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We would like to thank Richard Haier for his help in arranging this conference and Elsevier for sponsoring the Wine Reception.

Insert Short Program here.

International Society for Intelligence Research (ISIR) Program 2003

(Numbers in parentheses refer to page of abstract)

Thursday, December 4, 2003

Symposium (8:30-10:30) Brain Imaging Studies of Intelligence
Chair: Haier

8:00-8:30 Haier (14)
Why size matters: A voxel-based morphometric study of regional gray and white matter correlates of general intelligence

8:30-9:00 Thompson (15)
Genetics, brain structure and IQ

9:00-9:30 Prabhakaran (16)
Neural substrates of visuospatial and mathematical reasoning: An fMRI study of Raven's Progressive Matrices (RPM) and Necessary Arithmetic Operations Test (NAOT)

9:30-10:00 Gray (17)
An event related fMRI study of fluid intelligence

10:00-10:30 **Break**

10:30-11:00 Neubauer (18)
Intelligence and working memory systems: Evidence of neural efficiency in alpha band ERD

11:00-11:30 Stough, Song, and Van Rooy (19)
Examining the relationship between brain electrical activity and topography and intelligence during the Raven's Progressive Matrices and during working memory tasks

11:30-12:00 Jung (20)
Neurochemical correlates of *g*

12:00-12:30 Haier (13)
Conclusions and Audience Questions

12:30-2:00 **Lunch**

2:00-2:30 Jung (22)
Regional specificity of NAA-IQ relationships in schizophrenia and normal brain

2:30-3:30 Arthur Jensen
An interview with Arthur Jensen: His research
David Lubinski, Moderator

3:30-4:00 Questions from audience

6:00-7:00 **Wine Reception – Courtesy of Elsevier**

7:00-8:30 **Banquet**

Friday, December 5, 2003

Paper Session: Group Differences
Chair: Stough

8:00-8:30 Kane (23)
An empirical test of Spearman's hypothesis using the WISC-III

8:30-9:00 Sefcek, Vasquez, Kirsner, Figueredo, & Jacobs (33)
General Intelligence: Indicator of fitness or life-history strategy?

9:00-9:30 Templer & Arikawa (36)
Temperature, skin color, per capita income, and IQ: An international perspective

9:30-10:00 Rushton (32)
IQ, health, longevity, and brain size: Is little *g* part of big K?

10:00-10:30 **Break**

Paper Session: Group Differences (Cont.)
Chair: Rushton

10:30-11:00 Kane (24)
Developmental considerations of Spearman's hypothesis

11:00-11:30 Gottfredson (11)
Have Black-White gaps in IQ and achievement narrowed?

11:30-12:00 Fagan & Holland (10)
Equal opportunity and racial differences in IQ: Evidence from tests of comprehension, similarities, and analogies

12:00-12:30 Skuy, Seabi, Skuy, & Fridjhon (34)
Relationship of intellectual functioning and personality/attitudinal variables to university grades of first year African and non-African students in South Africa

12:30-2:00 **Lunch**

Paper Session: Genes and Cognition
Chair: Fagan

2:00-2:30 Tiu, DeFries, & Wadsworth (37)
Genetic and environmental test of the cognitive basis of reading and reading disability

2:30-3:00 Spinath & Plomin (35)
The amplification of genetic influence on general cognitive ability from early childhood to early school years: A large longitudinal twin analysis shows a high genetic correlation but a substantial increase in heritability

3:00-3:30 Wright, Luciano, Hansell, Wainwright, Leisser, Geffen, Geffen, & Martin (40)
Using endophenotypes in the search for genes underlying variation in cognitive ability

3:30-4:00 Johnson, Bouchard, Krueger, McGue, & Gottesman (21)
Three components of general intelligence: Genetic and environmental influences

Saturday, December 6, 2003

Paper Session: Intelligence, Achievement, Personality and Achievement
Chair: Legree

8:00-8:30 Rohde & Thompson (31)
Using specific cognitive abilities to predict achievement

8:30-9:00 Hartmann, Larsen, & Nyborg (12)
Personality as predictor of educational achievement

9:00-9:30 Wicherts & Dolan (39)
The Flynn effect: Testing for measurement invariance with respect to cohorts in time-lag and cross-sectional designs

9:30-10:00 Webb, Lubinski, & Benbow (38)
Trait constellations in intellectually precocious adolescents: Integrating cognitive abilities, interests, and personality

10:00-10:30 **Break**

Paper Session: Structure of Intelligence
Chair: McDaniel

10:30-11:00 Condon & Schroeder (9)
Establishing the factor structure of the Johnson O'Connor Research Foundations standard test battery

11:00-11-30 Primi (30)
Cognitive process of fluid intelligence

11:30-12:00 McGrew (28)
The Carroll Human Cognitive Abilities Project: An overview

12:00-12:30 Beaujean (8)
A univariate behavior genetic meta-analysis of mental chronometric tasks

12:30-2:00 **Lunch**

Paper Session: Miscellaneous Papers
Chair: Detterman

2:00-2:30 McDaniel & Whetzel (27)
The emperor's new clothes: Additional critiques of Sternberg's practical intelligence theory

2:30-3:00 Legree & Psotka (25)
Consensus based measurement

3:00-3:30 Mingroni (29)
Advantages of positing non-additive gene action in IQ

3:30-4:00 MacDonald & Chiappe (26)
The evolution of domain-general mechanisms in intelligence and learning

A Univariate Behavior Genetic Meta-Analysis of Mental Chronometric Tasks

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The purpose of this investigation was to apply meta-analytic procedures to mental chronometry studies, using a behavioral genetic research design. Because chronometric tasks are so simple, a large component of the variance in individual differences in the time it takes to complete them can be attributed to underlying biological and physiological mechanisms. The publications that come from these studies show trends, but they also show heterogeneity (effect sizes ranging from -.11 to .87), which makes it difficult to draw clear conclusions. Statistically integrating them through meta-analysis is a way to provide a clearer, more comprehensive picture of the magnitude of genetic influence involved in mental processing speed. Analyses show a general heritability across the studies of approximately .4, but that it is somewhat dependent on task difficulty, with performance on more complex tasks having a higher heritability. Implications of this study will be discussed, as well as some recommendations for future publications in this area.

Establishing the Factor Structure of the Johnson O'Connor Research Foundation's Standard Test Battery

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The purpose of this study was to investigate the factor structure of the Johnson O'Connor Research Foundation (JOCRF) test battery using confirmatory factor analysis (CFA). A great deal of research supports a hierarchical model of intelligence, in which a number of first-order factors – e.g., Verbal Fluency, Numerical Ability and so on – yield a second-order *g* factor (e.g., Gustafsson, 1984). In this study, we tested a series of first- and second-order models to see which model best represented the JOCRF battery. The best-fitting model contained a second-order *g* factor derived from four first-order factors (Reasoning, Numerical, Spatial, and Memory). The fit values for this model included a small RMR, an RMSEA below .10, and a CFI above .90. The results are consistent with previous research that shows that reasoning, numerical, spatial, and memory abilities are central to models of intelligence (Gustafsson, 1984).

