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Special thanks to Earl Hunt who organized the program We would also like to thank the Templeton Foundation for their generous support and Elsevier for sponsoring the reception.

Short Schedule for ISIR 2008

(#) = Page of Abstract - All Papers in Swanton Amph.

Time	Thursday, Dec. 11
8:00-8:20	Detterman, Humt
	Opening Remarks
8:20-8:30	Engle (58)
	Working Mem. Symposium
8:30-8:50	Conway (58)
	Neural bases
8:50-9:10	Kane (59)
	Mind Wandering
9:10-9:30	Redick (60)
	Eye-Movement and Age
9:30-9:50	Meinz & Hambrick (61)
	Skilled Performance
9:50-10:00	Engle
	Questions and Discussion
10:00-10:20	Break
10:20-10:40	Widaman (55)
	Working Mem. & Gf
10:40-11:00	Nettelbeck et al (42)
	IT & Memory Decline
11:00-11:20	Burns and Nettelbeck (28)
	Inspection Time
11:20-11:40	Fagan & Holland (31)
	Achievement & Learning
11:40-12:00	Woodcock & McArdle (56)
	Cog. Ability in Impaired Adults
12:00-1:30	Lunch
1:30-1:50	Afonso (27)
	Cognitive Complexity
1:50-2:10	Park, Lubinski, & Benbow (44)
	Creativity and Promise
2:10-2:30	Reynolds & Beuajean (47)
	SLODR
2:30-2:50	Wai, Lubinski, & Benbow(44)
	Creativity in STEM
2:50-3:10	Psotka , Legree & Miller (46)
	Psychophoresis & Self Assess.
3:10-3:30	Break
3:30-3:50	Johnson (37)
	Gentics of Intelligence
3:50-4:10	Stough, Kure, et al (53)
	Illicit Drugs and Cog. Perf.
4:10-4:30	Schroeder, Haier, et al (50)
	Gray Matter & Intelligence
4:30-4:50	Downey, Silber, et al (29)
	Amphetamine & Cog. Perf.
4:50-5:00	McGrew (19)
	Announcement: Human Capit.
5:00-6:00	**Interview: Nettelbeck**
	Interviewer: Lubinski
6:00-7:30	Elsevier Reception, Posters
	Henry Oliver Room

Time	Friday, Dec. 12
8:00-8:13	te Nijenhuis, Cho, et al (63)
	Flynn Effect in Korea
8:13-8:26	Murphy, et al (64)
	Flynn Effect in South Korea
8:26-8:39	Rodgers & Ang (65)
	Flynn Effect & Item Patterns
8:39-8:52	Beaujean & Sheng (66)
	Flynn Effect & Latent Var.
8:52-9:05	Oesterdiekhoff (67)
	Flynn Effect Consequences
9:05-9:18	Mingroni (68)
	Flynn Effect & Heterosis
9:18-9:31	Flynn (69)
	IQ Trends in the UK
9:31-9:44	Lynn
	Discussant
9:44-10:00	te Nijenhuis
	General Discussion
10:00-10:20	Break
10:20-10:40	Rushton (49)
	Personality and g
10:40-11:00	Flores-Mendoza, et al (33)
	Prediction of Achievement
11:00-11:20	Nyborg & Larsen (43)
	Hormones & Fertility
11:20-11:40	Heiling & Rindermann (35)
	Emot. Intell. & Fertility
11:40-12:00	Rindermann & Meisenberg (48)
	IQ, HIV, & AIDS
12:00-1:30	Lunch
1:30-1:50	Wolf (72)
	Literacy & Health
1:50-2:10	DeWalt, Rpthman, et al (72)
	Interventions for Health
2:10-2:30	Weiss, Gale, Batty, & Deary (73)
	Intell., Neuroticism, & Mortality
2:30-2:50	Gottfredson (74)
	Intelligence & Error Rates
2:50-3:15	Panel Discussion
3:15-3:35	Break
3:35-3:55	Embretson (30)
	Generated IQ Tests
3:44-4:15	Floyd, Shands, & McGrew (34)
	Dependability of g
4:15-4:35	Pesta & McDaniel (35)
	Religious, Soc., & Econ. Covar.
4:35-4:55	Lynn (40)
	IQ and Income in S. Italy
4:55-5:15	Semmes & Davison (51)
	Speed & Numerical Reas.
5:15-6:15	Invited Speaker
	K. Warner Schaie

Time	Saturday, Dec. 13
8:00-8:20	Spanoudes (52)
	Processes in Matrices
8:20-8:40	Lohman (29)
	NNAT & Ethnic Differences
8:40-9:00	Madysatha & Hunt (41)
	Racial & Ethnic Group Diff.
9:00-9:20	Ferriman, et al (32)
	Profoundly Gifted
9:20-9:40	Keith, Reynolds, & Low (38)
	Sex Differences in DAS-II
9:40-10:00	Irwing (36)
	Male Variability?
10:00-10:20	Break
10:20-10:50	Lakin & Lohman (76)
	Sex Diff. in Variability
10:50-11:20	Berenbaum (77)
	Hormones & Sex Differences
11:20-11:50	Halpern (78)
	Data on Cog. Sex Differences
11:50-12:00	Johnson
	Discussant
12:00-1:30	Lunch
1:30-2:00	Hambrick & Meinz (80)
	Gc & Real-World Learning
2:00-2:30	Beier, Crook, & Campbell(81)
	Knowledge Structure Dev.
2:30-3:00	Ackerman (82)
	Investment, Traits, & IQ
3:0003:10	Ackerman
	Discussion
3:10-3:30	Break
3:30-4:00	Detterman
	Student Awards & ISIR

Posters, Thur., 6:00-7:30

Afonso (12)
Bachelder (13)
Decker (14)
Earl, Burns, et al (15)
Hunt & Madhyastha (16)
Lakin, Gambrell, et al (17)
McArdle & Woodcock (18)
Meisenberg (20)
Neppe (21)
Park (22)
Templer (23)
Webb, Lubinski, et al (24)
Young & Beaujean (25)

Symposium =Shaded

International Society for Intelligence Research (ISIR) Program 2008

(Numbers in parentheses refer to page of abstract. Order and times may vary from program for Symposia)

All sessions will be in the Holiday Inn Conference Center, Swanton Amphitheatre with registration directly outside.

Thursday, December 11, 2008

8:00-8:20 Opening Remarks
Douglas K. Detterman, Earl Hunt

Symposium (8:20-10:00) Working Memory
Organizer: Randall Engle

8:20-8:30 Engle (58)
Introduction to symposium

8:30-8:50 Conway (58)
The neural bases of working memory span performance

8:50-9:10 Kane (59)
Working memory capacity, attention control, and mind wandering

9:10-9:30 Redick (60)
Individual and age differences in working memory capacity, processing speed, and intelligence: Insight from eye-movement and psychometric analysis

9:30-9:50 Meinz and Hambrick (61)
The role of working memory in skilled performance

9:50-10:00 Engle
Questions and discussion

10:00-10:20 Break

Paper Session (10:20-12:00) Information Processing
Chair: Frey

10:20-10:40 Widaman (55)
Working memory and fluid intelligence

10:40-11:00 Nettelbeck, Gregory, Wilson, Burns, Danthiir, and G. Wittert (42)
Inspection time as a potential marker for memory decline

11:00-11:20 Burns and Nettelbeck (28)
Inspection time

11:20-11:40 Fagan and Holland (31)
Achievement as a function of learning ability

11:40-12:00 Woodcock and McArdle (56)
Cognitive ability in impaired adults

12:-1:30 Lunch

Paper Session (1:30-3:10) Theory and High Level Ability
Chair: Fagan

1:30-1:50 Afonso (27)
What does it mean to integrate in the psychology of intelligence?

1:50-2:10 Park, Lubinski, and Benbow (44)
Creativity and exceptional promise

2:10-2:30 Reynolds and Beaujean (47)
Spearman's law of diminishing returns

2:30-2:50 Wai, Lubinski, and Benbow (54)
Creativity in science, engineering, and mathematics

2:50-3:10 Psotka, Legree, and Miller (46)
Psychophoresis and intelligence self assessment

3:10-3:30 Break

Paper Session (3:30-4:50) Biological Aspects of Intelligence
Chair: Lubinski

3:30-3:50 Johnson (37)
Genetics of intelligence

3:50-4:10 Stough, Kure, Tarasuik, Lloyd, Downey, Wesnes, and Reynolds (53)
Illicit drugs and cognitive performance

4:10-4:30 Schroeder, Haier, Colom, Condon, Tang, Eaves, and Head (50)
Gray matter and intelligence factors

4:30-4:50 Downey, Silber, Stough, Owens, and Croft (29)
Effects of amphetamine on human cognitive performance

4:50-5:00 McGrew (19)
ANNOUNCEMENT: Human capital project

5:00-6:00 Career Interview: **Ted Nettelbeck**
Interviewer: David Lubinski

6:00-7:30 Elsevier Wine Reception and Poster Session
Henry Oliver Room

Posters (In alphabetical order)

Afonso (12)
Exploring the generality of *g*: A structural study of the WAIS-III and the STAT-R (H) in a Portuguese sample

Bachelder (13)
A theory of intelligence, III: A unifying alternative to cognitive science and mainstream behaviorism

Decker (14)
Tactile measures in the structure of cognitive abilities

Earl, Burns, Nettelbeck, and Baghurst (15)
The impact of environmental lead on children's cognitive abilities and behavior

Hunt and Madhyastha (16)
Does the "Flynn Effect" apply uniformly throughout all ranges of intelligence?

Lakin, Gambrell, and Lohman (17)
Verbal reasoning skills measured with a picture-based format: Evidence of construct validity

McArdle and Woodcock (18)
The selection of a optimal battery for cognitive aging

McGrew (19)
The Human Cognitive Abilities Project: An overview and update

Meisenberg (20)
How does IQ reduce fertility?

