationality leads to biased, questionable and destructive results.

A cognitive theory of action can explain the effect mechanism: An increased ability to *understand* information, causal relationships, and consequences of somebody's own and others' behavior in everyday life improves one's own behavior and the behavior of important others like parents, friends, classmates, teachers, officials, managers, scientists and political leaders. Additionally, cognitive ability strengthens attitudes oriented towards a more *ethical lifestyle* including perspective taking, considerateness and general *pensiveness*. But cognitive ability is also connected – meaning leading to, depending on and relying on common background factors – to *better environments* (nurturing, training and gate keeper effects) and a greater *appreciation of civic virtues and bourgeois values* like appreciation of future life's quality, of security, of education, work and individualized love. Thinking ability forms an integrated part of a global pattern oriented towards a *rational*, active, self-controlled and farsighted lifestyle. They all create *positive feedback loops:* own intelligence and the intelligence of others enhance environmental (the physical, social and cultural) quality and by this again cognitive development.

Smart fraction theory

Thus far we have solely mentioned mean cognitive ability effects. But different authors of the past and the present have stressed the importance of smart fractions. They place less emphasis on mean intelligence, but champion the importance of the cognitive ability level of a smart fraction, say a society's upper 10, 5, 1 or 0.1%, which should be mainly responsible for the progress of a society in technological, economic, political and cultural development (Thomson, 1937; La Griffe du Lion, 2004; Gelade, 2008; Murray, 2008; Weiss, 2009). Because of the assumed relevance of gifted and talented persons the Scottish pioneer of intelligence research, Godfrey H. Thomson (1881-1955), recommended the furthering of intelligent children (similarly Gelade, 2008; Murray, 2008).

The smart fraction is regarded as responsible for progress in a utilitarian sense (wealth, health and power), but also for achievements in a non-utilitarian sense (music, literature, art, religion, ethics, philosophy and world-views).

For many this kind of thesis has an elitist taste. But it is first of all an empirical question, which could be solved with a rigorous orientation towards scientific standards, based on philosophically justified epistemic principles: Is it *true*, that smart fractions are more relevant for important indicators of societal development like wealth and democracy or scientific and technological progress? Up to now there is no research on this subject using empirical data. Gelade (2008) has solely used an assumed ability level, he and the anonymous scholar La Griffe du Lion (2004) have estimated smart fractions from the mean value. But the student assessment studies (SAS) TIMSS, PISA and PIRLS give results for the 95th percentile (comparable to an IQ of 125 or higher, mean around IQ 130) enabling us to directly test a smart fraction theory. Conversely, SAS makes it possible to prove a “non-smart” fraction theory (5th percentile, comparable to an IQ of 75 or lower, mean around IQ 70): If the cognitive level of the lower groups is more relevant for outcomes standing for lower cognitive ability (and at least partly explainable by this) like HIV and AIDS (Oesterdiekhoff & Rindermann, 2007; Lakhanpal & Ram, 2008; Rindermann & Meisenberg, 2009) or criminality (Thomson, 1937; Herrnstein & Murray, 1994; Ellis & Walsh, 2003; Cunha, Heckman, Lochner & Masterov, 2006).

A group in society especially important are statesmen (or rarely stateswomen). Simonton (1984, 1985, 2006) has done several studies on the measurement of *political leader’s* cognitive ability and its impact on political success. Apart from politically (and for the media) interesting information (e.g. comparatively low cognitive ability of Bush junior, Simonton, 2006, or comparatively high cognitive ability of Obama, Murray, Cardoso & Mendes, 2008) Simonton and others (Deary et al., 2007) were able to show that cognitive traits of political leaders are important for their success. Political leadership is a cognitively demanding task (Suedfeld, Guttieri & Tetlock, 2003, p. 255), so the influence of politicians’ intelligence and knowledge on the development of societies (apart from their private success in being reelected or continuing in power) would be expected.

The opponent hypothesis to the political leader thesis would be that it is not the attributes of politicians that are important but the ones of peoples themselves (e.g. Chomsky, 2009). Maybe there is no either-or: Both, the ability of peoples and their leaders are important. Empirical data will show us.

Method

To reduce problems of poor data quality and to ensure that countries are represented in the sample at all levels of cultural, social and economic development, an average score was formed from different measures and measurement points to create one construct for each country.

Cognitive abilities

Three cognitive competence measures were used: mean results in TIMS-, PISA and PIRL-studies, mean at 5th percentile in TIMS-, PISA and PIRL-studies and mean at 95th percentile in TIMS-, PISA and PIRL-studies. Sources were TIMSS 1995, 4th and 8th grade, math and science, TIMSS 1999, 8th grade, math and science, TIMSS 2003, 4th and 8th grade, math and science, TIMSS 2007, 4th and 8th grade, math and science; PISA (always around 15 year old students) 2000, 2003 and 2006, verbal, math and science literacy, 2003 also problem solving, PIRLS verbal literacy in 4th grade 2001 and 2006. All results were originally presented in student assessment scales (SAS M=500, SD=100).

Resources had been for *TIMSS 1995* (in the order of the grades and scales: Beaton, Mullis, Martin, Gonzalez, Kelly & Smith, 1996; Beaton, Martin, Mullis, Gonzalez, Smith & Kelly, 1996; Mullis, Martin, Beaton, Gonzalez, Kelly & Smith, 1997; Martin, Mullis, Beaton, Gonzalez, Smith & Kelly, 1997), *TIMSS 1999* (Mullis, Martin, Gonzalez, Gregory, Garden, O'Connor, Chrostowski & Smith, 2000; Martin, Mullis, Gonzalez, Gregory, Smith, Chrostowski, Garden & O'Connor, 2000), *TIMSS 2003* (Mullis, Martin, Gonzalez & Chrostowski, 2004; Martin, Mullis, Gonzalez & Chrostowski, 2004), *TIMSS 2007* (Mullis, Martin & Foy, 2008; Martin, Mullis & Foy, 2008), *PISA 2000* (OECD, 2003), *PISA 2003* (OECD, 2004a, b), *PISA 2006* (OECD, 2007a, 2007b), *PIRLS 2001* (Mullis, Martin, Gonzales & Kennedy, 2003) and *PIRLS 2006* (Mullis, Martin, Kennedy & Foy, 2007).

A sum value of different scales, grades/age groups, studies and study approaches (grade vs. age level studies; studies trying to measure abilities defined by curriculum like TIMSS vs. studies trying to measure abilities defined by cognitive demands in modernity like PISA) is more convincing (say more representative, reliable and valid). High correlations between scales within and across studies allow to sum up scales to a general sum value (all factor loadings on an international *G*-factor were λ >.90; Rindermann, 2007a, 2007b).

To form a common score the results were at first averaged within one grade, year and study between different scales (e.g. within TIMSS 1995, 4th grade, across math and science), secondly within one year and study between different grades (e.g. within TIMSS 1995, across 4th and 8th grade), thirdly within one study between different years (e.g. within TIMSS, across 1995, 1999, 2003 and 2007), fourthly within different grade vs. age study approaches across TIMSS and PIRLS (TIMSS and PIRLS are studies done in grades, PISA is a study done in a single age group), fifthly and finally between different study approaches (across grade and age approach studies: TIMSS-PIRLS-mean and PISA-mean). All averaging was done using *z*-transformations calculating means and standard deviations in countries which participated in all samples used for averaging (so *z*-formula are based on the same countries and over- or underestimation is avoided). Subsequently the *z*-results were re-normed using means and standard deviations obtained by simple arithmetical averaging of all three study results (SAS-scale with M=500 and SD=100, mean, 5th percentile, 95th percentile) as an orientation. At the end the values were transformed to the more usual IQ-scale, using Great Britain as reference country, SAS-*SD* were simply transformed to an IQ-scale ("Greenwich-IQ", M=100, SD=15). Results are provided for N=90 countries. Means in SAS-scale are 453, 304 and 596, in UK-IQ-scale 90, 68 and 111. The results are not identical with the formally published cognitive ability values of Rindermann (2007a), because a) psychometric intelligence test results were not used here (Lynn & Vanhanen, 2006, provided no information on the tails), b) older student assessment studies like IEA-Reading and IAEP were not used (for IEA-Reading we could not find information on the tails, IAEP 1991 only published percentages of solved tasks, additionally samples were seriously biased), c) newer studies were included (PISA 2006, PIRLS 2006, TIMSS 2007), and d) the results were not corrected for age and grade or sample quality. Nevertheless the correlations are very high (with former corrected cognitive ability sum r=.92, with uncorrected r=.95, N=88).