Next, we sought to establish the factorial invariance, or structural equivalence, of the model across gender and age. The results showed that the factor structure of males is not significantly different from that of females nor are three age groups (<= 20, 21-36, and >= 37) significantly different from one another. We tested for the equivalence of the (a) measurement model, (b) structural model, (c) structural residual variances and covariances, and (d) measurement error variances and covariances. Each of these tests of equivalence among the age groups showed good fit - the CFIs were .91, the GFIs were .95, and the RMSEAs were less than .05. These results indicate that our best-fitting model holds across gender and age. Future research should test our best-fitting model using different tests and populations.

Reference

Gustafsson, J-E. (1984). A unifying model for the structure of intellectual abilities. *Intelligence*, *8*, 179-203.

Equal opportunity and racial differences in IQ: Evidence from tests of comprehension, similarities, and analogies

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Fagan (1992)assumes that the IQ score depends on information processing ability and on the information provided for processing. If Blacks and Whites are equally able to process information, then any IQ disparity between Blacks and Whites lies in access to information. In the present study, 25 Blacks and 75 Whites (average age of 20.5 years, mean education 15.1 years) were compared for their knowledge of the meanings of sayings, of similarities, and of analogies, each based on either generally available information or on specific information. For example, a test of knowledge of sayings based on generally available information might be: PUT IN A PICKLE a. Watered b. Confused c. Enriched d. Imprisoned . Whereas a question based on specific information would be: BENEDICT ARNOLD a. President b. Patriot c. Monk d. Traitor. If Blacks and Whites are equally able to process information, they should be equally able to answer questions based on generally available information. If equal access to specific information is not culturally available, Blacks and Whites should differ in answering questions based on specific information. An analysis of variance yielded a reliable interaction between race and the type of information required for solution. Comprehension based on general information (whether for sayings, similarities, or analogies) on the part of Blacks did not vary by race. At the same time, knowledge based on specific information (no matter the material tested) was higher for the Whites than for the Blacks. Thus, when information was generally available, Whites and Blacks were equal in knowledge. Additional analyses indicated test bias for questions based on specific information in that Blacks who had the same test scores as Whites on tests of specific information proved to be superior to those same Whites on tests based on general information. In addition, the present results do not support Jensen's default hypothesis. Groups within each race who varied in comprehension based on specific information also varied in their comprehension based on general information . Such results indicate that the average difference in IQ between Blacks and Whites is not due to the same genetic and environmental factors, in the same ratio, that account for IQ differences among individuals within a racial group. Finally, the participants were given items from IQ tests based on knowledge of vocabulary, spatial relations, and matrices. An estimate of g was obtained by performing a principle factor analysis (un-rotated) on the three IQ tests given to participants and extracting the first principle factor. Similar factor analyses were performed on the three tests based on general knowledge and on the three tests based on specific knowledge. The three g scores along with race were entered into a multiple regression which revealed that, when the independent influences of general and specific knowledge were taken into account, race played no role in the determination of the g factor derived from the IQ tests.

Have Black-White Gaps in IQ and Achievement Narrowed?

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Many social scientists claim that Black-White (B-W) differences in intellectual ability have closed substantially in the United States (e.g., see chapters in Jencks and Phillips' *The Black-White Test Score Gap* and Neisser's *The Rising Curve*). For evidence, they usually point to the fact that B-W gaps on the National Assessments of Educational Progress (NAEP) in reading have narrowed substantially since the 1970s. This paper examines their claims by reviewing all the large, nationally representative studies that reported IQ or achievement test data for both Blacks and Whites during the 20th century.

The IQ studies reveal no evidence of change in the B-W IQ gap over that time, with the mean IQ difference remaining at about 1.1 SD. In contrast, research on standardized academic achievement reveals a narrowing of gaps in some subjects, at least during the 1980s. B-W gaps on the NAEP tests of academic achievement narrowed to an average of .79 SD in reading, .87 SD in math, and 1.04 SD in science. However, the narrowing seems to have ceased and may even be reversing. Moreover, of the 27 standardized B-W achievement gaps calculated from the NAEP trends data (3 ages by 3 decades by 3 academic subjects), virtually all fell within the .76-1.20 range of effect sizes predicted by a 1.2 SD mean difference in *g*. Thus, although B-W gaps in academic achievement may shrink or expand somewhat as socioeducational conditions change, their elasticity seems bounded by the more enduring B-W mean difference in *g*.

Personality as Predictor of Educational Achievement

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Several studies suggest that personality traits influence educational achievement, but the exact meaning of the various personality factors for education is still unclear. It is, on the other side, a well-established fact that general intelligence, *g*, is a powerful predictor of educational achievement.

We therefore tested linear, non-linear, and interaction effects of the four Eysenckian personality factors and ability on the length of education, while controlling statistically for age, in a sample of 4,319 middle-aged males believed to have completed most or all of their formal education. We found that partial correlations between any of the linear and non-linear personality variables, or their interactions, explained less than 1% of the total variance in educational achievement, whereas *g* related significantly to education, as expected. We concluded that personality has negligible explanatory power in accounting for individual differences in the length of formal education, whereas *g* remains the single most powerful predictor.

Haier Symposium:

Brain Imaging Studies of Intelligence: Do We Finally Know Where Intelligence Is in the Brain?

Richard J. Haier[1], Paul M. Thompson[2], V. Prabhakaran[3], Jeremy R. Gray[4], Aljoscha Neubauer[5], Con Stough[6], Rex E. Jung[7]

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Individual differences in intellectual ability and cognitive function are well studied and a genetic component for the general intelligence factor (*g*) is well established. The neurobiological basis of *g* has yet to be determined but a number of brain imaging studies have investigated "where" *g* may be in the brain. This symposium is the first time most of the researchers in this area appear together to present recent findings which support a surprising consistency and clarity of results across different imaging methods and experimental designs. Taken together, the data support the view that g is related to a small number of specific areas distributed throughout the brain and not just in frontal lobes.

Dr. Richard Haier will show specific PET and structural MRI correlates of *g*. Dr. Jeremy Gray will discuss a large sample fMRI study of individual differences in *g*. Dr. Vivek Prabhakaran will discuss fMRI data collected during a *g* task. Dr. Paul Thompson will discuss the heritability of regional brain structure and how it correlates with g. Dr. Con Stough will discuss EEG topographic mapping studies of brain areas working during *g* tasks. Dr. Aljoscha Neubauer will discuss EP mapping studies of high and low *g* tasks. Dr. Rex Jung will present data on the newest MRI spectroscopy technique and discuss how it can reveal neuro-chemical aspects of *g*. The debate about the neuroanatomy of *g* may be near an end and the next generation of imaging studies will begin to address "how" *g* may work.

Haier Symposium:

Why Size Matters: A Voxel-based Morphometric Study of Regional Gray and White Matter Correlates of General Intelligence

Richard J. Haier

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Many functional brain imaging studies have confirmed correlates between regional cerebral activity and tests of mental ability associated with general intelligence. Most of these implicate areas in the frontal lobes, as well as other areas throughout the brain. Since interpretation of functional brain imaging studies depends on the cognitive task undertaken during the imaging protocol, inconsistencies among study results are difficult to resolve. Structural brain imaging with MRI is independent of cognitive tasks, so results correlating individual differences in brain structure to test performance may be more interpretable.