Neppe (21)
Intelligence assessment by history taking in child prodigies with adult achievement-the SCHIQ

Park (22)
The nature and development of metalinguistic skills among extremely precocious readers

Templer (23)
The relationship of violent crime rates to Rushton K-Differential Theory variables

Webb, Lubinski, and Benbow (24)
Academic acceleration: Profoundly gifted adolescents' 20-year perceptions

Young and Beaujean (25)
Individual differences as predictors of accidents in early adulthood

Friday, December 12, 2008

Symposium (8:00-10:00) The Flynn Effect
Organizer: Jan te Nijenhuis (62)

8:00-8:13 te Nijenhuis, Cho, Murphy, and Lee (63)
The Flynn effect in Korea

8:13-8:26 Murphy, te Nijenhuis, and van Eeden (64)
The Flynn effect in South Korea

8:26-8:39 Rodgers and Ang (65)
Putting the Flynn effect under the microscope: Item-level patterns in the NLSY PIAT-Math scores

8:39-8:52 Beaujean and Sheng (66)
Examining the Flynn effect in the General Social Survey via latent variable modeling

8:52-9:05 Oesterdiekhoff (67)
The Flynn effect has deeper grounds and more consequences than usually assumed

9:05-9:18 Mingroni (68)
Heterosis as a cause for the Flynn Effect

9:18-9:31 Flynn (69)
Recent IQ trends in the United Kingdom: Making sense out of Raven's, Piagetian tests, and the WISC

9:31-9:44 Lynn
Discussant

9:44-10:00 General Discussion

10:00-10:20 Break

Paper Session (10:20-12:00) Misc. Papers
Chair: Lynn

10:20-10:40 Rushton (49)
Toward a resolution of the emotional intelligence/general intelligence debate: Is there a general factor of personality (GFP) analogous to the *g* factor of mental ability?

10:40-11:00 Flores-Mendoza, Mansur-Alves, Rodriques, Abad, and Colom (33)
The prediction of scholastic achievement by intelligence and psychoticism is invariant with respect to sex

11:00-11:20 Nyborg and Larsen (43)
Bright and dull people: Their hormones, marital status, sexuality, and fertility

11:20-11:40 Heiling and Rindermann (35)
The relevance of emotional intelligence for mental health and partnership

11:40-12:00 Rindermann and Meisenberg (48)
Relevance of education and intelligence at the national level for health: The case of HIV and AIDS

12:00-1:30 Lunch

Symposium (1:30-3:15) Causal Models that Integrate Literacy, *g*, and Health Outcomes: A Practical Guide to More Effective Disease Prevention and Health Promotion?
Organizer: Linda Gottfredson (70)

1:30-1:50 Wolf (71)
Literacy and its impact on health: An overview

1:50-2:10 DeWalt, Rothman, Malone, and Pignone (72)
Designing interventions to mitigate the relationship between literacy and health

2:10-2:30 Weiss, Gale, Batty, and Deary (73)
Next steps in charting the influence of intelligence on health: The influence of intelligence and neuroticism on later mortality in Vietnam-era veterans

2:30-2:50 Gottfredson (74)
How intelligence research can guide interventions to reduce error rates in health self-management

2:50-3:15 Panel Discussion

3:15-3:35 Break

Paper Session (3:35-5:15) Misc. Papers
Chair: Hunt

3:35-3:55 Embretson (30)
Generated intelligence tests: Impact on scores and psychometric properties

3:55-4:15 Floyd, Shands, and McGrew (34)
The dependability of *g*-factor loadings: A partial replication and extension of Thorndike's (1987) *Stability of Factor Loadings*

4:15-4:35 Pesta and McDaniel (35)
Religious, social, and economic covariates of state intelligence

4:35-4:55 Lynn (40)
IQs and income are lower in the south: The case of Italy

4:55-5:15 Semmes and Davison (51)
A test of speed-level hypothesis in the domain numerical reasoning

5:15-6:15 **Invited Speaker**
Introduction: Earl Hunt
Speaker: **K. Warner Schaie**
Cognitive Development in Adulthood - The Seatle Longitudinal Study: Past, Present and Future

Saturday, December 13, 2008

Paper Session (8:00-10:00) Group Differences
Chair: Rushton

8:00-8:20 Spanoudes (52)
Processes underlying matrices tests

8:20-8:40 Lohman (29)
Ethnic differences on fluid reasoning tests: Is the NNAT the panacea?

8:40-9:00 Madhyastha and Hunt (41)
Modeling racial and ethnic group differences in the general population from college admission tests

9:00-9:20 Ferriman, Lubinski, and Benbow (32)
Work preferences, life values, and personal views of top math/science graduate students and the profoundly gifted: Developmental changes and sex differences during emerging adulthood and parenthood

9:20-9:40 Keith, Reynolds , and Low (38)
Sex differences in latent general and broad cognitive abilities: Evidence from the DAS-II

9:40-10:00 Irwing (36)
Greater variability in cognitive test scores amongst males: Is the consensus view correct?

10:00-10:20 Break

Symposium (10:20-12:00) Three Perspectives on Sex Differences in Cognitive Abilities
Organizer: Wendy Johnson

10:20-10:50 Lakin and Lohman (76)
Sex differences in variability on the Cognitive Abilities Test: Real or the result of test construction

10:50-11:20 Berenbaum (77)
Sex hormones and cognitive sex differences

11:20-11:50 Halpern (78)
Data don't speak: Interpreting data regarding cognitive sex differences

11:50-12:00 Johnson
Discussant

12:00-1:30 Lunch

Symposium (1:30-3:15) Cognitive Investment, Domain Knowledge, and Intellectual Ability
Organizer: Phillip L. Ackerman

1:30-2:00 Hambrick and Meinz (80)
The role of G_c in real-world learning

2:00-2:30 Beier, Crook, and Campbell (81)
Ability and non-ability determinants of knowledge structure development

2:30-3:00 Ackerman (82)
Investment, trait complexes, and adult intellectual development

3:00-3:10 Ackerman
Discussion

3:10-3:30 Break

3:30-4:00 Detterman
Student awards and ISIR business

Posters

Exploring the Generality of *g*: A Structural Study of the WAIS-III and the STAT-R (H) in a Portuguese Sample

Maria João Afonso, PhD
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This paper presents a structural study of the measures provided by two representative intelligence tests administered together in a single sample: the Wechsler Adult Intelligence Scale – 3rd Edition (WAIS-III – Portuguese experimental version 2002) and the Sternberg Triarchic Abilities Test – Revised (Level H) (STAT-R (H) – Portuguese experimental version 2004).

The theoretical background for the study relies upon Sternberg's Triarchic Theory of Human Intelligence, and the associated concept of Successful Intelligence. According to Sternberg, traditional intelligence tests as the WAIS assess a narrow range of abilities – just analytical abilities – a feature that partly explains the emergence of a general factor (*g*) in the classic factorial approaches to intelligence test validation. Thereby, broadening the range of cognitive assessment, using new instruments like the STAT, new abilities not traditionally covered by intelligence tests may emerge – as creative and practical abilities –, and relationships between traditional measures and just the STAT analytical scores may contribute to a weaker importance of the general factor as a major explanation for individual differences in intelligence.

Taking as a methodological frame of reference the two kinds of evidence in the literature supporting these ideas – structural studies applying the factorial approach and convergent studies correlating the STAT-R to other intelligence tests –, and in line with the analysis by Brody [2003, *Intelligence, 31* (4), 319-329 and 339-342] concerning the construct validation studies of the STAT, the present research aimed at exploring the structure of the results provided by the STAT-R (H) and the WAIS-III in a sample of 250 Portuguese adults (aged 16 to 64), using exploratory and confirmatory factor analysis, as well as unidimensionality analysis applying the partial credit item analysis (latent trait theory).

The results, in spite of the diversity in methodology applied and in level of analysis adopted (item/scale/composite), consistently showed a better correspondence between the measures' empirical structure and the Hierarchical Model of human abilities, summarized by the C-H-C model, than with the Triarchic Model, and made clear the presence of a general factor emergent from both instruments. The implications of this emergency of g, even when intelligence is assessed by a test based on a broader systemic approach to human intelligence, are discussed on the methodological, the conceptual and the metatheoretical levels of analysis.

A Theory of Intelligence, III: A Unifying Alternative to Cognitive Science and Mainstream Behaviorism

Bruce L. Bachelder
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Span theory is closely associated with this meeting. Five early presentations were made at the "Gatlinburg meetings" (1976 to 1980). Two papers, *A theory of intelligence, I* and *II*, are published in *Intelligence* (1977). My collaborator, M. Ray Denny, was a prominent figure in the early meetings. My presentation will summarize the basic concepts of those early papers and update them with the main developments since then.

Span theory arose in the behavioral tradition aiming to bring a rigorous non-mentalistic approach to the study of intelligence and mental retardation. It was eclipsed by the cognitive revolution. The revolution is now over 50 years old and we hear voices of dissent from within cognitive science (e.g. William R. Uttal) as well as from without. A behavioral journal has reprinted a cognitivist paper by Michael Watkins. Span theory is a unifying alternative to both cognitive science and mainstream behaviorism. As with any challenge to the mainstream, there is much to trouble both behaviorists and cognitivists. There is also much to appeal to both.

The theory is a natural science account of individual and developmental differences in intelligence and mental retardation. It is firmly rooted in the literatures of behaviorism, cognitivism, and psychometrics. It incorporates key features of all three traditions, but rejects others. It focuses on the tasks of cognitive science, but has no mentalism. It incorporates behaviorism's repertoire notion of intelligence, but adds an ability construct defined in traditional behavioral terms. Its mode of explanation is much more in the behavioral than cognitive science tradition, making use of empirical generalizations expressed in mathematical form whenever possible. It avoids mental and neural reductionism. It has no mental processes, intervening variables, hypothetical constructs, or conceptual nervous system. It aims to observe, communicate about, and predict *behavioral events*; no more, no less.