"Normed" values of all variables at international data level are somewhat arbitrary, e.g. the student assessment scale with M=500 and SD=100. The norms are estimated by the authors of the student assessment studies in orientation to results in OECD-countries (and sometimes in accordance with older results). OECD-membership, however, is no scientific criterion. IQ-norms depend on the secular rise of intelligence and intelligence test results ("Flynn-effect"). Student assessment results are biased because only youth in school participated, in several countries pupils had been too old (especially in older studies and in developing countries), not all regions participated (especially in older studies and in developing countries) etc. (see Rindermann, 2007a; Wuttke, 2007). We have not applied corrections here because results at the higher ("smart", "gifted", "talented") or lower ("non-smart", "imprudent" or "dull") levels are differently affected by the distortions, presumably the high level results are nearly not affected, but the low level results (and less the means). Corrections should be tried in further studies. But also in the other variables the norms are arbitrary, e.g. in GDP (inflation, Dollar or Euro), in democracy (which scale?).

The competence levels of smart fractions, average and non-smart fractions are obtained through student assessment studies. But students do not work, do not win Nobel Prizes nor do they vote. We assume that the results of students could be generalized to adults, an assumption that is backed by high correlations with IQ measures (r=.87, N=86, Lynn & Vanhanen, 2006; often gained in adult samples), with an adult literacy study (r=.68, N=20; OECD, 2000) and the educational level of societies (r=.67, N=84, r=.75, N=85; measures see below). OECD is planning an adult literacy study for a larger country sample, by using their data on tails it would be possible to prove if our results are stable.

Because in high ability societies there is a larger percentage of a cognitive elite at a higher level (and inverted for the lower level) the three values are correlated (see also Table 2): mean with high (r=.97), mean with low (r=.97), high with low (r=.90). As a consequence of these high correlations suppressor effects are expectable in regression analyses.

For repeated measurements with cognitive abilities (Figure 5) old student assessment studies collected by Lee and Barro (1997) were used (here N=17; for further information see Rindermann, 2008b).

Cognitive ability of leading politicians

To estimate the cognitive ability of statesman (stateswomen) based on their formal education we selected the leading politicians of all the countries in the student assessment studies between 1960 and 2009. Leading politicians include presidents (33%), heads of government (64%) and the rest kings, emirs and sultans (3%). It was difficult for many countries to assess who has the real decisive power or who used or uses it (e.g. for Czech Republic, Iran, Poland, Russia and especially Switzerland). For these countries the two leading positions were used. A second problem was the modifications of countries (e.g. Yugoslavia, Soviet Union, Germany). In these cases the largest successor country represents the older one and vice versa, smaller successor countries start existing with their formal legalization. We also include (like SAS) some smaller territories which are not formal states (like Palestine or Taiwan). We always use the most usual names. A third problem often lies in not exactly knowing the leader's level of education. A fourth problem is the assessment of several educational vitae like those of clerical leaders in Iran (is it a university degree? – we estimated it as a university degree in this case). We have not assessed the content or the quality of a university degree (e.g. in Science, Technology, Engineering and Mathematics/STEM or law, highly or lowly ranked institutions). The most serious problem lies in the low comparability of education and educational degrees across countries. There is considerable heterogeneity in educational standards across the world. According to the student assessment results, a secondary degree in OECD-countries is hardly comparable to a secondary degree in developing countries, because the former have much higher scores. Furthermore, corruption and forging at universities and especially in conferring and claiming to have degrees is not impossible. We tried to exclude all honorary doctorates.

By using databanks (Munzinger-Biography: www.munzinger.de, MSN-Carta, Who is Who and only rarely Wikipedia) we could find information for N=896 leading politicians. Homepages of politicians were not used; from experiences in a study on Austrian and German politicians we found that they try to overestimate their educational record (e.g. university dropout given as a degree).

We assessed education for *school education* (as highest level: no school; primary school; secondary school; high-school diploma; university degree; doctorate; doctorate plus further scientific degrees, "Habilitation, Venia Legendi", or scientific achievement like publications), and education for *professional training* (as highest level: no vocational or professional training; vocational training; qualified training like technician; university degree; doctorate plus further scientific degrees, "Habilitation, Venia Legendi", or scientific achievement like publications). For the last category ("doctorate plus further scientific degrees or achievement") Fernando

Henrique Cardoso from Brazil is an example (published several scientific books, professor of political science, member of or taught at Institute of Advanced Study, Princeton, Collège de France, Stanford, Brown, etc.). Both overlapping indicators correlate with *r*=.90 (Cronbach-α=.95).

Finally we tried following Gottfredson (2004, 2005) to estimate IQ-levels: For no school IQ 80, for primary school IQ 90, for secondary school IQ 100, for high-school diploma IQ 113, for university degree 119, for doctorate 129 and for doctorate plus further scientific degree or achievement 138. For levels in between and different vocational or qualified trainings we gave values between 80 and 119. The mean of the two educational indicators and our IQ-estimate correlate with *r*=.96, IQ with school education *r*=.99, with professional training *r*=.88 (*N*=896). The mean IQ of politicians across countries is 118 (*SD*=7, *N*=90). The mean IQ is increasing from 1960 to 2000: in the 60s IQ 114, in the 90s IQ 118, in 00s IQ 119 and the variances are decreasing (from 12 to 7 and 7). Because we mainly include only countries participating also in student assessment studies the worldwide average could be lower. The sample for analyses was *N*=90 countries (for the map, Figure 2, *N*=95).

Wealth and development indicators of societies

Wealth: Gross domestic product 2003 (GDP per capita, purchasing power parity/ppp; Human Development Report/HDR, 2005, here for *N*=84 countries). GDP (ppp) 1998 per capita from Lynn and Vanhanen (2002), here for *N*=85 countries. GDP considers only goods and services produced within a country, not income received from abroad. GDP is an indicator for produced wealth. Their sources are UN data sets.

Developmental level of society: Human development index (HDI) from HDR (2005). The HDI is a composite indicating three basic dimensions of human development: a long and healthy life (life expectancy at birth), knowledge (adult literacy rate and the combined gross enrolment ratio for primary, secondary and tertiary schools) and a decent standard of living, as measured by GDP per capita in ppp US dollars (here for *N*=85 countries).

Educational level of societies and attributes of educational systems

The *general educational level of society* was estimated in two ways: 1. Standardized sum of literate adults' rate 1991, rate of persons between 12 and 19 years old from 1960 to 1985 having graduated from secondary school, and years of school attendance of persons 25 years or older 1990-2000 (Rindermann, 2007a). This indicator is used for analyses with data from a longer time interval (here for *N*=84 countries). 2. Education index 2003 (sum of adult literacy rate and combined gross enrollment ratio for primary, secondary and tertiary schools; HDR, 2005). This indicator is used for analyses with data around the turn of the century (here for *N*=82 countries).

Young tracking age: Age of initial tracking between schools (reversed: young age), for some countries (e.g. Hong Kong and Switzerland) the information given by OECD/PISA was corrected. *Class size*: Large class sizes, many pupils per class. For the two educational policy variables see Rindermann and Ceci (2009).

Attributes standing for high cognitive achievement of a society (excellence)

Patent rate: Number of patents of a nation (sum of residents and nonresidents) related to population size, average annual patents per 1 million people 1960-2007 and 1991-2007 (the two decades, in which the majority of student assessment studies were carried out, here used for *N*=81 and 76 countries). Source is the World Intellectual Property Organization (WIPO, 2009), an agency of the United Nations.

Nobel Prizes: Nobel Prizes in peace, literature and science 1901-2004 related to population size (sources: http://nobelprize.org/nobel_prizes/lists/all, http://en.wikipedia.org/wiki/List_of_Nobel_laureates_by_country). Science sums up Nobel Prizes in physics, chemistry, medicine and economics. Mean correlations between those are around r=.90 (α=.97, here for N=87 countries).

Scientist rate: Scientists and engineers in research and development per million people, 1985-1995 (source: Kurian, 2001, p. 388, here for N=51 countries).

High-technology exports: High-technology exports as percentage of manufacturing exports, 1997 (source: Kurian, 2001, p. 389-390, here for N=61 countries).

Political indicators

Government effectiveness: Government effectiveness 1996-2005 as “the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government’s commitment to such policies” (Kaufmann, Kraay & Mastruzzi, 2006, p. 2). The estimates are given here for N=88 countries.

Democracy: Democracy 1950-2004 and 1996-2000 from Vanhanen (2005) and Marshall and Jaggers (2000), α=.95. The estimates are used for N=84 countries.

Rule of law: Rule of law 1970-2000 and 2000 with emphasis on ownership law from Gwartney and Lawson (2003) and Knack and Keefer (1995), α=.90, here N=76 and 73.

Political freedom: Political liberty or freedom was taken from Freedom House (2004) for the year 1999 (here N=86).