Intelligence correlates of regional brain structure, however, have been difficult to determine because of inherent difficulties in traditional region-of-interest (ROI) analyses. We applied newer voxel-based morphometric (VBM) techniques to structural MRIs to determine gray and white matter volumes in 23 normal volunteers who also completed standard assessments of general intelligence using the Wechsler Adult Intelligence Scale (WAIS III) and the Raven's Advanced Progressive Matrices (RAPM). Each test score was correlated to gray and white matter volumes and the overlap in correlations among test scores was determined using conjunction analysis. The results support the view that the neural basis of general intelligence is distributed across the brain, and that gray matter volumes in frontal and temporal areas, along with posterior white matter volumes, may be the basis of individual differences in general intelligence**.**

Haier Symposium:
Genetics, Brain Structure and IQ

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Brain imaging and genetic studies can reveal how nature and nurture impact human brain structure and intelligence. In the last decade, we and our collaborators have been compiling large databases of brain images (N>7000 subjects). This has helped to identify patterns of brain structure that are linked with cognitive performance, general intelligence (g), age, gender, individual genetic variations, and specific brain disorders (e.g., Alzheimer's disease and schizophrenia). We recently developed a large-scale computational brain atlas, including data components from the Finnish Twin Registry, to store information on individual variations in brain structure and their heritability. We detected a genetic continuum in which brain structure is heavily genetically determined in some areas but not others[1,2]. Specifically, the quantity of gray matter in the frontal lobes of the brain was highly determined by heredity, and was linked with general intelligence (g).

High-resolution MRI scans of the brain were acquired from 20 sets of twins (10 identical pairs, 10 fraternal). 3D brain maps were created, revealing the amount of gray matter in different regions. Gray matter volume, in frontal brain regions, was more closely matched in the identical twins than in twins who were less similar genetically. Consequently, in these regions, the brain's structure is under strong genetic control[1]. Higher g scores were also found to be correlated with higher gray-matter volume in the brain's frontal lobes (p<0.0044), as well as with higher gray-matter volume over overall (p<0.05). These findings are in line with many earlier studies linking g with MRI-based brain measures [3]. The association between regional brain volume and intelligence also is genetic in origin[4]. Intriguingly, this implies that the heritability of g is partly mediated by differences in brain structure that can be identified in a brain scan. Color-coded brain maps also can reveal the degree to which differences in our brain structure are attributable to individual genetic differences.

Population-based brain mapping studies are likely to engender a second revolution in linking genes, brain structure, and cognition. These studies can link individual variations, identified in brain images, with cognitive and genetic differences[5]. As such, they provide a means to explore the inheritance personality differences and intellectual skills, and analyze the genetic transmission and dynamic spread of diseases that impact the human brain[6].

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Haier Symposium:

Neural Substrates of Visuospatial and Mathematical Reasoning: An fMRI study of Raven's Progressive Matrices (RPM) and Necessary Arithmetic Operations Test (NAOT)

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The RPM and NAOT are widely used measures of reasoning ability that reliably predicts performance in reasoning tasks from a number of different domains. The Raven's test can be divided into problems that can be solved by utilizing gestalt reasoning and abstract/analytical reasoning. fMRI was utilized in order to identify neural substrates particular to these two forms of reasoning. Three types of problems were adapted from the Raven's test: 1. Easy problems consisted of a 3X3 block of patterns related by the pairwise constant rule (Carpenter & Just, 1990). These problems can be solved by a visuospatial or gestalt strategy. 2. Hard problems consisted of patterns related by different rule sets (Distribution of 3, Distribution of 2, etc.) These problems cannot be solved by simple visuospatial or gestalt strategy but require abstract/analytical reasoning. 3. Match problems consisted of nonsense blocks of 3x3 patterns. Subjects matched a pattern to one of eight choices given. The match problems served as a control for sensory and motor areas of activation irrelevant to the cognitive factors of interest.

Three combinations of problem sets (easy-match, hard-match, and hard-easy) were presented to subjects in the scanner. Discrete activity localizable to a few regions of the brain was seen in all of these tasks. The easy-match task activated areas involved in gestalt reasoning or problems that utilize a visuospatial strategy. This task activated primarily areas in the right hemisphere as well as areas in the left parietal region similar to areas reported by Smith and Jonides in their spatial and object working memory paradigms. The hard-match task activated novel areas in the left hemisphere necessary for abstract/analytical reasoning and showed an increase in areas that were involved in gestalt reasoning. Extensive activation was seen bilaterally in posterior parietal, inferior temporal, extra-striate, prefrontal, and premotor areas in this condition. The hard-easy task isolated areas that were involved in abstract/analytical reasoning.

In the NAOT, participants solved problems requiring (1) one operation (Easy problems), (2) two operations (Hard problems) or (3) simple reading and matching of words (Match problems) a control for perceptual, motor and text reading demands of the NAOT problems. Major bilateral frontal activation and minimal posterior activation was observed while subjects solved Easy problems relative to Match problems. Minor bilateral frontal, temporal and lateralized activation of left parietal regions was observed in the Hard problems relative to Easy problems. All of these regions were activated more by Hard than by Match problems. Many of these activations occurred in regions associated with working memory. These results suggest that fluid reasoning is mediated by a composite of working memory systems with the most significant activity occurring in bilateral prefrontal areas which have been reported to show robust activity in many complex tasks.

Haier Symposium:
An event-related fMRI study of fluid intelligence

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We used an individual-differences approach to test whether general fluid intelligence (gF), or reasoning and novel problem solving ability, is mediated by brain regions that support attentional (executive) control, including subregions of the prefrontal cortex. Participants (n = 48) first completed a standard measure of gF (Raven's Advanced Progressive Matrices). They then performed verbal and nonverbal versions of a challenging working-memory task (3-back) while their brain activity was measured using event-related functional MRI. Trials within the 3-back task varied greatly in the demand for attentional control due to differences in trial-to-trial interference. Participants with higher gF had more accurate performance and greater neural activity in several brain regions on high-interference trials specifically. Regression analyses suggested that lateral prefrontal and parietal regions plausibly mediate the relation between ability (gF) and performance (accuracy), providing novel constraints on the cognitive and neural mechanisms of gF.

Haier Symposium:

Intelligence and Working Memory Systems: Evidence of Neural Efficiency in Alpha Band ERD

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Starting from the well-established finding that brighter individuals display a more efficient brain function when performing cognitive tasks (i.e. neural efficiency) we investigated the relationship between intelligence and cortical activation in the context of working memory (WM) tasks. Fifty-five male (n = 28) and female (n = 27) participants worked on (1) a classical forward digit span task demanding only short-term memory (STM), (2) an attention- switching task drawing on the central executive (CE) of WM, and (3) a WM task involving both STM storage and CE processes. During performance of these three types of tasks cortical activation was quantified by the extent of Event-Related Desynchronization (ERD) in the alpha band of the human EEG. Correlational analyses revealed associations between the amount of ERD in the upper alpha band and intelligence in several brain regions. In all tasks, the males were more likely to display the negative intelligence-cortical activation relationship. Furthermore, stronger associations between ERD and intelligence were found for fluid rather than crystallized intelligence. Analyses also point to topographical differences in neural efficiency depending on sex, task type and the associated cognitive subsystems engaged during task performance.