A theory of intelligence, I and *II* introduced the concepts of *joint relevance of stimuli, task complexity, span ability*, and *relative task difficulty*. They summarized the research strategy and the data showing how these concepts account for individual and developmental differences in diverse tasks, including memory span; span of absolute identification; span of apprehension/numerosity; probe-type STM tasks; language reception, expression, and development; IQ subtests; discrimination learning tasks; reading; verbal learning; the relation between intelligence and learning; and the efficacy of behavioral task analysis in training people with retardation.

Task complexity has been replaced by *span load*. The *task* is now taken as the central construct. The task is not viewed as a tool to investigate hypothetical underlying processes such as memory or conditioning. Rather, *the task is the fundamental unit of theoretical analysis*. A task is characterized in terms of its (1) stimuli, (2) responses, (3) procedure, (4) a statement of stimulus-response correspondence, (5) a counting rule, and (6) the task equation.

Performances in diverse tasks are linked via task equations of the form:

$$\text{Performance}_{\text{task}} = f(\text{span ability, span load, + other variables and setting conditions}) \quad (1)$$

Span ability is measured with a simple span test. Span measures vary continuously from low to high values which closely parallel measures and various indexes of intelligence ranging from well below to well above average. Span load is assessed through a process called *task analysis of span load* or *TASL* ("tassel") which grew out of behavioral task analysis.

Complex tasks are analyzed as configurations of simpler tasks leading to new task equations with the same form as Equation (1), though the mathematics are likely to be more complex. Task equations are treated as hypotheses which must be tested empirically and revised accordingly.

Finally, measures of span ability covary closely with measures of intelligence, but *Intelligence* is a term from cognitive theory and does not appear in span theory. It can, however, be linked to the concept of span ability. The standard measure of intelligence, the IQ test, is a complex task, so it follows from the arguments above:

$$\text{Performance}_{\text{IQ}} = f(\text{span ability, span load, + other variables and setting conditions}) \quad (2)$$

Tactile Measures in the Structure of Cognitive Abilities

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This study investigated the relationship of tactile abilities within the framework of a hierarchical structure of mental abilities. Data was analyzed from 248 participants who were administered tactile measures from the Dean-Woodcock Sensory Motor Battery along with a battery of co-normed cognitive measures representative of the CHC model of intelligence. Multiple measures of tactile performance were used including Palm Writing and Object Identification and each measure included a lateralized measure (i.e., right/left). Factor analytic and structural equation model results suggest tactile measures form an independent factor separate from cognitive factors (Gtk). Gtk was significantly related to overall cognitive ability (r=.50). Additional analyses suggest Gtk is more specifically associated with processing speed measures (Gs) and negatively associated with crystallized ability (Gc) when controlling for overall intelligence. Suggestions for cognitive processing models based on psychometric theory are discussed.

The Impacts of Environmental Lead on Children's Cognitive Abilities and Behaviour

Rachel Earl[1], Nick Burns[1], Ted Nettelbeck[1], and Peter Baghurst[2]
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This paper introduces a study exploring the relationship between children's intelligence and lead (Pb) exposure within the theoretical framework provided by the Cattell-Horn-Carroll (CHC) taxonomy of cognitive abilities.

An abundance of research has centered upon the environmental neurotoxicant, Pb and the outcomes of severe Pb poisoning (like brain damage and coma) are undisputed. Whilst people in industrialised societies have 500-to-1000 times more Pb in their bodies than their prehistoric ancestors, successful abatement programs have meant that Pb levels in humans are currently their lowest in 50 years. Paradoxically, questions have emerged about the effects of even these low levels of Pb exposure. Indeed, research (Lanphear BP, Hornung R, Khoury J, Yolton K, Baghurst P, Bellinger DC, et al. (2005). Low-level environmental lead exposure and children's intellectual function: an international pooled analysis. Environ Health Perspect; 113: 894–899) has suggested that lower levels of Pb exposure may have a more deleterious impact on cognitive abilities than exposure at higher levels.

Our study investigates the relationship between chronic low-level Pb exposure and child outcomes in Australian communities where Pb derived from ore bodies through mining and smelting remains a dominant source of exposure. Three hundred children aged seven or eight years and their parents are being tested and interviewed, and levels of Pb in the children's blood and teeth measured. We hypothesise that there will be an inverse association of child IQ with blood Pb concentration across the exposure range.

The cognitive battery measures ten broad factors delineated in CHC theory by supplementing Wechsler IQ scores with measures of CHC factors. In particular this includes Inspection Time (IT), considered to capture Speed of Information Processing. This paper contributes to discussions about the confounding effects of socio-cultural and environmental factors that influence children's IQ and compares the associations between Pb exposure and children's intelligence as measured by Wechsler IQ, CHC derived scores, and chronometric measures. Data collection is ongoing.

Does the "Flynn Effect" Apply Uniformly Throughout All Ranges of Intelligence?

Earl Hunt & Tara M. Madhyastha
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The term "Flynn effect" has become a shorthand for the general increase in intelligence test scores throughout the 20th century. It has been observed that the increase in test scores are generally smaller at the top of the range than at the bottom. A straightforward argument leads us to believe that underlying intelligence has increased less at the top and the bottom. There are reasons to believe that this should be the case, e.g. the disparity in resources devoted to special education classes compared to resources devoted to classes for the gifted. It is also possible that the increase is an artifact of test scoring. This argument rests on the assumption that the observed scores may be an ordinal but non-linear function of underlying cognitive ability. If that is the case it would be possible to have an apparent difference in the size of the increase in the top scoring groups, compared to the bottom scoring groups, even though the increase in underlying ability was the same throughout the range of abilities evaluated. For that matter, the converse would be possible. We utilize two techniques for test score equating, one based on IRT modeling and one based on percentile equating, to determine what changes have occurred in the latent trait of intelligence, presumed to underlie observed test scores.

Verbal Reasoning Skills Measured with a Picture-Based Item Format: Evidence of Construct Validity

Joni M. Lakin, James Gambrell, and David F. Lohman
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Researchers and practitioners have long sought a culture-fair measure of intelligence that would see through the veneer of education of students who differ in social class, cultural background, or language proficiency. Figural reasoning tests (e.g., the Raven's Progressive Matrices) in particular have been used widely as a culture-reduced method of assessing students from disadvantaged backgrounds and have played an important role in cross-cultural intelligence research. However, such tests have well known limitations when used to identify academic talent, as in selection for school gifted programs. While reasonably good measures of *g*, these tests do not measure the group factor of crystallized verbal ability and other specific verbal reasoning abilities which are critical for prediction of academic success. Thus the best nonverbal reasoning tests tend to predict concurrent academic achievement with an *r* of .4-.6, whereas verbal and quantitative ability tests typically predict on the order of .7-.8 (Lohman, Korb, & Lakin, in press).

There have been some promising efforts to develop figural or picture-based tests that measure verbal ability to some degree. Most notably, the Universal Nonverbal Intelligence Test (UNIT; Bracken & McCallum, 2005) includes an Analogical Reasoning subtest intended to measure symbolic reasoning in a picture-based format. Validity evidence reported by Bracken and McCallum shows that correlations with current academic achievement measures are higher for this test than for the figural sections of the UNIT, but the results vary from sample to sample (Bracken & McCallum, 1998). It remains unclear whether picture-based verbal tests can tap into uniquely verbal reasoning skills, or if they are simply measures of *g* (or Gf) like other figural item formats.

The current study investigated the potential of picture-based verbal item formats. Specifically, we were interested in whether picture-based verbal items measure the same verbal construct as either a vocabulary test or the same picture-based verbal items with spoken labels applied. Two picture-based measures of verbal ability—using analogy and classification formats— were designed for U.S. schoolchildren in kindergarten through second grade.

The sample consisted of 680 second-grade students from schools in the Midwestern U.S. Each participant completed a four-part battery with verbal instructions before each section. Participants were first administered 15 items in either the verbal classification or verbal analogy format without any verbal labels. Next, they were administered 15 additional items of the same format but with the teacher reading aloud a label for each of the pictures in the item stem. The third test in each battery was a 15-item oral vocabulary test adapted from the 2nd-grade level of Form 5 of the Cognitive Abilities Test. It was selected as a marker of crystallized verbal ability. The final test was a purely nonverbal figure analogies test, administered as a marker of nonverbal reasoning.

Our first hypothesis was that having teachers read labels for pictures in the item stems would encourage examinees to use verbal reasoning strategies to solve the items. Results showed that administering the picture-based tests with or without verbal labels had no significant effect on correlations with the oral vocabulary test. This constant relationship with our marker of crystallized verbal abilities indicates that picture-only items alone can elicit skills similar to items with verbal labels. To further investigate the dimensionality of the items with and without verbal labels, we conducted a centroid factor analysis of the items. After extracting a general factor, we inspected the residual correlations to see what relationships remained between the tests. The general factor (strongly verbal in this battery of tests) accounted for all of the relationship between the verbal tests with and without labels. The test with verbal labels did not show a stronger residual correlation with oral vocabulary, which would have been expected had it been a better measure of crystallized verbal ability. Additional analyses are planned to more carefully investigate the relationships between the four tests.

Measuring specific verbal reasoning abilities through the use of picture-based tests would add greatly to the ability of test developers to create tests that are fair and valid for students who lack cultural or language proficiency. This study is a first investigation into the constructs measured by such tests. Our tentative conclusions are that our picture-based tests appear to be measuring aspects of verbal intelligence that are independent of both vocabulary (Gc) and figural reasoning (Gf), and which might add incremental validity to prediction of academic achievement.

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The Selection of a Optimal Battery for Cognitive Aging Research

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Many existing cognitive tests which are sensitive to age changes, and we examined the utility of several existing batteries (e.g., TICS, WJ-III, WAIS). We then selected tests to (a) screen for cognitive impairment and acuity, and (b) yield good measurement characteristics of broad abilities. These new results will be reported.