For further description of political indicators see Rindermann (2008b).

HIV, AIDS and criminality indicators

HIV: HIV-infection rate 2001 and 2003 (mean r=.95, α=.99) for adults and adults 15-49 years old are from UNAIDS/WHO (2003), here N=82.

AIDS: Percentage (per 100.000) of people suffering on AIDS 1995-2000, source Statistisches Bundesamt (2002, p. 290ff.), here N=83.

Homicide: Homicide rate (per 100.000 inhabitants) 1995 and 2002 (α=.41, here N=80) from Interpol (2004).

Problems in international data sets

In all international data, problems and flaws are detectable. E.g. students are *older* than expected. How we define *grade level* if in some countries children start attending “school” by the age of four, in others by the age of seven? How can we compare *wealth* between First and Third World countries where much of the economy is based on subsistence farming and informal trading? Luxembourg, Ireland and the States seem to be too rich or at least richer than expected, Saudi Arabia is astonishingly constitutional (rule of law). How could *literacy* of students in Yemen be measured, where several regions are more or less out of state control? Kazakhstan seems to be too good in cognitive competence levels.

There are some anomalies in data like decreasing rates of *patents* in UK and Switzerland or years without patents in Norway (changed into missing values). *Nobel Prizes* also seem to be given with political considerations, e.g. there is a serious decline of Nobel Prizes for Germany starting with 1933 (Nobel Prizes are given for life’s work achievement and not for one single achievement in a current year); related to the population size persons from Sweden seem to receive a Nobel Prize more easily, US-Americans less easily. And not all countries (e.g. Israel) existed during the whole 20th century. Finally, there is no Nobel Prize in social sciences and humanities (e.g. in psychology, sociology and philosophy) and mathematics (though there is the Fields Medal). For future analyses additional awards should be considered.

The *scientist rate* is slightly misleading because many of the scientists and engineers in Western countries are of foreign origin (brain gain like in USA and Singapore). The quality of

HIV data is sometimes doubted, especially for countries from Eastern Europe, for developing countries, Muslim countries, and countries from sub-Saharan Africa.

We tried to solve or at least reduce these problems by aggregating data from different years and by using different indicators for the very construct, e.g. patent rates, Nobel Prizes, scientist rates and high-technology exports for cognitive excellence of a society (Figure 3).

Statistical methods

At first we calculated correlations between mean, non-smart and smart fraction competence measures on the one hand and different societal attributes on the other. Higher correlations for the non-smart or smart fraction indicate their larger relevance for these attributes. Secondly we present regression analyses showing relative impact of smart fraction ability or non-smart fraction ability compared to mean values. Finally we present results of cross-sectional and longitudinal path-analyses. Because of suppressor-effects the smart and non-smart fraction ability levels are not put together with mean ability in one regression analysis (only either smart or non-smart and average).

Regression and path analyses are used to calculate direct, indirect and net effects of variables. In these analyses the standardized path coefficients (β) between different variables are to be interpreted. Correlations are always added in parentheses. Correlations help to quickly estimate the influence of other variables in the model (difference between correlation and path coefficient), they allow the model to be checked ($\Sigma r\beta = R^2 = 1$-error) and the proportion of the explained variance in each factor to be calculated ($R^2 = \Sigma r\beta$). “Good” values for fit indices are SRMR≤.08 (Hu & Bentler, 1998, 1999) or SRMR≤.05 (Schermelleh-Engel, Moosbrugger & Müller, 2003) and CFI≥.95 (Hu & Bentler, 1998, 1999) or CFI≥.97 (Schermelleh-Engel et al., 2003), and “acceptable” fit is reached with SRMR≤.10 and CFI≥.95 (Schermelleh-Engel et al., 2003). For the analyses, SPSS 16.0 and LISREL 8.80 were used, while SAS 9.1 was used to produce the maps.

Significance tests were not used for interpretation (see Rindermann, 2008a; for an in-depth justification e.g. Cohen, 1994; Falk & Greenbaum, 1995; Gigerenzer, 2004; Hunter, 1997). Especially in comparisons between countries, they are not appropriate for scientific reasoning. The results of significance tests depend on the number of observations. The observations here are for a limited number of countries (around 90), but each country-level observation is based on thousands of individual observations within each country. Possible causal relationships are not more or less true if they are significant or not (see Rindermann & Meisenberg, 2009; Rindermann & Ceci, 2009).

Results

Distributions

The results for the most important variables are shown in Table 1. Figures (Maps) 1 and 2 show the distributions of the smart fractions’ and political leaders’ ability levels across the world. Because average, upper and lower levels are correlated there are at first sight no large differences: The highest values for the smart fractions are found in *East Asia* (1. Singapore IQ 127, 2. South Korea IQ 125, 3. Japan IQ 124, 5. Taiwan IQ 123, 9. Hong Kong IQ 122). A similar result was found in psychometric (average) intelligence or in student assessment studies (see Rindermann, 2007a). Different from the SAS, *Scandinavia* reaches in the cognitive elite not such a good rank (11. Finland IQ 121, 12. Estonia IQ 121 [the Baltics are added here], 16. Sweden IQ 120, 25. Denmark IQ 118, 34. Latvia IQ 117, 38. Lithuania IQ 116, 39. Iceland IQ 116, 41. Norway IQ 116). Maybe a homogenizing educational policy furthering weaker but disadvantaging high ability pupils leads to a smaller standard deviation and lower values for a gifted subgroup. Better are the traditional *Commonwealth* countries (5. New Zealand IQ 123, 7. Australia IQ 122 and 8. United Kingdom with IQ 122). They are followed by Western and Eastern European and North American countries, by South European countries, Arab or

Muslim and Latin American countries and finally by sub-Saharan countries. The countries with the lowest results are 84. Botswana (IQ 96), 85. Saudi-Arabia (IQ 95), 86. Morocco (IQ 95), 87. Kyrgyzstan (IQ 94), 88. Belize (IQ 90), 89. Ghana (IQ 89) and 90. Yemen (IQ 84). Presumably many not participating countries would have lower values.

Figure 1. World map of cognitive ability level at 95th percentile (mean of TIMSS 1995-07, IGLU 2001-06, PISA 2000-06, N=90 nations, darker means higher competence, hachured: no data)

Figure 2. World map of leading politicians' cognitive ability level 1960-2009, N=95 nations, darker means higher competence)

Table 1. Means of used variables (most important ones)