Haier Symposium:

Examining the Relationship Between Brain Electrical Activity and Topography and Intelligence During the Raven's Progressive Matrices and During Working Memory Tasks

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In this presentation we present data from 3 studies in which brain electrical activity was recorded using the Steady State Visual Evoked Potential. Brain activity using amplitude and latency statistics as well as brain topography are presented in relation to scores on the Wechsler Adult Intelligence Scale III and individual differences in performance on the Raven's Progressive Matrices. In the first two studies (N=33 and N=55) brain electrical activity was recorded during performance on the Raven Progressive Matrices. Despite recent claims that the biological basis of intellectual performance is seated in the frontal lobes the results from our studies indicate that there are individual differences in brain activity that relate to intelligence in several topographical areas across the brain. The third study (N-50) examined the brain electrical amplitude and latency during an n back working memory task in high and low IQ participants. Implications for a neuropsychological theory of intelligence are discussed.

Haier Symposium:
Neurochemical Correlates of *g*

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Modern functional neuroimaging techniques offer unprecedented opportunities to determine discrete brain regions associated with cognitive skills, including *g*. While these techniques provide valuable information regarding the locus and time course of cortical regions (i.e., gray matter) involved in a given cognitive task, they are not well equipped to reveal the functional capacity of underlying groups of myelinated axons (i.e., white matter). Recent theories of brain-behavior relationships have stressed the central importance of white matter interconnections underlying multiple neuronal networks. Thus, inquiry regarding the discrete or distributed location of *g* within the brain would be incomplete without addressing individual differences in white matter integrity.

One neuroimaging technique particularly amenable to studies of white matter function and integrity is Magnetic Resonance Spectroscopy (MRS). Using a standard MRI machine, this imaging modality provides a quantitative measurement of the neurochemical components of neural and glial variation in vivo. Voxels of interest may be placed to sample neurochemistry from particular brain regions, although larger white matter voxels (e.g., 8cc) are more common given current spectral resolution. Proton MRS (1H-MRS) resolves signals from three major neurometabolites including N-acetylaspartate (NAA), creatine (Cre), and choline (Cho). Reduced NAA has been well associated with neuronal injury or death, impaired cognition, and poor functional outcome across myriad neurological disorders.

Our research has established a relationship between *g* and white matter NAA within a cohort of neurologically normal adults utilizing both intellectual[1] and composite neuropsychological measures[2]. We have since replicated and extended these initial findings in a cohort comprised of both normal subjects and patients recently diagnosed with schizophrenia[3]. Moreover, the *g*-NAA relationship appears to be somewhat specific to the left occipito-parietal white matter, as correlations within frontal white matter, caudate nucleus, and cerebellum failed to reach statistical significance. Potential roles, significance, and regional implications of NAA in brain function underlying intelligent behavior will be discussed.

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Three Components of General Intelligence: Genetic and Environmental Influences

Wendy Johnson, Thomas J. Bouchard, Jr., Robert F. Krueger, Matt McGue,and Irving I. Gottesman,
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Over the past 10 years, some consensus has developed around the concept that cognitive abilities can be organized in a hierarchical structure with a general factor supported by a number of group factors representing more specific abilities. Though it is clear that general intelligence plays a strong role in determining where within this structure any given individual's strengths and weaknesses may fall, it has also become clear that the relationships among scores on tests making up the group factors provide differential predictive information about areas of individual educational and occupational success. The group factors thus represent important specific abilities in addition to contributing to general intelligence, making their specific content of importance as well.

In this study, we present the results of an exploratory factor analysis of a cognitive ability assessment consisting of 42 tasks in a heterogeneous sample of 436 adults. The results suggested 8 first-order ability factors contributing to 3 correlated second-order ability factors representing verbal, perceptual, and mental rotation abilities. The verbal and perceptual factors were correlated .81, and the perceptual and mental rotation factors were correlated .85. The verbal and mental rotation factors were, however, correlated only .42. Because the sample included 74 monozygotic and 52 dizygotic twin pairs, we also estimated the proportions of variance attributable to genetic and environmental influences on the 3 second-order factors, and their genetic and environmental correlations.

Regional Specificity of NAA - IQ relationships in Schizophrenia and Normal Brain

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Synopsis

N-acetylaspartate has been related to intellectual functioning in both disease and normal human brain. Cognitive decline (i.e., *dementia prae* is a characteristic symptom of schizophrenia; thus, we hypothesized a relationship between NAA and IQ reflecting both metabolic and behavior decline. NAA was correlated with IQ in both control ($n = 14$, $r = .72$, $p < .01$) and patient groups ($n = 14$, $r = .53$, $p < .05$), and the relationship specific to occipito-parietal white matter. Our current findings highlight the importance of white matter interconnections to cognitive functioni both disease and health.

Background

Intelligence is a composite measure of brain function representing integration of specific cognitive skills important to adaptive human behav N-acetylaspartate (NAA) has been associated with lower intellectual status (IQ) in such disorders as mental retardation (Hashimoto et al. 1995), temporal lobe epilepsy (Gadian et al. 1996) and Williams syndrome (Rae et al. 1998). Recent evidence also suggests that NAA is related to IQ both young (Jung et al., 1999) and elderly (Valenzuela et al., 2000) normal subjects. Schizophrenia offers a unique disease process in which to explore NAA – IQ relationships, as intellectual decline is hypothesized to be central to disease process, and NAA reductions are observed acros numerous brain regions, particularly white matter volumes (Lim, 1998). We sought to determine the regional specificity of the relationship betw NAA levels and intellectual functioning in a cohort of patients recently diagnosed with schizophrenia and normal subjects.

Methods

Subjects: Patients with recent diagnosis of schizophrenia (DSM-IV) and neurologically healthy controls were recruited. All subjects were eva for for premorbid (New Adult Reading Test) and current intellectual ability (Wechsler Abbreviated Scale of Intelligence), and scanned within th same week. Magnetic Resonance Imaging and Spectroscopy: All MR acquisitions were carried out on a 1.5 Tesla GE clinical MR scanner usi standard software. A PRESS pulse sequence, including water suppression, was prescribed to sample four voxel locations (TE = 40 ms, TR = 2 ms, 128 averages): left caudate nucleus (6 cm^3 voxel), left frontal white matter, left occipito-parietal white matter (OPWM), and right cerebellu 12.6 cm^3 voxels) identified on a T_1-weighted axial image (Figure 1). All metabolic values were corrected for percent tissue within each voxel.