There are many existing cognitive tests that are sensitive to age differences and age changes -- But there are also many available measures to choose among. In this research we examined the theoretical and practical utility of several broad batteries of tests and measures that could be effectively combined for use in our own research (the NGCS).

The primary selection of tests were based on the need to screen for cognitive impairment and acuity. The current tests used in the Telephone Interview of Cognitive Status (TICS) proved most useful here, especially due to the large and representative (i.e., norming) sample available (e.g., in the HRS). The selection of additional tests were based on a tradeoff between good measurement characteristics (e.g., IRT precision) and wide breadth of representation of the important common factors of the "theory of fluid and crystallized intelligence" (Gf/Gc theory; Horn & Cattell, 1967, 1985). These criteria led to the selection of 10 tests from the larger WJ-III testing battery (Woodcock, McGrew & Mather, 2007) to provide both a broad and a focused portrait of adult age growth and changes.

These 10 tests were selected from the larger WJ-III testing battery of 53 tests to provide both a broad and a focused portrait of adult age growth and changes. These 10 tests all reflect operationally independent common factors of the Gf/Gc theory. These 10 tests have all been used in our prior studies and have the empirical capacity to distinguish between different patterns of aging – both detrimental aging and successful aging. All of the tests have been studied in our large cross-sectional studies with wide adult age differences (25-95), and most of these tests have been used in our longitudinal studies of adult age changes. This abbreviated battery can be useful in almost any study of age-related changes in cognitive abilities, and the availability of a large set of focused norms, allows clinicians or researchers to use these tests to determine the cognitive status of any adult from most any background. In addition, the WJ-III test development process based on Item-Response modeling is essential in terms of measuring the significance of cognitive changes over any period of time in the same individuals. In all of these ways, these tests should be far superior in measuring adult growth and changes than any traditional test battery, such as the WAIS, PMA, or other psychometric instruments.

The Human Cognitive Abilities Project: An Overview and Update

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The Human Cognitive Abilities (HCA) project was initiated in the fall of 2002. The HCA project is an ongoing set of activities focused on electronically archiving, for historical purposes and secondary data analysis, as many of the 460+ correlation matrices analyzed in Jack Carroll's (1993) seminal treatise on the structure of intelligence. The HCA project currently focuses on two sets of activities. The first is the electronic data entry of the correlation matrices from Carroll's original printouts (and from select recovered disk files) and associated publications. The second is the development of a free web-based dataset archive repository and retrieval system by which independent researchers can access these materials.

The preliminary plans for the HCA project were presented at the 2003 ISIR annual conference. The purpose of the current presentation is to update ISIR members on the status of the HCA project. More importantly, the HCA archive is now available as a free on-line resource. The on-line HCA archive system will be presented and described . A demonstration illustrating how to access and view the HCA archive system (and download matrices and manuscripts) will be provided. Communication mechanisms (the WMF HCA listserv) will be presented to allow interested researchers to receive routine updates regarding additions to the archive. Finally, assistance from ISIR members will be requested in the location of fugitive correlation matrices and manuscripts that belong in the HCA archive

How Does IQ Reduce Fertility?

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A negative relationship between intelligence and fertility is one of the most consistent findings in the literature about intelligence. In the NLSY79, IQ measured in 1980 is negatively related to the number of children in 2004, when respondents were between 39 and 47 years old. The correlations are -.160 for white females, -.070 for white males, -.236 for black females and -.032 for black males. Path models with length of marriage up to age 39, educational attainment, log-transformed family income, religious attendance and gender attitudes as intermediate variables show that the IQ effect is mainly indirect. IQ leads to higher education and income. High education reduces fertility in the female samples. Also high income reduces fertility independently except for black males. Another finding is a robust positive effect of IQ on liberal gender role attitudes in all demographic categories, which in turn reduce the number of children significantly for white females. For all demographic categories, the fertility-reducing effects of IQ through education, income and gender attitudes are opposed by a direct positive effect of IQ on time spent in the married state, which in turn increases the number of children. Direct fertility-reducing effects of IQ that are not mediated by the other variables in the model are marginally significant only in white males.

Intelligence Assessment by History Taking in Child Prodigies with Adult Achievement—the SCHIQ

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Quantifying the validity of the scores in current IQ testing in the *exceptionally* intelligent is fraught with problems and several difficulties in conceptualizing such testing as valid intelligence measures. Several questions on these tests reflect this:

1. Does their *construct* validity reflect *accurate gradations of very high intelligence*?
2. Does their *face validity* strongly correlate with specific outside creative, occupational and educational *achievements*?
3. Is the *statistical validity* of "IQ tests" compromised? (E.g., limited sampling at ≥ 4d or even ≥ 3.4d IQ? Still "normally distributed"? Any "twisted pear" or bimodal curve or other distortion? More frequent occurrence than expected?)
4. Does IQ testing focussing on the *"convergent"* questions (e.g. difficult to solve problems of mathematical or symbolic or logic kind) correlate strongly with "divergent" measures that could more accurately reflect exceptional intelligence?

Whereas these purported IQs certainly measure a high level of accomplishment on these tests, there is a known lower correlation of the "g factor" at "high IQ" levels: These "convergent IQ tests", despite being ingenious at times, may not necessarily reflect increased intelligence itself, but a related skill subset. This is so as creative intelligence (I describe this as the "c factor") is usually ignored as not easily measurable. This may involve ostensibly divergent skills added to the requisite grounding convergent measures. This results in multiple appropriate creative answers complicating accurate measurement of correct answers in these potentially very exceptional individuals. These factors together suggest a possible new approach.

This paper reports on a preliminary pilot study to evaluate intelligence at the higher ranges using a different technique, namely applying historical data about the accomplishments of child prodigies. Child prodigies were chosen because the extent of their advancements could relatively easily be compared with older children and any rare exceptional creativity would stand out.

All prodigies were chosen who met the following two criteria:

1. *Profoundly advanced milestones as a child*, even when it was not necessarily recognized at the time as prodigy behavior. This could include a subgroup that also exhibited profound creative achievement as children (which skill / discovery/ invention could not even be replicated by adults trained in the area).
2. *Demonstrable achievement in adulthood*. This generally related to exceptional accomplishment or education e.g. doctorate (or in young adults, a career leading in that direction). We excluded the prodigy subgroup who became limited achiever adults or even disabled.

An attempt was made to locate these rare prodigies worldwide through high IQ societies (e.g., ISPE), as well as approaching very creatively accomplished adult outsiders known to the author, and asking about very advanced childhood behavior.

This initial pilot study involved only 7 child "prodigies" (raised in 7 different countries), A total of 21 achievements were described during their childhood years (youngest, 6 months; oldest age 19) and their composite 7 adult achievements were also described. These achievements were each succinctly summarized in 2-4 lines (examples will be discussed). Generally, the individuals described these, but outside validating information, when available, was requested so as to ensure maximal accuracy.

Three raters were carefully chosen. All had had major interest, personal involvement, knowledge and experience in the high IQ measurement domain, substantial knowledge in research or theory of intelligence, and were involved in evaluating high IQ individuals e.g. for admission to various high IQ groups. They ranked the estimated IQ score (standard deviation 15) for each of the 28 individual items described. Their mean IQ estimates of each item were used to compare interrater reliability, though all raters recognized the need for an item IQ range. Despite 28 items, the mean differences between the 3 raters were extraordinarily close (a range of 1.9 total; implying <0.1 IQ point per item). However, several items showed more marked variations in scoring. The most difficult to estimate IQ items were the accomplishments in the very young (particularly <5 years old and even more so under 3 years) and the extremely intelligent (≥4.5d). Overall assessments of "IQ scores" were more difficult with less than 4 items listed per individual prodigy. Matching the prodigy children with the correct corresponding creative and educational accomplishments in adults was complex, though rank ordering the adult-child pairs correlated well.

Given the paucity of comparable outside child research to validate this technique, we used these preliminary results to further correct by guesstimation applying an increased standard error for younger age groups, very exceptional intelligence, and less test items. The scores were then recalculated producing a composite IQ score called SCHIQ (standard, corrected, historical IQ) for the 7 subjects. This ranged from 146 though to 179. The two individuals with the largest number of data points *correlated exactly* with their estimated IQs using other techniques (179, 169), after corrections (Scoville's for mental/chronological age: Ferguson's combination of scores calculation). The results of the other five subjects also appeared appropriate based on the data available. We believe our results reasonably represent these exceptional subjects.

Applying a history taking technique using key illustrative vignettes appears to be a promising way to measure IQ in child prodigies who then become high achiever adults. This is so as the SCHIQ measures allow for a possibly accurate measure of extremely high intelligence using outside validators of creative, academic and other recognized achievement. A replication is in process. More data could allow for more accurate standard error estimates, and a way to apply validity information for high IQ. The SCHIQ, and its principles, can potentially be applied to other settings, as well, including highly accomplished adults, creative individuals, polymaths, very high IQ individuals who were not prodigies, and prodigies who did not succeed as adults.

The Nature and Development of Metalinguistic Skills among Extremely Precocious Readers

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This paper reviews relevant research publications on the subject of metalinguistic skills among precocious readers under five years of age. Metalinguistic skills are considered prerequisites to reading in an alphabetic language such as English because the process of learning to read requires skills to map between the basic elements of spoken language and the properties of the writing system. In addition, the development of these prerequisite skills starts around the age five or six among normal children. This review, therefore, is particularly important for understanding and identifying extremely precocious readers when compared to the development of reading skills in the normal population. Both case and group studies were examined to describe metalinguistic skill profiles among the precocious readers, and to compare metalinguistic skill profiles between precocious readers and older but normal readers. The results from the reviewed studies support the view that extremely precocious readers' advanced metalinguistic skills are characterized by specific skill patterns, most notably exceptional phonological decoding skills, not by chronological age. Accordingly, multi-methodological approaches to investigating the development of metalinguistic skills for extremely precocious readers are discussed and suggested.