Country	CA-mean	CA-5%	CA-95%	CA-politicians 60-09	CA-politicians 90-09	GDP 2003	HDI 2003	Patent rate 1960-2007	Patent rate 1991-2007	Nobel Peace 1901-2004	Nobel Literat. 1901-2004	Nobel Science 1901-2004	Scientists 1985-95	High technology 1997	Gov. eff. 1996-2005	Democracy 1950-2004	Rule of law 1970-2000	Political liberty 1999	HIV rate 2001-2003
	IQ-scale (M=100)					ppp $	0-1	per mill		per 10 mill			per mill		"IQ"-scale (M=100)				%
Albania	81.10	55.84	103.56	120.20	122.00	4584	.780	–	–	0	0	0	–	1	92.6	90.0	96.3	92.8	0.05
Algeria	80.56	63.23	97.94	106.63	107.75	6107	.722	5.52	5.80	0	0	0	–	22	90.7	87.2	82.7	85.2	0.06
Argentina	81.50	54.72	105.79	117.83	120.67	12106	.863	51.35	21.25	0.79	0	0.30	671	15	100.4	103.8	95.2	108.0	0.61
Armenia	93.06	69.34	116.94	125.33	125.33	3671	.759	20.12	20.76	0	0	0	–	–	93.9	107.3	–	96.6	0.12
Australia	101.12	79.06	121.94	115.55	116.75	29632	.955	252.81	320.48	0	0.77	0.77	3166	39	129.7	128.3	125.8	119.4	0.09
Austria	99.65	78.16	119.34	128.20	123.80	30094	.936	305.42	84.45	2.70	1.35	2.70	1631	24	127.4	129.9	127.7	119.4	0.21
Azerbaijan	84.62	73.01	98.84	119.00	119.00	3617	.729	2.81	2.81	0	0	0	–	–	86.4	89.5	–	89.0	0.04
Bahrain	84.24	61.99	105.80	107.00	107.00	17479	.846	42.61	43.73	0	0	0	–	–	108.7	83.8	103.6	77.6	0.17
Belgium	99.13	75.02	116.53	121.31	121.50	28335	.945	432.19	40.55	3.12	1.04	1.04	1814	23	125.9	132.9	128.5	115.6	0.18
Belize	63.55	40.93	89.95	119.00	119.00	6950	.753	16.00	28.00	0	0	0	–	–	97.9	105.5	103.2	119.4	1.93
Bosnia	90.60	69.88	110.07	121.14	121.14	5967	.786	9.46	10.48	–	–	–	–	–	89.8	–	–	–	–
Botswana	73.93	50.79	96.15	116.00	115.00	8714	.565	15.23	–	0	0	0	–	–	111.3	104.6	110.1	111.8	33.99
Brazil	81.59	58.43	104.65	116.50	116.50	7790	.792	9.38	8.13	0	0	0	168	18	99.0	101.1	103.5	100.4	0.59
Bulgaria	93.46	67.92	117.22	115.92	124.00	7731	.808	45.19	22.78	0	0	0	–	–	96.7	93.6	107.8	108.0	0.04
Canada	101.75	79.59	120.32	120.11	119.00	30677	.949	306.43	211.49	0.46	0	0.92	2656	25	130.9	123.1	127.0	119.4	0.27
Chile	83.62	60.95	105.97	122.75	124.00	10274	.854	18.70	12.33	0	2.02	0	–	19	119.6	101.4	93.6	111.8	0.27
Colombia	80.61	58.15	101.38	119.67	119.00	6702	.785	5.88	4.91	0	0.44	0	–	20	98.3	104.3	87.7	96.6	0.51
Croatia	95.96	77.23	115.06	119.67	119.67	11080	.841	20.67	20.82	0	0	0	1978	19	103.1	104.8	107.5	96.6	0.04
Cyprus	91.59	68.65	112.63	122.33	124.00	18776	.891	54.36	59.70	0	0	0	–	–	118.0	119.6	100.8	119.4	0.03
Czech Republic	99.96	78.92	119.96	118.25	120.78	16357	.874	67.35	70.75	0	0.97	0.24	1159	13	111.4	102.8	104.7	115.6	0.05
Denmark	98.46	76.86	118.17	115.00	119.00	31465	.941	181.40	67.90	2.03	6.09	3.55	2647	27	132.1	133.0	128.0	119.4	0.17
Egypt	81.14	53.73	107.28	90.00	90.00	3950	.659	3.26	3.23	0.28	0.28	0.07	458	7	97.4	85.6	91.1	85.2	0.04
El Salvador	77.53	59.36	96.19	118.42	120.00	4781	.722	5.45	3.94	0	0	0	19	16	95.6	96.4	84.1	108.0	0.59
Estonia	102.26	84.40	120.75	120.11	120.11	13539	.853	86.90	107.30	0	0	0	2018	24	113.0	116.7	107.4	115.6	0.84
Finland	102.91	84.96	120.92	120.24	119.00	27619	.941	174.86	197.50	0	2.14	0.54	2812	26	131.7	127.3	119.7	119.4	0.08
France	98.17	77.01	117.77	119.67	119.00	27677	.938	219.04	102.56	1.56	2.74	1.17	2584	31	124.7	122.5	114.2	115.6	0.33
Georgia	87.62	66.16	107.50	123.00	123.00	2588	.732	28.04	26.38	0	0	0	–	–	90.5	107.3	–	100.4	0.05
Germany	99.08	75.71	119.72	123.25	125.67	27756	.930	118.02	101.35	0.83	1.17	2.50	2843	26	126.4	128.8	131.0	115.6	0.09
Ghana	61.25	32.86	89.38	118.60	122.33	2238	.520	1.23	0.30	0	0	0	–	–	98.2	89.7	84.9	104.2	2.73
Greece	94.37	71.45	115.46	123.07	126.50	19954	.912	87.48	54.56	0	2.21	0	774	12	112.4	117.1	102.6	111.8	0.17
Hong Kong	103.66	83.32	121.54	119.00	119.00	27179	.916	155.19	231.93	0	0	0	98	29	123.3	–	117.7	96.6	0.09
Hungary	99.37	78.07	119.77	119.77	125.00	14584	.862	84.62	64.53	0	.99	0.74	1033	39	111.2	95.9	105.9	115.6	0.05
Iceland	96.45	75.34	116.00	120.08	119.00	31243	.956	73.66	115.52	0	47.66	0	–	–	131.3	132.2	122.9	119.4	0.19
Indonesia	81.75	62.00	100.93	119.33	117.40	3361	.697	0.85	0.85	0	0	0	–	20	93.9	89.1	91.0	96.6	0.09
Iran	82.83	60.64	104.46	115.38	119.00	6995	.736	4.66	2.41	0.32	0	0	521	–	93.4	86.4	86.7	81.4	0.09

Table 1. (continued)

Country	CA-mean	CA-5%	CA-95%	CA-politicians 60-09	CA-politicians 90-09	GDP 2003	HDI 2003	Patent rate 1960-2007	Patent rate 1991-2007	Nobel Peace 1901-2004	Nobel Literat. 1901-2004	Nobel Science 1901-2004	Scientists 1985-95	High technology 1997	Gov. eff. 1996-2005	Democracy 1950-2004	Rule of law 1970-2000	Political liberty 1999	HIV rate 2001-2003
	IQ-scale (M=100)					ppp $	0-1	per mill		per 10 mill			per mill		"IQ"-scale (M=100)				%
Ireland	99.92	78.55	119.95	117.75	117.80	37738	.946	133.03	101.43	3.19	9.58	0.80	1871	62	126.1	124.7	128.4	119.4	0.09
Israel	92.57	64.65	117.52	117.00	118.25	20033	.915	147.58	170.02	6.24	3.12	0.78	–	33	117.1	126.8	117.5	115.6	0.08
Italy	96.57	74.09	117.45	125.22	123.00	27119	.934	201.68	53.02	0.18	1.11	0.32	1325	15	113.1	133.4	106.9	115.6	0.41
Japan	104.55	82.85	124.30	117.25	119.00	27967	.943	284.74	501.64	0.09	0.19	0.19	6309	38	118.0	122.4	127.1	115.6	0.04
Jordan	86.08	61.37	108.47	113.35	113.91	4320	.753	6.08	3.93	4.03	0	0	106	26	104.3	85.9	94.9	96.6	0.04
Kazakhstan	101.93	79.52	122.11	113.00	113.00	6671	.761	43.78	43.95	0	0	0	–	–	88.1	89.8	102.2	85.2	0.13
Korea (South)	106.37	86.11	125.25	118.11	119.80	17971	.901	0.27	0.34	0.30	0	0	2636	39	112.4	103.1	104.5	111.8	0.04
Kuwait	75.72	53.10	97.77	105.00	105.00	18047	.844	–	–	0	0	0	–	4	103.4	84.0	91.5	92.8	0.10
Kyrgyzstan	69.93	45.78	93.36	119.00	119.00	1751	.702	10.25	9.50	0	0	0	703	24	89.7	91.9	–	89.0	0.06
Latvia	97.47	77.07	116.96	121.73	121.73	10270	.836	66.28	48.82	0	0	0	1189	15	106.7	121.1	104.9	115.6	0.46
Lebanon	83.61	61.50	105.99	119.22	119.00	5074	.759	30.77	–	0	0	0	–	–	96.2	100.6	101.2	85.2	0.09
Liechtenstein	100.93	78.79	121.21	123.00	123.00	–	–	–	–	0	0	0	–	–	124.3	–	–	119.4	–
Lithuania	96.96	76.70	116.41	123.00	123.00	11702	.852	26.44	20.50	0	0	0	–	21	107.8	124.9	104.0	115.6	0.09
Luxembourg	98.31	76.19	118.84	127.00	124.00	62298	.949	1489.94	87.96	0	0	0	–	–	131.9	130.2	126.3	119.4	0.18
Macau	101.11	84.43	117.94	119.00	119.00	–	–	13.82	19.30	0	0	0	–	–	117.5	–	–	–	–
Macedonia	84.58	60.08	107.12	122.33	122.33	6794	.797	21.82	21.19	0	0	0	–	–	95.0	110.0	–	104.2	0.04
Malaysia	95.54	74.74	115.92	119.67	122.33	9512	.796	24.94	46.22	0	0	0	87	67	113.2	104.8	104.3	89.0	0.35
Malta	92.41	63.40	116.70	126.14	129.00	17633	.867	70.59	249.93	0	0	0	–	–	111.7	127.1	100.0	119.4	0.13
Mexico	85.37	64.97	105.47	121.22	124.00	9168	.814	20.83	32.43	0.17	0.17	0.04	213	33	101.7	92.4	92.5	100.4	0.26
Moldova	92.29	70.06	112.71	120.43	120.43	1510	.671	26.39	27.86	0	0	0	1539	9	88.6	108.2	–	104.2	0.18
Montenegro	84.22	63.95	104.36	119.00	119.00	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Morocco	71.02	47.48	95.36	118.65	123.86	4004	.631	6.88	9.10	0	0	0	–	27	99.5	85.1	96.1	92.8	0.08
Netherlands	101.89	82.74	119.96	124.82	122.33	29371	.943	94.30	74.07	0.76	0	2.28	2656	44	133.5	132.7	129.6	119.4	0.18
New Zealand	100.11	75.94	122.65	114.40	116.00	22582	.933	432.51	556.67	0	0	.87	1778	11	131.0	126.9	127.2	119.4	0.09
Norway	95.80	73.73	115.83	112.47	120.67	37670	.963	264.38	260.45	5.12	7.68	2.56	3678	24	130.7	129.6	126.6	119.4	0.09
Oman	80.64	55.43	104.12	114.00	113.00	13584	.781	–	–	0	0	0	–	–	111.3	83.7	108.4	81.4	0.09
Palestine	79.96	52.23	106.04	122.33	122.33	–	.729	–	–	–	–	–	–	–	–	–	–	–	–
Peru	74.03	49.77	97.00	118.27	121.50	5260	.762	7.17	7.53	0	0	0	625	10	95.3	99.3	80.1	92.8	0.40
Philippines	73.55	46.61	101.02	121.57	118.50	4321	.758	5.98	7.08	0	0	0	157	56	100.2	102.6	95.3	108.0	0.07
Poland	96.95	74.99	117.89	121.31	121.53	11379	.858	45.51	32.25	0.52	1.04	0	1299	12	109.7	93.1	97.8	115.6	0.08
Portugal	92.12	70.89	112.14	121.53	121.00	18126	.904	62.28	20.47	0	1.07	0.27	1185	11	117.6	105.4	105.1	119.4	0.38
Qatar	72.11	49.37	96.20	97.67	101.50	19844	.849	–	–	0	0	0	–	–	109.9	83.7	–	81.4	–
Romania	89.00	65.77	110.77	117.00	123.77	7277	.792	39.63	24.90	0	0	0	1382	7	94.1	92.7	95.2	111.8	0.05
Russia	97.27	75.66	118.09	116.18	124.00	9230	.795	137.30	70.60	0.10	0.21	0.13	3520	19	92.1	95.2	87.5	92.8	0.82
Saudi Arabia	74.40	53.11	95.40	90.00	90.00	13226	.772	3.24	4.21	0	0	0	–	29	97.0	83.7	107.5	73.8	0.05