Figure 1

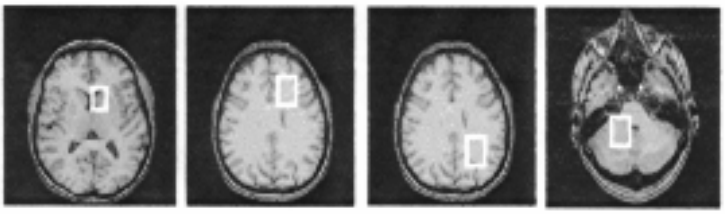
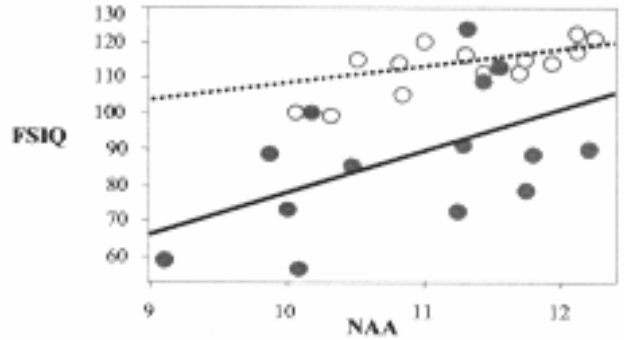


Figure 2



Results

Patient ($n = 14$) and control ($n = 14$) groups did not differ significantly in age, head of household socio-economic status, and premorbid IQ, b current IQ was significantly lower in patients (mean FSIQ = 88) compared to controls (mean FSIQ = 113). Levels of NAA did not differ significantly across the four voxels of interest, although the greatest trend towards a group difference (.43mM) was observed in the OPWM (p = Levels of NAA within OPWM were correlated with Full Scale IQ in both control ($r = .72$, $p < .01$) and patient groups ($r = .53$, $p < .05$). No significant relationships between NAA and IQ were observed for patients or controls within caudate, frontal or cerebellum voxels. Figure 2 demonstrates the patient's current IQ (solid circles), as well as control current IQ (open) stratified to NAA within OPWM.

Discussion

To our knowledge, this is the first study to identify concurrent relationships between neuronal metabolism and intellectual functioning in both patients with schizophrenia and normal controls. Although the exact mechanism by which NAA is related to neuronal functioning, and hence intelligence, is unknown, it has been demonstrated that NAA contributes to lipid synthesis for myelination, is a metabolic precursor of the excit dipeptide N-acetyl-aspartyl-glutamate, is a marker of neuronal oxidative phosphorylation, and may protect neurons from osmotic stress (see Ba 2001 for review). Thus, white matter NAA may reflect the quality of the myelinated interconnections linking association cortices critical to intellectual functioning in both disease and health. The range of NAA in the OPWM trended lower in schizophrenia compared to controls, sugg that metabolic derangement within white matter may underlie the cognitive decline observed early in the disease process. Future studies with increased sample sizes will elucidate whether NAA within the OPWM in schizophrenia is sensitive to disease symptomatology, course, or outc

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An Empirical Test of Spearman's Hypothesis Using the WISC-III

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One of the most controversial topics in psychology is the well-documented differences in performance between Blacks and Whites on IQ tests. Three explanations have been offered to account for this phenomenon: (a) racial differences arise because of test characteristics (e.g., psychometric bias, culturally loaded items), (b) differences are attributable to specific cognitive abilities (e.g., spatial & verbal abilities), or (c) differences are a function to the degree the test measures general intelligence (i.e., *g*). This third explanation originated in Charles Spearman's 1927 treatise, *The Abilities of Man*[1]. Spearman offered that observed Black-White differences in cognitive performance were best described as a function of the specific test's loading on the *g* factor. That is, the greater the test's saturation of *g*, the greater the Black-White difference.

Central to criticisms of Spearman's Hypothesis is the oft-cited denunciation of *g* as mere statistical artifact (Schonemann, 1985)[2]. If *g* is truly a statistical artifact, then Spearman's Hypothesis should hold true for all between group differences, not simply Black-White differences. The present study empirically tests the construct validity of Spearman's Hypothesis with groups of Black, White, deaf, and blind children.

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Developmental Considerations of Spearman's Hypothesis

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Spearman (1927) speculated that Black-White differences on cognitive tests are a function of the test's loadings on the general factor *g*. Eminent scholar Arthur Jensen termed this explanation of group differences Spearman's Hypothesis. Despite considerable controversy, Spearman's Hypothesis has weathered considerable empirical scrutiny. Surprisingly, no studies to date have investigated this important phenomenon with a sample young children. Inasmuch as critics of Spearman's *g* often denounce Black-White differences as the result of differential educational experiences, the use of a preschool sample is especially important in establishing the construct validity of Spearman's hypothesis.

The present study uses a sample of preschool children who were assessed using the Woodcock-Johnson Tests of Cognitive Ability, Revised. Developmental trends in Spearman's Hypothesis and implications for future research are discussed.

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Consensus Based Measurement

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Situational judgment tests have been developed in the fields of Industrial/Organizational and Cognitive Psychology to predict performance and to evaluate theories of cognition. Production of these scales has usually required the opinions of subject matter experts to produce scoring keys or criterion data to compute empirically based standards. A simpler, more cost-efficient procedure is considered that allows examinee responses to be scored as deviations from the consensus defined by the response distributions of the examinee sample. This approach is termed "Consensus Based Measurement" and has been applied to validate scales in domains that lack certified experts.

Data are summarized demonstrating substantial convergence between situational judgment tests scored using expert and examinee-based scoring standards computed without reference to criterion data for which substantial expert and examinee data are available. The convergence indicates that examinee response distributions may be used to score situational judgment tests when expert responses are not available. Validity data are summarized that utilized this approach to score situational judgment scales.

The Evolution of Domain-General Mechanisms in Intelligence and Learning

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Evolutionary psychologists propose the human mind consists predominantly of highly specialized mechanisms designed to solve specific problems in the environment of evolutionary adaptedness (EEA). Though they acknowledge the existence of domain-general mechanisms as a possibility, they have not provided analyses of the evolutionary function of these mechanisms or of how they interface with domain-specific ones. Their view is domain-general mechanisms are inherently weak because "jacks of all trades are masters of none. They achieve generality only at the price of broad ineptitude" (Cosmides & Tooby, 2002, p. 170). On the contrary, we argue mechanisms of general intelligence and domain-general learning are powerful tools designed to solve problems not recurrent in the EEA. For both humans and animals, domain-general mechanisms are fallible but powerful tools for attaining evolutionary goals (e.g., resources) in uncertain, novel environments that were not recurrent features of the EEA. Domain-general mechanisms interact in complex ways with domain-specific, information encapsulated modules, most importantly by manipulating information obtained from various modules in attempting to solve novel problems. Mechanisms of general intelligence, particularly the executive functions of working memory, underlie analogical reasoning as well as the decontextualization processes that are central to human thought. General intelligence therefore assumes a central position in evolutionary psychology as the primary mechanism underlying the humans' ability to solve novel problems, create the extraordinary human culture characteristic of the last 50,000 years of human evolution, and cope with life in a constantly changing world far removed from the Pleistocene world of our ancestors.

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The Emperor's New Clothes: Additional Critiques of Sternberg's Practical Intelligence Theory

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Gottfredson (2003) provided a detailed critique of Sternberg's (Sternberg et al., 2000) practical intelligence theory. Although very thorough, Gottfredson's work did not draw on relevant evidence from the situational judgment literature in industrial/organizational psychology. The current paper seeks to supplement Gottfredson's extensive critique of practical intelligence using research and practice in the situational judgment literature. This paper makes six major points.