The Relationship of Violent Crime Rates to Rushton K-Differential Theory Variables

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The purpose of the present research was to relate violent crime to Rushton's r-K life history dimension on an international level. Rushton postulates that individuals and groups at the K end of the continuum exhibit higher intelligence, lower birth rates, more adequate care of their offspring, less sexual activity, low rates of sexually transmitted diseases, better impulse control, more altruism, and greater social organization. The violent crimes chosen were homicide, assault, and rape. Rape was accorded special importance because it is both a violent and a sexual crime. Previous research found that rapists are lower in IQ than other inmates and even lower than other violent criminals. The r-K variables correlated in the expected direction with the crime variables. Those that yielded the highest correlations with crime were HIV/AIDS rates and IQ. These variables correlated more highly with rape than did per capita income, Rape was the crime that yielded the highest correlations.

Academic Acceleration: Profoundly Gifted Adolescents' 20-year Perceptions

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This study drew upon the most able cohort of participants in the Study of Mathematically Precocious Youth. When initially identified in 1980-1983, these participants met top .01% (top 1 in 10,000) selection criteria by scoring at least 700 on the SAT-M or 630 on the SAT-V before age 13. At time-1, participants were examined extensively with regard to cognitive and noncognitive attributes, and, subsequently, participants have been surveyed 5, 10, and 20 years later. These participants were particularly well-positioned to evaluate the benefits and costs associated with academic acceleration; more than 95% of them had used at least one form of acceleration in their own educations (e.g., advanced coursework, grade skipping, early entrance to college). Therefore, as one focus of the 20-year follow-up, we surveyed participants about their views regarding the importance of accelerative opportunities for intellectually gifted children.

We assessed their views in multiple ways. First, we asked them about their overall perceptions regarding the importance of providing accelerative educational opportunities to intellectually gifted youth, parsed by four age groups (preschool-kindergarten, 1^{st}-4^{th}, 5^{th}-8^{th}, and 9^{th}-12^{th} grades). We found that, averaged across all age groups, more than 80% of participants indicated at least a moderate level of importance in providing accelerative opportunities, but importance ratings were even higher for older children, with 93% indicating at least moderate importance for the two older age groups. Moreover, we surveyed participants regarding the resources that they would have liked to have had available to them during their educational and career development and found that, although many of their academic needs were met through other accelerative options, many participants would have liked to have more opportunities to receive mentoring.

Finally, because of their firsthand experiences with educational acceleration and because these participants were at an age (early 30s) when they were beginning to have their own children, we surveyed them regarding their likelihood of using various accelerative opportunities for their children. Respondents reported strong likelihoods of using advanced coursework (e.g., AP courses, college courses in high school), special programs (e.g., academic camps, contests, enrichment opportunities), and mentoring opportunities to supplement the educational experiences of their own children if they were gifted. Less strong, but nevertheless positive, support was found for more salient accelerative options that separate gifted students from their age peers such as grade-skipping and early admissions (e.g., to kindergarten, to college).

Individual Differences as Predictors of Accidents in Early Adulthood

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Within the last decade, researchers have begun to use measures of intelligence to predict health-related outcomes (i.e., cognitive epidemiology [CE]; Deary & Batty, 2007). Researchers within CE have been successful in demonstrating that intelligence is a significant predictor of important heath-related outcomes ranging from mortality to dementia (Batty, Deary, & Gottfredson, 2007; Snowdon, et al., 1996), often independent of potentially confounding variables (e.g., socioeconomic status). One health outcome that has not been thoroughly explored in the CE literature is accidents and unintentional injuries. Such health impairments pose a significant health threat for adults and children, due to their long term sequelae, both individually (Berger & Mohan, 1996), and at the public health level (Segui-Gomez & Mackenzie, 2003). Subsequently, their investigation and, ultimately, prevention appears to be a fruitful area of inquiry.

One potentially confounding variable that has not been investigated extensively in the study of accidents, as well as CE literature in general is personality--despite a literature that suggests certain personality measures predict important life outcomes (Roberts, et al., 2007). Thus, this study seeks to investigate the relationship between cognitive ability (as measured during early adolescence) and personality traits in predicting accident incidence in early adulthood using the National Longitudinal Study of Adolescent *Health* dataset.

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Presentations

What Does it Mean to "Integrate" in Psychology of Human Intelligence? In Search for Cues to Theory Construction.

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In the 80s, three "systemic" or "plurimetaphorical" major models emerged: the Triarchic Theory (R. Sternberg, 1985), the Theory of Multiple Intelligences (H. Gardner, 1983, *1999*), and the Bioecological Theory (S. Ceci, 1990). Common features of these models are explored – taking the perspectives of the *Loci* of Intelligence identified by R. Sternberg (1986) [internal, external, and their interaction], of the levels of observation and explanation postulated by M. Reuchlin (1995, 1999) [elementarism, holism, and structuralism], and of the ontological foundations or world views proposed by S. Pepper (1942, 1966) [formism, mechanicism, contextualism, organicism, and selectivism]. The systemic nature of the models is discussed, on the basis of W. Overton's metatheoretical conceptualization [split and relational metatheories] (Overton, 1984, 2006).

The line of argument is based on four main points: 1) research on human intelligence is less in need of new theories than in need of a deeper metatheoretical, epistemological and ontological questioning of well established theories; 2) although different paradigms (or metaphors) of research gave rise, in the past century, to different perspectives on, and levels of analysis of, human cognition, the lack of consensus appears far more promising, and heuristic, than a premature effort to articulate the paradigms in complex plurimetaphoric models resistant, to say the least, to current validation tools; 3) tentative efforts to bring together diverse paradigms of research (or different levels of observation and explanation) must, moreover, take into account philosophical foundations (categories/contours, e.g, eclectism, integrativism and systemism), and meanings and implications of each; 4) any complex "plurimetaphoric" theory should prove incremental value, in comparison to the included paradigms or metaphors taken separately, and pass the test of "scientific pertinence and social relevance" (Miranda, 2001), in terms (Messick, 1975, 1980) of construct validity (meaning) and consequence analysis (value).

The discussion of the three systemic approaches to human intelligence in such a framework aims a contribution to clarifying '*where* we stand' and '*where to* we are (or should be) going' in theory development, to reach a better understanding of human intelligence.

Inspection Time in the Structure of Cognitive Abilities: More on Where IT Might Fit

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The journal *Intelligence* has published 55 articles with 'Inspection Time' in the title, the abstract, or as a key word; many of these (e.g., Burns et al., 1999; Burns & Nettelbeck, 2003; Crawford et al., 1998; Osmon & Jackson, 2002; Petrill et al., 2001) have been concerned, one way or another, with the question of which abilities construct(s) inspection time (IT) is related to, or measures. Interest has centred on the extent to which IT is related to general ability, fluid ability, general speed of processing, and visual-perceptual ability. Outcomes remain equivocal with some researchers concluding IT is related to general ability via speed of processing whereas others have concluded that the relationship includes fluid ability. We present new data to assess this question based on a sample of $N = 478$ with an age range from 8 years to 87 years ($M = 28.1$, $SD = 21.7$ years). Participants completed a battery of computerised cognitive and chronometric tests to measure fluid ability (Gf), crystallised ability (Gc), visuo-spatial ability (Gv), working memory (WM), cognitive speed (Gs), and processing speed (Gt). Measurement models assessed the relationships of these constructs with IT for the whole sample and for separate age groups. Relationships of IT with these constructs depend on the age range considered and are more complex than those reported previously.

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The Acute Effects of Amphetamines on Human Cognitive Performance and Information Processing Speed

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Recently there have been claims that acute doses of amphetamines may act as nootropic agents or smart drugs improving cognitive/intellectual performance. In this presentation we assess whether different doses of d-amphetamine and methamphetamine improve cognitive performance across three double blind placebo controlled experimental trials. The results have implications for our understanding of the biological basis-particularly the neurotransmitter basis of intelligence. Improvements in information processing speed, attention and psycho-motor speed were observed due to the amphetamines.

Generated Intelligence Tests: Impact on Scores and Psychometric Properties

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The traditional method of developing intelligence and ability tests involves a long process. Items are carefully handcrafted by human item writers and then give empirical tryout to establish their psychometric properties. Item attrition is often high. Then test forms must be constructed, calibrated, equated and validated. Automatic item generation in the last decade has changed this process considerably. Items are produced by computer algorithms. Under certain conditions, generated items may need little or no empirical tryout, thus creating the opportunity to develop "on-demand" or "on-the-fly" tests. That is, the item generator must include algorithms to 1) produce the diverse items in the domain for a particular ability and 2) adequate prediction of the psychometric properties of new items. Such item generators have been described over the last decade (Bejar et al., 2003; Embretson, 1999).

This current paper examines the psychometric properties of tests produced "on-demand" from an item generator for abstract reasoning (matrix) items. Results from four studies on diverse populations are presented. A major issue is the extent to which the IRT ability scores are impacted by substituting predicted item parameters for calibrated item parameters. Another issue is whether or not the various aspects of construct validity are supported by using "on-demand" tests. The results indicated that ability scores are not greatly impacted by using predicted item parameters. Slight increases in measurement error were observed, which can be offset by increasing the number of test items that are administered. Also, expected relationships for aspects of construct validity were obtained.

Achievement as a Function of New Learning Ability, Knowledge, and Self-Control

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The purpose of the present study was to discover if learning ability, knowledge, and self-control contribute independently to academic achievement. Our previous studies have identified two factors that independently predict success in higher education, one is new learning ability and the other is the extent of one's general knowledge. Recent findings indicate a third determinant of achievement in complex situations, one's sense of self-control. The generality of current findings on any independent role of self-control in achievement is limited by the nature of the samples studied, students at highly selective academic institutions. Does self-control contribute independent variance to the prediction of achievement in samples where a wider range of intellectual functioning and past knowledge is present? The theory guiding the present research assumes that self-control is part of knowledge of the self-gained by the processing of information given by the culture. One learns whether determination and persistence allow goals to be attained. Armed with the knowledge that self-control leads to success, a person may spend more time in study to achieve higher grades. Thus, it is possible that one's sense of self-control may contribute variance, independent of that contributed by intelligence (defined in the present theory as new learning ability) or independent of that contributed by the extent of one's general knowledge, to achievement in complex situations. Specifically, in the two studies reported here, 561 young adults attending either a private university or a community college were tested for their ability to process new information under conditions of equal opportunity for exposure to the information to be acquired, for the extent of their existing knowledge of word uses and meanings, and for their responses to questions about their sense of self-control. Regression analyses revealed that new learning ability, knowledge, and self-control contributed independent variance to the prediction of achievement. Further analyses indicated that race played no differential role in new learning ability or in self-control.