Table 1. (continued)

Country	CA-mean	CA-5%	CA-95%	CA-politicians 60-09	CA-politicians 90-09	GDP 2003	HDI 2003	Patent rate 1960-2007	Patent rate 1991-2007	Nobel Peace 1901-2004	Nobel Literat. 1901-2004	Nobel Science 1901-2004	Scientists 1985-95	High technology 1997	Gov. eff. 1996-2005	Democracy 1950-2004	Rule of law 1970-2000	Political liberty 1999	HIV rate 2001-2003
	IQ-scale (M=100)					ppp $	0-1	per mill		per 10 mill			per mill		"IQ"-scale (M=100)				%
Singapore	104.56	78.86	127.22	119.00	119.00	24481	.907	433.42	910.35	0	0	0	2728	71	135.7	95.4	125.8	89.0	0.18
Slovakia	97.59	75.61	117.83	125.67	125.67	13494	.849	327.11	58.58	0	0	0	1821	15	107.2	124.7	108.7	111.8	0.04
Slovenia	98.57	78.13	118.27	121.00	121.00	19150	.904	87.20	78.02	0	0	0	2544	16	112.9	127.4	113.0	115.6	0.05
South Africa	63.26	35.69	100.06	114.17	110.40	10346	.658	115.57	–	1.24	0.83	0.10	938	–	108.8	103.7	116.7	115.6	18.64
Spain	95.65	75.36	115.19	122.43	119.00	22391	.928	98.04	25.06	0	1.44	0.07	1210	17	124.9	106.4	114.0	115.6	0.53
Sweden	100.14	79.21	119.98	117.73	116.60	26750	.949	327.75	125.43	4.99	7.48	4.99	3714	34	130.1	129.9	121.1	119.4	0.09
Switzerland	99.83	77.25	120.07	122.33	119.00	30552	.947	559.78	72.71	4.93	3.28	6.16	–	28	135.3	130.0	134.9	119.4	0.37
Syria	80.57	64.91	104.84	120.71	121.00	3576	.721	4.56	–	0	0	0	–	1	85.8	86.0	83.7	73.8	0.04
Taiwan. RoCh	102.93	80.92	122.57	121.33	125.67	–	–	–	–	0	0	0	–	–	118.9	91.6	116.0	111.8	–
Thailand	90.11	71.12	109.99	117.12	118.11	7595	.778	3.37	5.45	0	0	0	119	43	104.9	93.7	104.5	108.0	1.07
Trinidad/Tobago	84.55	57.61	110.05	121.50	122.33	10766	.801	46.10	26.89	0	10.03	0	–	–	107.3	113.9	102.4	115.6	2.17
Tunisia	80.81	60.33	100.63	109.50	100.00	7161	.753	10.57	7.85	0	0	0	388	11	109.9	84.7	97.8	85.2	0.04
Turkey	87.06	65.69	110.17	120.30	124.00	6772	.750	5.25	8.27	0	0	0	261	9	100.1	112.1	96.1	92.8	0.05
Ukraine	92.99	70.91	113.33	124.00	124.00	5491	.766	51.74	63.53	0	0	0	3173	–	89.3	118.6	89.9	100.4	0.68
United A. Emirates	91.91	67.76	115.05	92.50	91.67	22420	.849	–	–	0	0	0	–	–	110.3	84.3	91.5	85.2	–
United Kingdom	100.00	76.14	121.92	115.10	116.00	27147	.939	239.84	72.43	1.63	1.45	3.08	2417	41	131.6	126.7	126.6	115.6	0.13
United States	98.41	74.90	120.30	119.36	121.50	37562	.944	168.81	272.74	0.90	0.48	2.03	3732	44	127.3	124.4	134.1	119.4	0.40
Uruguay	87.99	61.08	112.19	118.87	124.00	8280	.840	27.96	13.48	0	0	0	688	8	108.7	115.1	102.4	115.6	0.20
Yemen	63.52	43.27	84.10	100.00	100.00	889	.489	0.28	–	0	0	0	–	0	88.4	85.4	–	85.2	0.09
Yugoslavia/Serbia	90.20	67.81	111.03	117.58	122.27	–	–	30.04	10.74	0	0.48	0	–	–	91.1	88.9	–	89.0	0.11
M	89.83 (453)	67.53 (304)	111.21 (596)	117.72	118.51	15331	.824	113.11	83.24	0.53	1.37	0.45	1667	24.08	109.4	106.9	107.0	105.0	0.91
SD	10.95 (73)	12.00 (80)	9.54 (64)	7.14	7.50	11399	.104	197.59	141.55	1.31	5.40	1.10	1301	15.46	14.4	16.6	14.5	13.8	4.24

Note: As country names the normally used names; all standardized and unstandardized scales are somewhat arbitrary (e.g. GDP and inflation, IQ and reference groups); *CA-mean*: cognitive ability mean normed according to UK ("Greenwich-norm") *M*=100, as *SD* used students assessment results (*SD*=100) transformed into IQ-scale (*SD*=15), means calculated across countries, for student assessment results are also reported original mean in SAS-scale (*M*=500, *SD*=100); *CA-5%*: cognitive ability mean at 5th percentile; *CA-95%*: cognitive ability mean at 95th percentile; *CA-politicians 60-09*: estimated cognitive ability of leading politicians (1960-2009) of a country according to their formal education; *CA-politicians 90-09*: estimated cognitive ability of leading politicians (1990-2009); *GDP 2003*: GDP per capita in purchasing power parity (ppp) US Dollars; *HDI 2003*: Human Development Index 2003, scale 0 (low) to 1 (high); *Patent rate 1960-2007*: average annual patents per 1 million people 1960-2007; *Patent rate 1991-2007*: average annual patents per 1 million people 1991-2007; *Nobel Peace, Literature* and *Science 1901-2004*: sum of Nobel Prizes in Peace, Literature and Science per 10 million people 1901-2004; *Scientists 1985-95*: scientists and engineers in research and development per million people, 1985-1995; *High technology 1997*: high-technology exports as percentage of manufacturing exports, 1997; *Gov. eff. 1996-2005, Democracy 1950-2004, Rule of law 1970-2000* and *Political liberty 1999*: government effectiveness 1996-2005, democracy value across 1950-2004, rule of law value across 1970-2000 and political liberty in 1999 in IQ-scale with *M*=100 and *SD*=15 (in world samples, here positively selected by having data in student assessment results); *HIV rate 2001-2003*: HIV rate 2001-2003 of adults in percent.