First, there is a research and practice tradition in personnel selection that has used the item type that Sternberg re-invented and called tacit knowledge. This item type is called situational judgment in the personnel selection field. There is an extensive literature on situational judgment tests that contradict Sternberg's claims concerning practical intelligence. Second, we present evidence that such situational judgment tests do not measure a general factor, whether labeled practical intelligence, or something else. Both the individual test items and the tests are factorially complex and measure multiple known constructs. Third, these measures are moderately correlated with *g*. Fourth, these measures assess multiple constructs and are best viewed as measurement methods. In fact, the correlation of the measures with personality and cognitive constructs can be influenced by the instructions given to the respondents. Fifth, we compare the validity of the measures with *g* for the prediction of job performance. Sixth, we provide suggestions for future research on tests of this type.

The Carroll Human Cognitive Abilities Project: An Overview

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There is little doubt that J. B. Carroll's 1993 book Human Cognitive Abilities: A Survey of Factor-Analytic Studies has had a significant impact on the field of intelligence research and measurement. In his seminal treatise, Carroll reported the results of his systematic exploratory factor analysis of over 460 human ability data sets, many of which were classic data sets reported during the past 50 to 60 years. Through the application of a systematic and uniform methodology, Carroll produced a meta-analysis of the extant human cognitive abilities literature.

Through a fortuitous sequence of events, Carroll's original computer disks, programs and printouts (which include the original input correlation matrices) are now available for analyses and serve as the foundation for the Carroll Human Cognitive Abilities Project (HCA) (http://www.iapsych.com/chchca.htm). The Carroll HCA project was initiated in the fall of 2002 in order to: (a) build on the past 60+ years of factor analytic research on the structure of human cognitive abilities and (b) to extend this line of research into the future.

The primary goals of the Carroll HCA project are to:

- Electronically archive and document the 460+ datasets used in Carroll's seminal review so they can be made available for secondary analysis by students and researchers in the area of human cognitive abilities.
- Supplement Carroll's 460+ (largely pre-1985) datasets with additional datasets published since the mid-1980's in order to extend and expand the pool of datasets available for analysis regarding the structure of human cognitive abilities.
- Establish a CHC HCA "Work Group" that will develop long-term plans for: (a) retrospective re-analysis of the 460+ datasets analyzed by Carroll with contemporary statistical methods (e.g., confirmatory factor analysis) and (b) prospective analysis of contemporary (post-1985+) datasets with both CFA and Carroll's EFA methods.
- Produce manuscripts intended to refine and extend the understanding of the nature of the broad and narrow abilities subsumed by the Cattell-Horn and Carroll Gf-Gc theories of human cognitive abilities.

The purpose of this presentation is to provide an overview of the Carroll HCA project to researchers in the field of intelligence. Information will be presented on how researchers can access the electronic Carroll HCA archives. In addition, the Carroll HCA searchable database, an on-line database that organizes the descriptive information as per 34 different dataset descriptive characteristics, will be described and demonstrated. Summary descriptive statistics of the current status of the datasets in the Carroll HCA archive will be presented.

Advantages of Positing Non-Additive Gene Action in IQ

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An approach to modeling the genes that influence IQ is presented. The approach begins by making certain simplifying assumptions and setting certain model parameters. These parameters include: the number of loci involved, the nature of the alleles at each locus, the frequency of each allele, the extent to which the alleles interact additively or non-non-additively, and the relationship between the genotype and phenotype. Once the model parameters are set, three types of simulations are run and the results compared with observed data. First, consanguineous unions are simulated and the results compared with studies of the effect of inbreeding on IQ. Next, non-consanguineous unions are simulated and the results compared with family studies of IQ. Lastly, demographic changes like those that have occurred throughout the developed world in recent history such as urbanization are simulated to gauge the potential contribution of the genetic phenomenon heterosis in the secular rise in IQ.

The simulations reveal several interesting findings including 1) increasing the number of loci increases both the inbreeding depression and heterosis effect, 2) making recessive alleles rare (making dominant alleles common) generally increases both the inbreeding depression and heterosis effects, 3) making recessive alleles rare increases the expected difference in IQ variance between inbred and non-inbred groups (the inbred group has greater IQ variance), 4) positing more non-additive gene action reduces the parent-child correlation more than it reduces the sibling correlation, 5) traditional efforts to partition genetic variance into additive and non-additive components represent a poor indicator of the extent to which the alleles influencing IQ are interacting additively or non-additively.

Taken together, the above findings suggest a significant role for non-additive gene action in IQ. First, at least some non-additive gene action must be posited in order to explain IQ inbreeding depression; by contrast, positing mostly additive gene action requires positing a very large number of gene loci. Second, positing considerable non-additive gene action is not inconsistent with the results of family studies: On the contrary, doing so offers the prospect of resolving the apparent discrepancy between direct and indirect measures of IQ heritability by predicting, for example, parent-child correlations that are significantly lower than sibling correlations. Lastly, non-additive gene action is an essential element in the genetic phenomenon heterosis, which represents an ideal causal factor to explain the rise in IQ, as well as the trends that have occurred in other traits and the incidences of other disorders, such as height, age at menarche, myopia, and autism, to name just a few (Mingroni, in press, *Intelligence)*. The limitations of the current modeling approach are discussed, as are ways in which the modeling process could be refined in the future.

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Cognitive Process of Fluid Intelligence[1]

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Ability testing has been criticized because of the lack of a more complete understanding of the construct being assessed. This presentation focuses on the application of cognitive psychology to understand the tasks designed to assess fluid intelligence and the application of Rasch model to create new measure for this construct. It discusses the advances in the understanding of fluid intelligence that can be achieved using new methods. Two studies will be presented The first one presents the development of two structurally equivalent tests, each one with 32 geometric analogies matrices items that were created by the orthogonal combination variables that are believed to be sources of item complexity. The aims of the study were to investigate the effects of these item features on complexity in order to enhanced understanding of the cognitive processes associated with item performance and to investigate the relevance of new scores that were collected during the computerized administration. The second study shows the use of these information in the development of a scale for fluid intelligence. Instead of focusing on the development of a test, if focuses on the application of the Rasch model in the definition of a variable for the creation of a criterion-referenced measure for fluid intelligence based on the findings of cognitive psychology. The main result was a criterion-referenced scale based on information obtained from item features linked to cognitive components such as storage capacity, and executive functions such as goal management and abstraction. The scale proposes that levels of fluid intelligence run from the ability to solve problems with a limited number of bits of information with obvious relationships up to the ability to solve problems involving abstract relationships when confounded with an information overload, and distracted by mixed noise. This scale can be employed to provide interpretations for the measurements of people in terms of cognitive processes mastered and the kinds of difficulty experienced.

[1] This paper was developed as part of a larger project called "Development of a Computerized Componential Fluid Intelligence Test" financed by the Foundation for the Support of Research in the State of São Paulo (FAPESP, Process 2000/05913-4), by the Brazilian National Research Council (CNPq, Process 300884/01-0) and by the University of São Francisco.