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Work Preferences, Life Values, and Personal Views of Top Math/Science Graduate Students and the Profoundly Gifted: Developmental Changes and Sex Differences during Emerging Adulthood and Parenthood

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Sex differences in vocational interests (Geary, 1998; 2005; Lippa, 1998, 2006), specific abilities (Strand, Deary, & Smith, 2006; Hedges & Nowell, 1995), commitment to work versus to parenting (Browne, 2002, 2004-2005; Rhoads, 2004), and other lifestyle preferences (Hakim, 2000, 2006) have been observed among the general population. In addition, sex differences in vocational interests, intellectual pattern, and commitment to work have been observed among intellectually talented populations (Lubinski & Benbow, 2006; Park, Lubinski, & Benbow, 2007; Pinker, 2008), those most likely to develop into eminent contributors to their fields (Murray, 2003, 2008). The purpose of this study was to ascertain empirically whether sex differences in lifestyle preferences that may contribute to a sex difference in high-level occupational achievement also surface among these highly select groups of intellectually gifted participants during emerging and young adulthood, both on average and as a function of parenthood.

Work preferences, life values, and personal views of top math/science graduate students (275 men, 255 women) were assessed at age 25 and age 35. In Study I, analyses of work preferences revealed developmental changes and sex differences in priorities: Consistent with Guttman (1987), sex differences increased more among parents than among childless participants. This differentiation seemed to be due to changes in mothers' work preferences. In Study II, sex differences in the graduate students' life values and personal views at age 35 were compared with those of profoundly gifted participants (top 1 in 10,000, identified by age 13 and tracked for 20 years: 265 men, 84 women). Again, sex differences were larger among parents.

Across both cohorts, men appeared to assume a more agentic, "telescopic", or career-focused perspective than women did, placing more importance on creating high-impact products, compensation, risk-taking, and being recognized as the best in their fields. Women appeared to favor a more communal, "wide-angle" life perspective, emphasizing community, family, friendships, and less time devoted to career. Although these sex differences among parents in agentic versus communal preferences will likely diminish as their children grow, the sex differences in life priorities present during parenthood anticipate differential male-female representation in high-level and time-intensive careers, even among extraordinarily talented men and women with similar ability-preference profiles and educational experiences.

The Prediction of Scholastic Achievement by Intelligence and Psychoticism is Invariant with Respect to Sex

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Intelligence (abstract reasoning) and three key personality dimensions (psychoticism, extraversion, and neuroticism) were concurrently measured in a sample of 316 students belonging to a broad SES range. Their scholastic differences were assessed by a standardized achievement test (TDE) measuring reading, writing, and arithmetic scholastic skills. Several path models were tested. The results show that (1) controlling for age and SES differences, abstract reasoning and psychoticism predict general scholastic achievement (.41 and -.23, respectively), reading (.38 and -.23, respectively), and writing skills (.39 and -.23, respectively) –arithmetic skills are predicted by abstract reasoning (.31) but not by psychoticism—and (2) this same pattern emerges when boys and girls are compared, suggesting an invariant structure regarding sex. Some theoretical and practical implications are discussed.

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The Dependability of *g*-Factor Loadings: A Partial Replication and Extension of Thorndike's (1987) *Stability of Factor Loadings*

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Thorndike (1987) demonstrated that the *g*-factor loadings of cognitive ability tests exhibit remarkable consistency across analyses using independent batteries. This study was designed to understand better the extent to which the *g*-factor loadings of tests are inherent in the nature of tests when the tests are inserted in varying batteries and when varying factor extraction techniques are used. Using test scores from an individually administered cognitive ability test battery, the Woodcock–Johnson III (WJ III; Woodcock, McGrew, & Mather, 2001; Woodcock, McGrew, Mather, & Schrank, 2003), from nationally representative samples of young adults, 7 probe tests were first inserted into 5 independent batteries of tests. The 7 probe tests were then inserted one at a time into 30 batteries of randomly selected tests. Principal axis factor analysis, maximum-likelihood analysis, and principal components analysis yielded *g*-factor loadings for each probe test. Strong dependability of the *g*-factor loadings across batteries and factor extraction methods was evident. Variance components revealed that variance attributable to the factor extraction method and its interactions was relatively minimal. Although variance attributable to varying test batteries was negligible, psychometric sampling error that stemmed from the interaction between the probe test and the test batteries produced sizeable variance in some analyses. However, variance attributable to characteristics of the probe tests accounted for the vast majority of the variability across *g*-factor loadings. These results indicate that the *g* factor is robust across variations in sampling of its constituents and factor extraction techniques.

The Relevance of Emotional Intelligence for Mental Health and Partnership

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Emotional intelligence seems to be especially important in the domain of non-achievement like for well being, satisfaction, social interaction and partnership (Rindermann, 2008). Deficits in emotional intelligence show influence on development and maintenance of a wide range of mental disorders (Berking et al., in press). In this context the dimensions "recognition of own emotions", "recognition of emotions of others" and "regulation and control of emotions" are of particularly interest.

In path analyses (N=264-509) recognition of emotions, in oneself as well as in others, show a positive effect on regulation of emotions, both of oneself and of others. For mental health are important recognition of own emotions and regulation of own emotions. These results were confirmed by a further path analysis with quality of living as a criterion. But for partnership are only positively relevant recognition of emotions of others and regulation of emotions of others. Further analyses could demonstrate that a *g*-factor of personality (Big Five) seems to depend largely on emotional intelligence.

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Greater Variability in Cognitive Test Scores Amongst Males: Is the Consensus View Correct?

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In the recent APA compendium of expert views on women in science, almost all contributors endorsed the view that there is greater variability in cognitive test scores amongst males (Ceci & Williams, 2007). We present meta-analyses of the progressive matrices, WISC, and WAIS, which show greater male variability on total scores for each of these tests amongst child and adolescent samples, but not amongst adults. For the WISC the variance ratio at 1.117 ($df = 29054/23825$, $p < .001$) favoured males; for the WAIS, there was a non-significant variance ratio of 1.043 ($df = 5393/5587$, $p > .05$); for the Progressive matrices amongst children and adolescents there was a variance ratio of 1.036 ($df = 25643/25431$, $p < .01$) in favour of males, but amongst adults the variance ratio at 1.26 ($df = 1280/2421$, $p < .001$) favoured females. Why do these data differ from some of the most compelling evidence suggesting greater male variability (e.g. Hedges & Nowell, 1995; Deary et al., 2003)? The explanation may reside in the existence of known but largely ignored artefacts, plus the unacknowledged influence of greater male variability in development. The strength of both the Hedges & Nowell (1995) and Deary et al. (2003) findings is that they employed population representative samples. The samples reported here consist of standardization, and, to a lesser extent, random samples. Arguably, both these types of sample are subject to recruitment effects (Hunt & Madyastha, 2007), however, current evidence suggests that such effects are small (Dykiert, Gale & Deary, in press). However, there are three potentially serious problems which may apply to previous studies. Firstly, it is well established that composite scales may well show group differences in variance, which do not exist in the underlying latent traits (Keith, Reynolds, Patel & Ridley, 2007). Secondly, ceiling effects can transform a mean difference into a difference in variance. Thirdly previous studies have not taken account of age effects. All of these difficulties potentially apply to the Hedges and Nowell (1995) and Deary et al. (2003) studies. In contrast, only the problem of composite scales applies to the data presented here. However, it is known that scores on the Progressive matrices are related at better than .99 to the underlying latent trait measured by these tests (Lynn, Allick & Irwing, 2004), and it is arguable that the WISC and WAIS full-scale scores are sufficiently well constructed to be similarly closely relate to *g*. In sum, it may be the case that greater male variability in cognitive test scores applies only to children and adolescents, and that conclusions to the contrary have ignored age effects, artifacts or both.

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The Genetics of Intelligence: Exploring Byways on the Long and Winding Road from High Heritability to Specific Genes

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Intelligence is one of the most stable and reliably and validly measured behavioral traits. It shows good variability in the population and high heritability, as well as genetically mediated correlations among specific cognitive abilities, with a variety of biomarkers, and over time. Despite this, the specific genes involved in intelligence have been very difficult to track down, and at this point we really know nothing about the specific genes involved in individual differences in normal range intelligence. In this talk I will point out some parallels between intelligence and height and show that they present similarly puzzling data. Some of these data indicate that, though at least as heritable as intelligence, height is also quite sensitive to environmental circumstances and may not be the unitary trait we consider it to be. We would be remiss not to consider the possibility that intelligence may have similar characteristics. I will propose several possible explanations for the apparently contradictory data with which we are currently faced and suggest directions for future research.