Some astonishing results are observable like the high level of Kazakhstan (6., IQ 122) and the comparatively low for Israel (31., IQ 118, mean 93). For Kazakhstan we have only results from TIMSS 2007 (4th grade); Mullis et al. (2008, p. 34) describe sample anomalies, a correction would be necessary. Israel has participated in several studies, compared to older studies and Jews in the Western World the results are deteriorating (e.g. Lynn & Longley, 2006). Most probably multiple reasons are responsible and *not* only the 20% fraction of Arabs (a thorough analysis would be necessary).

There are also characteristic differences between mean, upper and lower levels. For instance between Canada and USA there is no difference in the upper level (IQ 120 and 120), but in the lower level (IQ 80 and 75). The past history of slavery and a different immigration policy (or different success of migration policies and geographical distance to societies with lower mean abilities) may be reflected into this difference. A similar pattern could be found for Finland and Germany: The difference in the upper level is only 1.20 IQ-points (IQ 121 and 120), but at the lower level 9.60 IQ-points (IQ 85 and 76). Most likely different immigration histories are reflected here, furthermore differences in educational policy (age of tracking, in Germany between age 10 and 12, in Finland at age 16). Early tracking increases ability variance. Using regression analysis (as predictors mean and lower level) the largest residual (standing for difference between upper level and the rest) is found in South Africa (with its heterogeneous population of European, Asian and African descent), inverted the largest residual (standing for difference between lower level and the rest) is found in Belgium (probably a result of immigration and educational policy).

The highest cognitive ability values (measured by education and educational degrees) of leading *politicians* are found in 1. Austria (IQ 128), 2. Luxembourg (IQ 127) and 3. Malta (IQ 126), the lowest in Arab countries: 82. Tunisia (IQ 110), 83. Bahrain (IQ 107), 84. Algeria (IQ 107), 85. Kuwait (IQ 105), 86. Yemen (IQ 100), 87. Qatar (IQ 98), 88. Emirates (IQ 93), 89. Egypt (IQ 90) and 90. Saudi-Arabia (IQ 90). In all these countries the leaders are not elected by their population. Austria has the highest statesman cognitive ability level because up to the early 70s it was common (and almost universal) to complete studies with a doctorate (as it is still the case with medicine in Germany and Austria).

Cross-sectional analyses

The upper and lower levels are highly correlated with the means (r=.97), among each other with r=.90 (see Table 2). The correlation of the 95th percentile with cognitive ability of political leaders is slightly higher (r=.364 and .365) than of the average competence values (r=.361 and .354) or of the 5th percentile (r=.345 and .324), indicating that the politicians' ability depend more on the smart fraction value. Political leaders most likely stem from this fraction (and considering the complexity of political tasks this is a reasonable result; s. Suedfeld et al., 2003). A regression analysis (criterion: IQ of politicians) increases this pattern (for politicians 1960-2009, average ability $\beta_{aA\rightarrow PIQ}$=.13, $\beta_{95\%\rightarrow PIQ}$=.24; for politicians 1990-2009, same time ability measures $\beta_{aA\rightarrow PIQ}$=.00, $\beta_{95\%\rightarrow PIQ}$=.37, N=90).

Table 2. Correlations within cognitive ability indicators

	CA-mean	CA-5%	CA-95%	CA-politicians 60-09	CA-politicians 90-09
CA-mean (average)	-				
CA-5%	.97	-			
CA-95%	.97	.90	-		
CA-politicians 60-09	.36	.35	.36	-	
CA-politicians 90-09	.35	.32	.37	.93	-
N	90	90	90	90	90

Note: See Table 1.

Table 3: Correlations between cognitive ability indicators and indicators of societal development

	GDP 2003	HDI 2003	Patent rate 1960-2007	Patent rate 1991-2007	Nobel Peace 1901-2004	Nobel Literat. 1901-2004	Nobel Science 1901-2004	Scien-tists 1985-95	High techno-logy 1997	Gov. eff. 1996-2005	Demo cracy 1950-2004	Demo-cracy 1996-2000	Rule of law 1970-2000	Rule of law 2000	Politi-cal liberty 1999	HIV rate 2001-2003	AIDS 1995-2000
CA-mean (average)	.61	.79	.40	.45	.21	.13	.34	.61	.38	.61	.60	.62	.62	.59	.49	-.30	-.21
CA-5%	.56	.74	.35	.37	.15	.13	.31	.57	.35	.55	.55	.55	.56	.53	.42	-.31	-.24
CA-95%	.61	.78	.42	.50	.23	.13	.34	.64	.40	.63	.62	.65	.66	.63	.53	-.24	-.20
CA-politicians 60-09	.13	.27	.22	.03	.02	.06	.10	.10	.15	.19	.52	.58	.22	.12	.55	-.05	.08
CA-politicians 90-09	.08	.25	.13	.04	.01	.04	.07	.16	.12	.12	.45	.57	.13	.02	.52	-.10	.05
N	84	85	81	76	87	87	87	51	61	88	84	84	76	73	86	82	83

Note: See Table 1; *AIDS 1995-2000*: percentage of people suffering on AIDS 1995-2000.

Table 4: Regression analyses, predictors: cognitive ability indicators, criteria: indicators of the development of societies

	GDP 2003	HDI 2003	Patent rate 1960-2007	Patent rate 1991-2007	Nobel Peace 1901-2004	Nobel Literat. 1901-2004	Nobel Science 1901-2004	Scien-tists 1985-95	High techno-logy 1997	Gov. eff. 1996-2005	Demo cracy 1950-2004	Demo-cracy 1996-2000	Rule of law 1970-2000	Rule of law 2000	Politi-cal liberty 1999	HIV rate 2001-2003	AIDS 1995-2000
CA-mean (average)	.22	.47	-.13	(-.75)	-.35	.09	.13	-.12	-.29	-.12	.02	-.13	-.30	-.35	-.41	.03	.15
CA-5%																-.34	-.36
CA-95%	.40	.33	.55	(1.23)	.57	.04	.22	.76	.68	.75	.59	.77	.95	.97	.93		
N	84	85	81	76	87	87	87	51	61	88	84	84	76	73	86	82	83
Educational level											.54	.56	.61	.58	.47		
CA-politicians											.27	.32	-.05	-.22	.32		
N											83	83	73	71	84	82	83

Note: See Table 1 and 3. For educational level is used for long term criteria (democracy 1950-2004, rule of law 1970-2000) a general long-term educational index, for more recent criteria (democracy 1996-2004, rule of law 2000 and political liberty1999) a current education index from HDR, the same was done with cognitive ability estimations of politicians.

The *smart fraction* (or gifted or high ability fraction) is not only more relevant than the average cognitive ability level or the non-smart fraction's level for the *cognitive competence levels of politicians,* but also for *wealth* (GDP; see Tables 3 and 4). For the general human development level of a society, the 95th is less important than the average, but more than the 5th level.

Even stronger are the effects on all indicators of high intellectual achievement from *patent rates,* over *Nobel Prizes* to the *rates of scientists* and *high technology exports*. Only for *Nobel Prizes in Literature* the impact is lower, presumably because of the low reliability and validity of this judgement process (if it should rate literature quality) and because of political considerations in giving this award (sometimes it seems to be an award given to nations not receiving science Nobel Prizes, aiming at equal distribution across different cultures and continents).

Also impressive is the high impact of the *smart fraction* (exactly: variance in indicators between different countries statistically explained by differences in cognitive levels of the 95th percentile groups) on all *political variables:* on *government effectiveness, democracy, rule of law* and *political liberty.* The political development of nations seems to depend heavily on the cognitive ability of their smart fraction.

On the other hand the development in indicators standing for undesired outcomes (*HIV* and *AIDS*) depends on the cognitive level of the *lower fraction*. This is a strong support for all studies demonstrating that health and especially HIV depends on cognitive ability, leading to more or less risky behavior resulting in the long run in health or death (e.g. Goldman & Smith, 2002; Gottfredson, 2004; Rindermann & Meisenberg, 2009). Additionally, the opposite effects of the high ability fraction on intellectual outcomes and of the low ability fraction and their abilities on anti-intellectual outcomes strongly support the theoretical framework: Cognitive ability specifically matters through a cognitive effect mechanism. Finally, similar results for crime (homicide) substantiate the pattern: Homicide is higher (negatively) correlated with the ability level of the 5th percentile than with the average or even with the ability of the 95th percentile (5th r=-.34, average r=-.33, 95th r=-.23; N=80). The regression analysis strengthens the result: $\beta_{5\%\rightarrow Hi}$=-.35, $\beta_{aA\rightarrow Hi}$=-.01, N=80). Because of this opposite effect pattern an objection, that the results are a consequence of different reliability (high for 95th percentile ability, mean for the average value, low for 5th percentile), could be ruled out.