Using Specific Cognitive Abilities to Predict Achievement

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Academic achievement can be thought of as a measure of success, and measures of IQ correlate .5 to .7 with academic achievement (Jensen, 1980). The primary objective of the present study is to investigate how well specific cognitive abilities such as Working Memory (WM), Processing Speed (PS), and Spatial Ability (SA) predict achievement with and without indicators of general cognitive ability. The Raven's Advanced Progressive Matrices (RAPM) and the Mill Hill Vocabulary Scales (MHVS) were used to assess general cognitive ability, and basic cognitive tasks were given to each participant to form composite scores for WM, PS, and SA. Participants were undergraduates (male = 29 and females = 42) with an average age of 18.86 years. Three measures of academic achievement – cumulative Grade Point Average (GPA), Wide Range Achievement Test III (WRAT3), and Scholastic Aptitude Test composite scores (SAT), were used to assess the participants' academic achievement.

When predicting measures of academic achievement, specific cognitive abilities accounted for a significant amount of the variance. When combined with *g*, over half of the variance in achievement could be accounted for. In general, the specific cognitive abilities did not account for any unique variance once *g* was controlled. However, *g* accounted for significant additional variance after controlling for the specific cognitive abilities. One interesting exception to the above was found when SA and PS accounted for variance in SAT math scores but not in SAT verbal scores after controlling for *g*. Implications and limitations of the current study will be discussed.

IQ, Health, Longevity, and Brain Size: Is Little *g* Part of Big *K*?

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One gene-based answer to Gottfredson and Deary's (in press) question, "*Intelligence predicts health and longevity, but why*?" is provided by Rushton's (1987, 2000) application of *r-K* life-history theory. Anchored in evolutionary biology, this theory explains multifarious inter- and intra-species differences in both human and non-human animals, including the relation between brain size and longevity, with the general factor of intelligence, *g*, as part of the *r-K* rubric. In this paper I test the *r-K* hypothesis of a positive correlation between brain size and longevity (independent of body size).

Across 126 mammalian species (so far) I find a correlation of 0.28 (Pearson) and 0.35 (Spearman) between the encephalization quotient (EQ; brain size corrected for body size derived from John Eisenberg's 1981 book *The Mammalian Radiations*) and maximum longevity (derived from independent sources; *p*s < 0.001). Other analyses show that faster maturation, smaller brains, and shorter lives characterize the *r*-reproductive strategy; slower maturation, larger brains, and longer lives characterize the *K*-reproductive strategy.

Large brains are costly to build and run, both metabolically and in life-history trade-offs. Thus larger brains are typically housed in stronger, longer-lived bodies. Humans are *K*-selected relative to other species but some people are more *K* than others. The more *K*-selected a group or an individual, the longer the gestation, the slower the rate of maturation, the bigger the brain, the higher the IQ, the better the health, and the longer-lived the individual will be. This theory helps to explain individual, social class, and other human group differences in health and longevity.

General Intelligence: Indicator of Fitness or Life-History Strategy?

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Currently, there are two major competing evolutionary hypotheses for the existence of general intelligence, or *g* in humans. The general fitness model, proposed by Miller (2003) suggests that *g*, along with numerous other variables such as psychopathology, fluctuating asymmetry, and immunocompetence, is one small component of an overarching factor that indirectly measures some portion of an individual's endogenous genetic quality. This model suggests that while *g* may be correlated to life-history strategy, there is not necessarily a direct causal pathway between them.

The second one, proposed by Rushton (2000), is that *g* is a direct measure of life-history strategy, as explained by r/K theory. The ideas inherent in this second point of view are that if an individual's ancestors evolved in an unstable environment in which their genotype is predisposed to anticipate a shorter life expectancy, it would pay to invest more metabolic energy in reproducing rapidly, at a cost to neurological and, hence, cognitive functioning. In the tradition of strong inference and stemming from recent research that established the validity of measuring life-history strategy via self-report measures (Figueredo et al. 2003), the current study is a first step in testing these competing hypotheses.

Relationship of Intellectual Functioning and Personality/Attitudinal Variables to University Grades of First Year African and non-African Engineering Students in South Africa

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A previous study addressed the question of whether some of the measured differences between Africans and non-Africans found in studies on the Raven's Progressive Matrices Tests (see Rushton & Skuy, 2000; Rushton, Skuy & Fridjohn, 2002, Skuy et al., 2002, all in *Intelligence*) could be related to educational background and socio-economic status. In fact, the school background of Africans was shown to relate to intellectual ability, and to academic performance at a university, while language and SES were related to IQ only. Contrary to previous findings, intellectual ability itself was not found to correlate with academic performance. The question arose of whether non-intellective (personality and attitudinal) factors play a larger role than intelligence, in determining academic performance of engineering students at a university.

Data were yielded for 93% (N=100) of a Chemical Engineering class in terms of their performance on two measures of intellectual ability (Raven's Matrices and the Organiser test by Feuerstein), together with measures of self-concept, motivation, study attitudes, anxiety, locus of control, and autonomy. Results showed that, while the Raven's and Organiser scores of non-African students (N=36) were significantly higher than those of African students (N=64), this was not the case for any of the non-intellective measures, or for academic results. In some instances, the scores of the African students on the non-intellective measures tended to be higher than the scores of the non-African students.

While neither the Organiser nor the Raven's yielded any significant correlations with academic results, certain of the non-intellective measures did, and were able to differentiate between high and low academic performers. This was particularly true for the African group. This suggested the significant contribution of non-intellective factors to academic performance, particularly in ameliorating the effects of lower IQ.

The Amplification of Genetic Influence on General Cognitive Ability from Early Childhood to the Early School Years: A Large Longitudinal Twin Analysis Shows a High Genetic Correlation but a Substantial Increase in Heritability

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We have previously reported the emergence of general mental ability (*g*) in early childhood and its genetic and environmental etiology (Spinath, Ronald, Harlaar, Price & Plomin, 2003). This study used children from a representative population sample of twins assessed on verbal and nonverbal measures at 2, 3 and 4 years derived from parent-administered tests and parent reports of children's abilities. The present study provides a follow-up at the end of the first year of primary school at age 7.

Children's general cognitive ability was indexed by verbal and performance IQ subtests administered via telephone. In a sample of 618 monozygotic (MZ) and 584 same-sex dizygotic (DZ) twin pairs born in 1994 and 1995 in England and Wales, a multivariate genetic model was employed to test the extent to which genetic and environmental influence on *g* in early childhood and *g* in the early school years are correlated.

Three major findings are reported: First, phenotypic *g* is clearly present throughout early and into middle childhood with latent g factors from our model correlating as high as r=.61 across time. Second, the relative importance of genetic and environmental influences changes significantly at this particular age as genetic influences on *g* increase from a moderate (h^2_{234}=.22) to a substantial level (h^2_7=.57) whereas shared environmental influences decrease (c^2_{234}=.75 and c^2_7=.32). Third, despite this pronounced change in the etiology of *g*, genetic (r_G) and shared environmental (r_C) correlations were high (.78 and .65, respectively) indicating substantial overlap of genetic and shared environmental influences on *g* over time.