Sex Differences in Latent General and Broad Cognitive Abilities: Evidence from the DAS-II

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Research on sex differences in cognitive abilities has been generally consistent in showing an advantage for males in visual-spatial ability (Gv), but other findings, such as differences in *g* or crystallized ability (Gc), are less consistent. Inconsistencies in findings may be due, in part, to developmental changes in cognitive abilities, or to the use of subtest and composite scores versus latent factors. Research using composite scores, for example, has often suggested differences in *g* favoring males; in contrast, recent studies using latent variable methods have suggested no sex differences in *g*, or small differences favoring females. The purposes of this research were to determine the presence and magnitude of sex differences in the broad (Gc, Gf, Gv, Gs, Glr, Gsm) and general (*g*) cognitive abilities underlying the Differential Ability Scales, Second Edition (DAS-II), and to determine whether those differences varied by age. Multiple indicator —multiple cause (MIMIC) models were used to investigate sex differences in latent abilities. This approach allows the examination of sex differences in broad abilities while controlling for *g*, as well as sex differences in *g* with the broad abilities considered. It also enables the simultaneous testing of age-related differences in effects across the age levels (ages 5 to 17) by testing for age by sex interactions. Based on previous research, we expected to find sex differences favoring girls on the latent processing speed (Gs) factor, and differences favoring boys on a latent visual-spatial (Gv) factor. Results showed consistent (across ages) differences favoring girls on the Gs, Glr (long-term retrieval), and Gsm (short-term memory) factors. Boys scored consistently higher on the latent Gv factor across ages. No significant differences were shown on the Gf (fluid intelligence) or Gc (crystallized intelligence) factors. In addition, sex differences on the higher-order *g* factor were non-significant, as was the sex by age interaction. The use of crossproducts in a MIMIC model contributes to the methodological literature for studying developmental sex differences. The findings of this research concerning sex differences in Gs and Gv and, to a lesser extent, *g*, are consistent with recent examinations of sex differences in latent abilities. Findings concerning long and short-term retrieval are less common with such research. Results will be interpreted in relation to previous research and relevant developmental theory.

Ethnic Differences on Fluid Reasoning Tests: Is the NNAT the Panacea?

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Nonverbal, figural reasoning tests such as the Raven Progressive Matrices are often used as markers for Gf in research on intelligence. These tests are also widely used in schools to help identify academically gifted students. The Naglieri Nonverbal Ability Test (NNAT) has been particularly popular following a recent report that in a large, representative sample of U.S. school children, it was found to identify equal proportions of high-scoring White, Black, and Hispanic students. Although questions have been raised about the integrity of the data analyses used in this study, the author of the study continues to defend it as the most important research yet conducted with the NNAT. The goal of this investigation was to compare the NNAT with two other nonverbal assessments: the Raven Progressive Matrices and the Nonverbal Battery of the Cognitive Abilities Test (CogAT). All three tests were administered by trained examiners in counterbalanced order to 1,200 children in grades K to 6 in an ethnically diverse school district. Results showed provided no support for the assertion that the NNAT reduced ethnic differences – either at the mean or at the tails of the distribution. Rather, ethnic differences were actually somewhat larger on the NNAT than on the other two tests. Furthermore, it was discovered that the variance of basic normative score on the NNAT (M = 100, SD = 15) substantially exceeded the reported value of 15 at all but one test level. Re-analyses of the standardization data for the NNAT confirmed this finding. A similar normative score on the Raven (computed from the most recent U.S. national norms) was 10 points too lenient. Consequences of invalid or outdated normative scores for research and practice are discussed.

IQs and Income are Lower in the South: The Case of Italy

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Intelligence is positively related to income among individuals, across nations and across regions within nations. Here it is shown that regional differences in IQ in 15 regions of Italy are correlated with average incomes at r = .930. There is a north-south gradient of IQs and income in Italy such that both are lower in the South.

Modeling Racial and Ethnic Group Differences in the General Population from College Admissions Tests

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Racial/ethnic subgroup differences measured on achievement tests used for college admissions (the SAT and the ACT) for decades have often been used to infer the existence of differences in cognitive skills in all members of ethnic groups, not just those who take the test. We show that the decision process of whether or not to take a college admission test differs by racial/ethnic subgroups, and present a simple recruitment model that can be used to estimate the effect of differential recruitment on mean subgroup scores. At a given level of ability, high school students from minority groups are more likely to take a college admission test, decreasing their relative performance in the test-taking population. Using data from the National Assessment of Educational Progress to validate our approach, we demonstrate how group differences in the general population can be estimated from a recruited population, given a fitted recruitment model. The technique also provides a way of bringing two tests into a common metric, without having pairs of test scores for each individual, as is required for regression analysis.

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Inspection Time is a Potential Marker for Memory Decline

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Eighty-five elderly adults (70 to 85 years at baseline) were followed longitudinally for 42 months. They completed the inspection time (IT) task and the Alzheimer's Disease Assessment Scale-cognitive subscale (ADAS-Cog) on four occasions. At time 4, participants were subdivided into three groups based on ADAS-cog performance; higher functioning (0 – 3 errors, n = 38); normal functioning (3 – 6 errors, n = 32); minor impairment (6 – 10 errors, n = 15). Groups were equivalent for several moderating variables, including age. However, IT trajectories over time for these groups were statistically different. The group with only minimal signs of incipient cognitive impairment showed a continuous, gradual increase in IT, whereas ITs for the groups with lower ADAS-Cog scores were stable across time. Although participants with minor impairment were unlikely to meet clinical criteria for mild cognitive impairment, their higher ADAS-Cog scores at time 4 reflected poorer recall and recognition memory. Slowing IT therefore predicts poorer memory performance and is a marker for less favourable cognitive aging.

Bright and Dull People: Their Hormones, Marital Status, Sexuality and Fertility.

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Bright and dull people differ in important ways. The present study concentrates on their hormones, marital status, sexuality and fertility, with point of departure in the common observation that the brightest have the fewest children. This fact is often explained in terms of socio-economic factors or differential use of contraceptive means. However, the present study uses the General Trait Covariance Model (GTC) to test the alternative hypothesis that bright males are sub-fertile for bio-evolutionary reasons.

Through breaking down representative archival cognitive data for 3.556 white middle-aged American males into 7 IQ categories from the normal distribution - from the brightest over normals to the dullest - we first demonstrate that Bright and Dulls differ in plasma testosterone (T) level. We then show that IQ is positively related to a combined achievement index and inversely related to T. More Brights than Dulls are married, but Brights nevertheless have fewer children. Brights display a non-significant tendency for weakened heterosexual arousal and unwanted homosexual arousal. Brights and Dulls have similar semen concentration and number of cells per ejaculation as normals, but some indicators suggest a compromised semen quality. Extreme IQ groups do not differ from Normals in adult Dehydroepiandrostendion (DHEAS) and Gonadotropin values (LH and FSH).

We propose that the brightest males are sub-fertile primarily for biological reasons, and recognize that this may to be the case also for the brightest females. In general, this pattern dovetails nicely with the evolutionary notion of balanced Darwinian selection. In particular, our observations seem explainable in causal terms by a specific ontogenetic bio-energetic economic trade-off between two most expensive developmental parameters: The build-up of neural brain efficiency (as manifested in IQ) and progressive somatic sexual differentiation. The overall bio-energetic budget has to remain balanced. We speculate that national differences in inverse IQ-fertility ratios also reflect aggregated individual differences in such a bio-energetic trade-off.

Creativity and Exceptional Promise: The Other Half of Cognitive Epidemiology

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While cognitive epidemiology has traditionally sought to identify health risk factors associated with individual differences in cognitive abilities, it may also be used to conceptualize base rate changes in positive outcomes. Using data from the Study of Mathematically Precocious Youth (SMPY), a planned 50-year longitudinal study of intellectual talent, we demonstrate how individual differences within the top 1% of cognitive ability are associated with creative expression, not only in the humanities and science but also in business, industry, and leadership roles in global markets. A recent survey of over 3,000 participants, using public internet databases (and modern search engines), and yielded updated information on career accomplishments among intellectually precocious youth initially identified before age 13 and tracked for over 25 years. The human accomplishments and promise typically associated with exceptional cognitive abilities are broader and more heterogeneous than many social scientists realize.

Religious, Social, and Economic Covariates Of State Intelligence

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We examined relationships between state intelligence (IQ; McDaniel, 2006), religiosity, and a variety of economic (e.g., income and poverty levels) and socially-important (e.g., teenage pregnancy and crime rates) outcome variables. The outcome variables were coded from the US census, and then sorted into components using principal components analysis (PCA). Moderate-to-large correlations existed between state IQ and components representing Religiosity (r = -.55), Crime (r = -.77), Education (r = .49), Family and Health (r = .77) , and Economics (r = .52). State religious beliefs, however, were better predictors of a state's overall condition (measured as a General Component via hierarchical PCA) than was state IQ. Specifically, entering state IQ and religiosity as predictors of General Component scores produced an R^2 value of 74%, with beta weights of .246 for state IQ, and -.698 for state religiosity. Implications for intelligence research are discussed.

Psychophoresis and Intelligent Self Assessment (ISA) Scales

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We have developed a technique for the separation of individual relationships among human knowledge, skills, attitudes, and values by three-dimensional Consensus Based Assessment (CBA) Psychophoresis. Given its resolution and sensitivity, this technique is a powerful tool for the analysis and detection of relationships among human attributes, especially cognitive ability. Respondents are separated according to two subordinate attributes in the first two dimensions, and according to a superordinate, but semantically related, attribute in the third dimension. If these two subordinates and superordinates are related, it is possible to obtain a perspective on the stepped variation of higher order relationships among the two subordinates as the superordinate attribute varies. This technique has resolved 1100 different respondents to Likert scaling procedures of attributes related to leadership, and uncovered some surprisingly strong but previously hidden relationships. This presentation will offer a speculative but principled theoretical argument that Psychophoresis extends the range of applicable cognitive ability measures to go beyond general knowledge tests to surveys of opinions and personal values. A detailed description of the methods as well as the characteristics of this system is presented. Additional data is solicited.

* The views presented here do not represent official Army positions or doctrine.

An Investigation of Spearman's Law of Diminishing Returns Using the WAIS-III/WMS-III Norming Data

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Charles Spearman (1927) was the first to report that correlations between mental test scores were lower in higher IQ groups. The phenomenon, often referred to as Spearman's law of diminishing returns (SLODR), suggests that *g* becomes less important in explaining individual differences in mental test scores at higher levels of *g*. SLODR research is an increasingly important area in the measurement of intelligence because one implication of SLODR is that *g* is not measured equally well across the ability distribution. Second, SLODR studies have the potential to help to understand how cognitive ability, specifically *g*, manifests itself in the extremes of cognitive ability.