The results for *political leaders* and their *ability levels* across the countries are less impressive: Correlations are always low except for democracy and political freedom. For both variables political leaders' competence could explain the variance beneath the general educational level of society (democracy: $\beta_{Edu\rightarrow Dem}$=.54, $\beta_{PIQ\rightarrow Dem}$=.27, N=83; political freedom: $\beta_{Edu\rightarrow PoF}$=.47, $\beta_{PIQ\rightarrow PoF}$=.32, N=84).

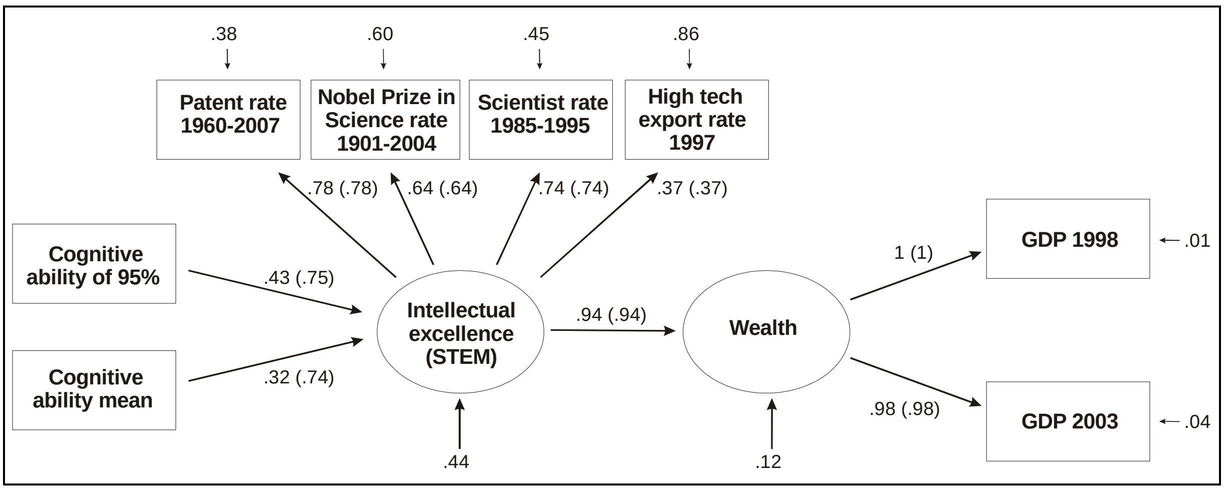

Figure 3. Standardized path coefficients (and correlations in parentheses) between cognitive ability of nations, high intellectual achievement and wealth (error term as unexplained variance), N=48 nations

For a path analysis four indicators of intellectual excellence in STEM subjects were used (patent rate, Nobel Prizes in science rate, scientist rate and high technology export rate), wealth was measured by GDP 1998 and 2003 (latent variables in circles, measured/manifest in boxes; see Figure 3). Only countries with data in all measures were used (N=48), the pattern of results is similar to the larger samples (see Tables 3 and 4). The fit indices are good (SRMR=.04, CFI=.99). For high STEM achievement the cognitive competence of the smart fraction rate is more important ($\beta_{95\%\rightarrow IE}$=.43, $\beta_{aA\rightarrow IE}$=.32). The impact of cognitive ability on wealth goes completely through intellectual excellence ($\beta_{IE\rightarrow GDP}$=.94), a further direct effect would be small and even negative ($\beta_{aA\rightarrow GDP}$=-.05 and $\beta_{95\%\rightarrow GDP}$=-.16), indicating, that cognitive ability not going through STEM-like achievement has no positive impact on wealth (similar: Schofer, Ramirez & Meyer, 2000).

Longitudinal analyses

Student assessment studies with information on the tails do not allow longitudinal analyses, the time interval between the 90s and the first decade of 21st century is too short. But we can do these analyses with political leaders' cognitive ability from the 60s to the 00s. In the Tables 3 and 4 high correlations and a cross-sectional impact of politicians' ability on democracy were observable. Maybe this relationship does not include an effect of ability on democracy, but of democracy on politicians' ability. This could be tested by a cross-lagged panel analysis.

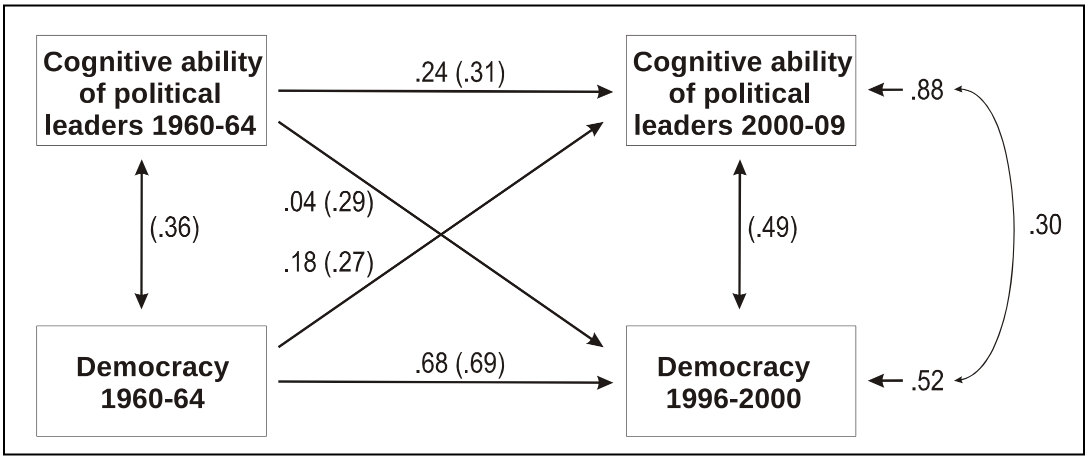

Figure 4. Cross-lagged coefficients (and correlations in parentheses) between cognitive ability of political leaders and democracy (error term as unexplained variance, correlated error), N=64 nations

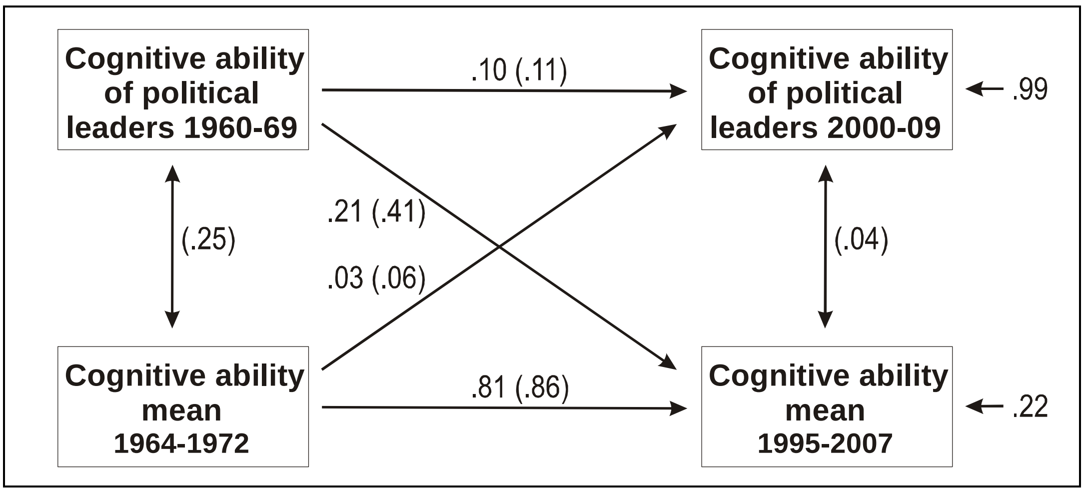

Figure 5. Cross-lagged coefficients (and correlations in parentheses) between cognitive ability of political leaders and society (error term as unexplained variance), N=17 nations

The relation between politicians' ability and democracy could be analyzed between the early 60s and the 00s (see Figure 4; the fit of the model is perfect). The years for political leaders are somewhat misleading because the majority of leaders in 1960-64 had ruled the country also for several years before, the same is true for 2000-09. The cognitive ability of politicians has only a small impact on the development of democracy ($\beta_{PIQ1 \rightarrow Dem2}$=.04), but democracy leads to more educated and competent politicians ($\beta_{Dem1 \rightarrow PIQ2}$=.18). The low competence levels of Arab leaders described above could at least be partly explained by their nondemocratic (self-)appointment (and only under rare circumstances non-democratic leaders like Mohammed VI in Morocco and bin Said in Oman could push their societies forward).