These findings suggest that the observed increase of heritability is not primarily due to the introduction or activation of new genetic effects but that the same genetic influences become more important, explaining more than half of the individual differences in ability among children as they reach the early school years.

Temperature, Skin Color, Per Capita Income, and IQ: An International Perspective

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The present study was based on the observations of Rushton (1995) and Lynn (1991) that countries with colder climates tend to have higher mean IQs. The mean IQ of 129 countries was correlated with mean high winter temperature, mean low winter temperature, mean high summer temperature, mean low summer temperature, skin color, and per capita income. Skin color was conceptualized as a multigenerational reflection of climate. Per capita income was employed because inadequate nutrition, inadequate health care, and less adequate education can have an unfavorable influence on IQ. The highest correlations were -.92 for skin color, -.71 for mean high winter temperature, .63 for per capita income, and -.61 for mean low winter temperature.

Genetic and Environmental Test of the Cognitive Basis of Reading and Reading Disability

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The genetic and environmental relationships among measures of phonological awareness, naming speed, IQ, and reading were investigated in 1015 identical and fraternal twin pairs from the Colorado Learning Disabilities Research Center (CLDRC; DeFries, Filipek, Fulker, Olson, Pennington, Smith, & Wise, 1997). A Cholesky decomposition model on composites of phonological awareness, naming speed, IQ, and reading provided genetic evidence supporting the double deficit hypothesis for reading disability. Additionally, the model revealed a small genetic relationship between IQ and reading independent of the double deficit hypothesis. We concluded that a triple deficit of phonological awareness and naming speed are central to reading disability and a double deficit of phonological awareness and IQ are central to general reading ability.

Trait Constellations in Intellectually Precocious Adolescents: Integrating Cognitive Abilities, Interests, and Personality

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The construct validity of ability, interest, and personality measures initially developed for high school seniors or adult populations has been extended to intellectually precocious youth with a fair amount of confidence. These assessments have been useful for answering basic scientific questions about the development of intellectually precocious youth, and they have provided educational-vocational counselors with critical information for designing and structuring developmentally appropriate opportunities for intellectually talented adolescents. However, models that provide a theoretical framework for organizing how abilities, interests, and personality dimensions operate collectively have only recently begun to appear (Lubinski & Benbow, 2000), and how measures of these constructs relate to one another among members of this special population is not yet fully understood.

This study examines the extent to which more integrative models of adult development (e.g., Ackerman's PPIK model) may be extended to the development of intellectually precocious youth. For example, do the same trait constellations uncovered by Ackerman, *science/math*, *intellectual/cultural*, *social*, and *clerical/conventional*, emerge by early adolescence in intellectually precocious youth. If so, how does this observation inform our understanding of talent development? In this study, 1131 (668 males, 463 females) intellectually precocious young adolescents were assessed on the Scholastic Assessment Test (or the American College Test); the Strong Vocational Interest Inventory; Allport, Vernon, and Lindzey's Study of Values; and the Adjective Check List, among other psychometric instruments. They also received a background questionnaire. Participants were surveyed approximately five years later regarding their high school experiences and their future educational and vocational plans.

Evidence for the cross-attribute constellations observed in adults was found in our sample of precocious adolescents, highlighting important antecedents to the development of a variety of expertise. Just as a wide array of adult expertise is engendered through the combination of cognitive and noncognitive determinants, with opportunity, intellectually precocious youth seeking learning environments congruent with their individuality appear to draw upon the same constructs. Understanding how constellations of individual differences routinely combine appears to be an important first step toward understanding the process of acquiring specialized knowledge and developing expertise.

Some models of the development of expertise based on adults appear to be helpful in modeling the learning patterns of intellectually precocious youth. Moreover, as Paul Lazarsfeld proposed with his formulation of substruction, the reconstruction of the entire property-space from which a subset of trait combinations was originally (and often implicitly) derived, our examination of these trait clusters illuminates how ostensibly orthogonal types of intelligence might be erroneously inferred from observations of groups of individuals of extreme standing on distinct constellations of continuous personological attributes.

The Flynn Effect: Testing for Measurement Invariance with Respect to Cohorts in Time-lag and Cross-sectional Designs

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The gains of scores on standardized intelligence tests (i.e., Flynn Effect) have been subject of extensive debate concerning their nature, causes, and implications. The aim of the present study is to investigate whether intelligence tests are measurement invariant with respect to cohort. Measurement invariance implies that gains over the years can be attributed to increases in the latent variables that the tests purport to measure. With Multi-Group Confirmatory Factor Analysis (MGCFA) it is possible to address within-group differences (i.e., the covariance between cognitive subtests within a cohort) and between-group differences (i.e., the mean difference between cohorts on these tests) simultaneously.

If measurement invariance is tenable, this supports the notion that (within-group) individual and (between-group) cohort differences are differences on the same underlying constructs. We use both a time-lag design (e.g., two cohorts measured in 1970 and 2000, respectively), and a cross-sectional design (i.e., different age groups measured in 2000) to investigate the nature of cohort differences on the Wechsler Adult Intelligence Scale (WAIS). Results indicate that measurement invariance with respect to cohort is generally untenable. The implications of these findings are discussed.

Using endophenotypes in the search for genes underlying variation in cognitive ability

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Endophenotypes of cognitive ability such as information processing (inspection time [IT] and choice reaction time [CR])), working memory (delayed response performance), reading (Cambridge Contextual Reading Test [CCRT]), and various electrophysiological derived indices of brain function (P300, SW, EEG power and coherence), in addition to general cognitive ability (Multidimensional Aptitude Battery [MAB]), have been measured in an adolescent twin and family sample (>500 families comprising of a twin pair and N non-twin siblings). The aim is to identify endophenotypes associated with specific aspects of cognition, and then to map and identify genetic variations related to neural function, thereby providing discrete windows through which brain pathways leading from genes to complex cognitive processes can be investigated.

Multivaraite genetic modelling was used to establish heritabilities (ranging from 0.32 to 0.83), and investigate the inter-relationships among endophenotypes and IQ, to examine whether the same genetic factors influence cognitive processing at different levels of complexity. Genetic covariance among information processing and IQ, working memory and IQ, and reading and IQ was found to be moderately high, and primarily due to additive genes. (Genetic correlations range from 0.22 to 0.75). In contrast, genetic covariance between electrophysiological indices and IQ was relatively low (0.02 to 0.19). A combined analysis including both behavioural and electrophysiological endophenotypes and IQ, showed that while covariation among the diverse range of measures was generally low, with a large specific genetic variance for IQ (36%), a number of associations were strongly influenced by genes.

The search for quantitative trait loci (QTLs) associated with these endophenotypes using linkage analysis and a genome-wide scan (400 markers) is underway. Genotypes, thus far, are available for 326 families (mostly comprising a dizygotic twin pair and their parents). Preliminary results show evidence for linkage on chromosome 2 for the CCRT; and suggestive linkage in this same region for performance IQ. No evidence for linkage was evident for IT or CRT. As the CCRT is used as a measure of premorbid IQ, this region may harbour genes influencing general cognitive ability.