But politicians' ability has a positive impact on cognitive development of a society ($\beta_{PIQ1 \rightarrow CA2}$=.21; see Figure 5; SRMR=.01, CFI=1.00). The reverse effect is smaller ($\beta_{CA1 \rightarrow PIQ2}$=.03). Unfortunately the sample with 17 countries is small, but after wealth and rule of law it is the third factor that longitudinally seems to influence cognitive development at the country data level. In the long run smart politicians increase their nations' abilities.

Cognitive ability and educational policy

Large class sizes affect low ability fractions stronger than high ability fractions, the opposite is true for early tracking, which shows larger benefits for high ability fractions and smaller for low ability fractions (see Table 5). Both results are in accordance with assumptions and studies at the national and within-national data level (Rindermann & Ceci, 2009): Less able students need smaller classes (Krueger, 1999). Early tracking is more beneficial for highly capable students because they will be together with comparable high able students leading to a more stimulating instruction, interaction and school climate, the ability of others nurtures one's own ability (Rindermann & Heller, 2005), but less able students lose their possible models. Both patterns of results strongly support former analyses at the country data level.

Rather astonishing is the high correlation between early tracking and cognitive ability of political leaders (*r*=.41-.44, *N*=66; compare them with correlations in Table 3). Maybe in educational systems with early tracking the political elite stems from the – cognitive development stimulating – higher tracks and higher education is seen as something prestigious and valuable for a political career within parties, society and voters (furthering and gate keeper effect of early tracking). The other way around it may be that more intelligent and competent politicians are in favor of tracking systems (which seem to benefit cognitive development). Future longitudinal analyses should prove this.

Table 5: Correlations between cognitive ability indicators and attributes of educational policy

	Young tracking age	**Class size**
CA-mean	.31	-.45
CA-5%	.25	-.47
CA-95%	.33	-.38
CA-politicians 60-09	.41	-.19
CA-politicians 90-09	.44	-.22
N	66	74

Note: See Table 1; *Young tracking age*: tracking age inverted; *Class size*: large class size and pupil-teacher-ratio.

Discussion

As other studies before have shown, there are large cognitive ability differences between societies. They are reflected in the upper and lower levels, but East Asian and Commonwealth countries seem to have comparatively stronger smart fractions than Scandinavian or other First-World-countries. Maybe these countries not only benefit from their educational policies and, especially in East-Asia, from harsh educational efforts with very extensive studying times per day, week, year and youth, but also from a more successful migration policy. Beneath cultural background factors relevant for education in family and school genetic factors could be important, but genes for cognitive ability are not known up to now.

The ability value (intelligence, knowledge and the intelligent use of knowledge) of the smart fraction (95^{th} percentile, comparable to an IQ 125 or higher in within-country norms) is more important for country differences in wealth, nations' intellectual excellence (in STEM fields: patents, Nobel Prices in science, scientists, high technology exports) and political attributes of societies (government effectiveness, democracy, rule of law and political liberty) than the average ability or the ability level of a non-smart fraction (5^{th} percentile, comparable to an IQ 75 or lower in within-country norms). But the cognitive ability level of the non-smart fraction is more important for country differences in HIV, AIDS and homicide. Wealth differences between countries could be completely explained through differences in high intellectual achievement in STEM fields, which itself largely depends on differences in smart fractions ability. The smart fraction is essentially relevant for beneficial societal development.

The cognitive ability of political leaders is far less important. We could only find higher correlations to democracy and political liberty, in a longitudinal analysis democracy has a positive impact on cognitive ability of political leaders. People, if they have the chance to elect their leaders, prefer more educated ones. Political leaders have, in the long run, a positive influence on countries' cognitive ability, presumedly by creating better educational and social environments increasing cognitive ability.

This study could show how in former studies discovered mean cognitive ability effects on growth could work: In societies with a higher cognitive average the smart fraction reaches a higher cognitive level (resp. is also larger from a "real" threshold of high ability on – see below). This smart fraction pushes growth through excellence in areas relevant for economic affluence, like in technology and science. We did not expect such a high impact of the smart fraction on the destiny of societies. The current data do not allow us to present a historical analysis of modernization processes from the ancient past up to 1960. We can only use our findings on present day comparisons between countries in terms of cognitive ability as an analogy to surmise that the same cognitive effects occurred during historical periods. It seems very likely that the achievements of cognitively eminent persons coming from the smart fraction, and stimulated by their peers, was decisive for the betterment of their societies.

But the results are somewhat contradictory: On one hand, international differences in important attributes of societies (and, we would argue, in the historical development of nations) depend on the cognitive ability of an elite. On the other hand these differences do not depend on the cognitive ability levels of politicians. Peoples and nations themselves seem to be important for the destiny of their countries and societies, more so than politicians. Leaders stem by a majority from smart fractions of their societies and they seem to reflect social attributes and especially their cognitive ability levels, rather than influencing them. One possibility is that in developed societies with a large smart fraction, political leadership is drawn from somewhat less intelligent elite members (see Cox, 1926, p. 84), willing to earn less intellectual merits or money in return for the possibility of fame. Another possibility is that the cognitive ability of politicians is less important because they have competent consultants and experts who give advice (the first author discussed this in 2006 at an ISIR-meeting in San Francisco with Dean Keith Simonton, his reply was, that politicians also need to understand them). Maybe formal education is not the best estimate, better would be real life criteria like used by Simonton. But we should not use verbal ability here. Rhetorical brilliance is not solving problems. Verbal fluency could be a dangerous competence, a seduction to talk people into believing or doing something that they would not do by the use of thinking and rationality. In the Greek tradition, Plato (Gorgias) similarly assessed rhetorical competence in a very critical manner. Finally, in German analyses political and "weltanschauliche" orientations are showing more explanative strength than education of politicians.

One remark on Singapore: Its long-term Prime Minister *Lee Kuan Yew* has in our data set only as highest degree "university degree", no doctorate or an additional scientific degree. But he has studied at London School of Economics and in Cambridge and finished his studies with exceptional "Double Starred First Class Honours". Our assessment procedure seems to underestimate his cognitive ability level. Furthermore, Singapore has reached the highest rank in the smart fraction ability (IQ 127) in our list and the second highest rank in average ability (IQ 105), but "only" the 14th rank in the lower non-smart fraction ability ranking (IQ 79). In patents (1991-2007) Singapore has the first place. And, that is especially remarkable, Singapore has reached the first place in government effectiveness. Singapore seems to have the best government in the world. Lee Kuan Yew's ability – indicated by his success – seems to be underestimated again by the solely use of formal education. Of course, Singapore was and still is no standard-bearer of liberty and democracy and Lee Kuan Yew has attracted criticism because of this. But, he stands apart from other leaders in terms of his exceptional success for Singapore in growth, modernization, technology and since several years also in science (up to now only STEM including biotechnology). Lee is also apparently the only politician who has read and used the results of intelligence research in his politics. In speeches he has cited Thomas Bouchard and Richard Lynn (Chan & Chee, 1984), and he is the only statesman, who has seen that intelligence enhancement not only needs an improvement in the environment (like in educational policy) but also in demographic policies, because parents transfer cognitive ability to their children by creating a stimulating environment (especially by education and modeling) and by transmission of their genes.

Further research should not only use as an indicator for smart fractions a value like the 95th percentile and the ability at this level, but also a defined threshold of cognitive ability like IQ 130 or SAS 700 and the percentage of population above this threshold. The present editing of TIMSS, PISA and PIRLS results complicates this. Research using different ability levels seems to be a fruitful approach. Also further indicators of high achievement like Fields Medal or of low achievement like traffic accidents should be used as indicators to stand for high or low intelligence (Dagona, 1994; O'Toole & Stankov, 1992). Migrations and their impact on countries' cognitive ability and development should be analyzed (so Singapore benefits from a smart fraction import, similarly to Switzerland, Australia and Canada, but Eastern Europe and less so Germany suffer from a brain flight, others from a low brain immigration; e.g. Levels, Dronkers & Kraaykamp, 2008; te Nijenhuis, de Jong, Evers & van der Flier, 2004). The possibilities of education for cognitive enhancement are still not sufficiently explored (e.g. Heckman, 2000; Nisbett, 2009; Rindermann & Ceci, 2009). Our results emphasize the importance of nurturing the highly gifted. Their support will be beneficial in the long run not only for themselves but even more through general effects on societal development including wealth, health, politics, science, ethics and culture for the less smart and non-smart fractions.

Finally, at the level of societies, there is an integrative theoretical framework on causes and mechanisms of cognitive competence still missing. By showing the influence of ability on wealth through high intellectual STEM achievement we hope to provide some further building block in development of such a theory.

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