Several studies have found evidence to support SLODR, but the effect magnitude is not consistent, and a few studies failed to find an effect (Hartmann & Nyborg, 2004). Two areas within SLODR investigations have been of particular interest in explaining the variability in results: the representativeness of the data and the methods used to investigate SLODR. This study will address both issues. First, the standardization sample data from the Wechsler Adult Intelligence Scale-III and Wechsler Memory Scale-III will be analyzed to investigate SLODR, allowing for the study of a wide variety of cognitive abilities using a nationally representative sample. Second, a latent variable methodological approach will be used. Multiple-group mean and covariance structure analysis will be used to test for evidence of SLODR. High and low ability groups will be compared at different age groups. In addition, factor mixture modeling will be applied to the same data. The results will be synthesized across methods and reported in our presentation.

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Relevance of Education and Intelligence at the National Level for Health: The Case of HIV and AIDS

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Studies at the individual level have shown a negative effect of education and intelligence on risky behavior and a positive effect on health (e. g. Goldman & Smith, 2002; Gottfredson & Deary, 2004; Kanazawa, 2006). The same has been demonstrated for risky sexual behavior and for HIV-infection rates in sub-Saharan Africa (e. g. Sanderson, 2004). In path analyses at the country data level cognitive abilities (seen as depending on education) show a strong negative effect on HIV-infection rates, whereas gross domestic product and modernization have a small positive effect (Rindermann & Meisenberg, 2008). Also religion is important. A higher proportion of Muslims in the population reduces the HIV-infection rate. Explanations for the positive impact of education and intelligence include a better understanding of causal relationships between one's behavior and health, greater awareness of future consequences, better behavior control, and more competent management of the problem by governments, e. g. through public education programs about HIV transmission and AIDS.

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Toward a Resolution of the Emotional Intelligence/General Intelligence Debate: Is There a General Factor of Personality (GFP) Analogous to the *g* Factor of Mental Ability?

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In a 2002 book chapter, John B. Carroll suggested how the hierarchical structure of cognitive ability might be generalized to taxonomic problems in personality. In this paper I draw important parallels between cognitive ability and personality, and examine their inter-relations. Little consensus exists on how to conceptualize the factors of personality: There is a Big Two, two Big Threes, a Big Four, two Big Fives, a Big Six, and many lower-order traits such as Cattell's 16 and Jackson's 35. However, just as *g* occupies the apex of hierarchical structure of cognitive ability and has established properties, it has been postulated that a General Factor of Personality (GFP) has many parallel features: (1) The GFP occupies the apex of the organization of personality; (2) the GFP has a clearly defined positive pole (gifted people have high levels of social intelligence) and a negative pole (challenged people have personality disorders); (3) non-additive genetic variance (dominance and epistasis) contributes to the GFP and implies recent natural selection; and (4) studies of inbreeding depression imply directional selection. Since, as Darwin (1871) surmised, people have larger brains, higher levels of intelligence, and more cooperative personalities than "primeval man and his ape-like progenitors," increments in both *g* and the GFP were likely selected because of the greater efficiency they conferred, one in the cognitive domain and the other in the social. Research suggests that individuals high on the GFP are cooperative, open to experience, conscientious, sociable, agreeable, and emotionally stable, with a sense of well being, positive humor style, and high emotional intelligence. Many intriguing questions remain about the relation of *g* and the GFP, which an evolutionary perspective might enlighten.

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Gray Matter and Intelligence Factors: Is There a Neuro-*g*?

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In this study we related cognitive-ability scores based on a hierarchical factor model to regional brain volumes assessed with structural magnetic-resonance imaging (sMRI). Specifically, 21 male and 19 female young adults took a battery of eight cognitive tests and completed sMRI scans. Regional gray-matter volumes (GMs) were determined using voxel-based-morphometry and correlated with factor scores. Results for the *g* factor showed correlations with GMs distributed throughout the brain, with some resemblance to the pattern predicted by Jung and Haier's (2007) Parieto-Frontal Integration Theory. The four group factors showed patterns that were distinct from *g* and from each other.

The results here can be compared to the results of a similar study conducted recently by Colom et al. (in press). The Colom et al. factor model had *g* and Spatial factors in common with the model in this study. Although their Spatial factor showed similar GM correlates to our Spatial factor, the pattern for their *g* factor showed only minimal resemblance to the pattern here. This provides tentative evidence that the *g* factors derived from different batteries may not represent the same variables at a neuroanatomical level if the *g* factors are not derived from comparable group factors.

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Jung, R. E., & Haier, R. J. (2007). The Parieto-Frontal Integration Theory (P-FIT) of intelligence: Converging neuroimaging evidence. *Behavioral and Brain Sciences, 30*, 135-154.

A Test of the Speed-Level Hypothesis in the Domain of Numerical Reasoning

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Suppose a person were asked to answer a set of cognitive test items that were all of the same type (e.g., all verbal analogies) but varied with respect to their difficulty. If the person were given a stringent time limit within which to answer the items, would the person's total number-correct score measure the same ability (or abilities) as would be measured were the person allowed to answer the items without time constraints? We approached this problem as a test of the level-only hypothesis vs. the speed-level hypothesis. . *Level* is the ability that, under self-paced performance conditions, mediates accuracy on tasks drawn from a homogeneous task domain. S*peed* is a hypothetical cognitive ability, distinct from level, that is postulated to co-mediate (with level) sufficiently time-constrained performances of tasks drawn from a homogeneous task domain. The level-only hypothesis---our null hypothesis---states that, on tasks sampled from a homogeneous task domain, a single cognitive ability, level, mediates performance under both self-paced performance conditions and time-constrained performance conditions. The speed-level hypothesis---our alternative hypothesis---states that, on tasks sampled from a homogeneous task domain, when item time limits are sufficiently short, then, in addition to a level ability, one or more speed abilities mediate performance.

We constructed two approximately equivalent test forms, V and W, consisting of 40 free-response numerical reasoning items. Both forms were administered by computer to each member of two independent samples of college students. One of the samples took form V under self-paced conditions and form W under experimenter-paced conditions. Under experimenter paced testing, each test item had an assigned and preannounced time limit. The other sample took form W under self-paced conditions and form V under experimenter-paced conditions. Two latent variable models were fit to each sample's combined self-paced and experimenter-paced item accuracy scores. One of the models yielded a level of performance score for each examinee and the other model yielded both a level of performance score and a speed of performance score for each examinee.

We will present the two models we fit to our data, estimates of score reliabilities, and validity evidence for both level and speed scores. We will also discuss how our approach to eliciting a speed of performance dimension might be improved. The most widely accepted model of the structure of human cognitive abilities---John Carroll's (1993) model---does not recognize the existence of separate speed and level abilities within specific cognitive task domains. Carroll was aware of this possible deficiency, but our work appears to be the only research since Carroll's book aimed at investigating whether the structure of cognitive abilities is more complicated than most abilities researchers currently suppose. Because most existing tests of so-called ability within narrowly defined task domains are administered with a time limit, the science of human cognitive abilities would almost surely be strengthened if researchers were to pay much closer attention to the conditions of task performance.

A Decomposition of Processes Underlying Performance on Raven's Progressive Matrices: A Developmental Study

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Raven`s progressive matrices test (RPM) is a widely used intelligence measure designed to tap fluid intelligence or g. There is a bulk of evidence on processes underlying performance on the Raven's test. Some researchers suggest that a fundamental variable on the solution process of Raven's test is working memory capacity. Carpenter, Just, and Shell (1990) propose two factors in RPM solving ability: available or induced logical rules and number of results stored simultaneously in working memory. Additionally, they argue that individual differences in intelligence could be accounted for by differences on working memory ability. In spite of much research concerning Raven's test, few attempts have been made to study the Raven's matrices solution process in school age children. The present study aimed at investigating the influence of visual working memory on processes underlying solution of the Raven`s Coloured Progressive Matrices (CPM). Children aged 6, 8 and 10 years (N=96) were administered Raven's CPM, Corsi-block test and a figure memory test measuring visual working memory storage (ViWM) and a test consisting of Raven's Progressive Matrices-like items (RPM-like task). The RPM-like task encompasses two conditions. In the first condition, one or two complex geometric figures in the upper side of a computer screen is presented at the same time with one or two rules to be applied to figures located in the middle of the screen and five alternative responses in the lower side of the screen. In the second condition the rule or rules were presented first. Children had to store them and then apply them in the following complex geometric figure or figures. The same battery of tasks was also presented to a group of young adults with the difference of using the Raven's Standard Progressive matrices (SPM) in spite of CPM. Data suggest that performance on ViWM could predict individual differences in RPM solving ability across age groups. At all ages as the number and type of rules that must be held in ViWM increases, the solution process appears to become unstable. Findings are discussed in the frame of current models concerning the relationships of intelligence with working memory.

Examining the Acute Effects of Illicit Drugs on Cognitive Performance

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There is some preliminary evidence that indicate that Huperzine, Vinpocetine, Acetyl-L-Carnitine, and Alpha-Lipoic Acid improve biological processes that underpin normal brain functioning and human intelligence. However most of the evidence is based on either animal or open human clinical trials. This study was a randomized double blind placebo controlled trial designed study in which 70 participants were either given placebo, or Ceretrophin (Huperzine,Vinpocetine and Acetyl-L-Carnitine, R-Alpha-Lipoic Acid, Rhodiola Rosea and Biotin) to take daily for 4 weeks. Significant improvements in performance on the Raven Progressive Matrices as well as several computerised cognitive tasks were observed due to the Ceretrophin treatment at 4 weeks. Implications for the biological basis of intelligence are discussed.

Creativity in Science, Technology, Engineering, and Mathematics (STEM) and its Relationship to STEM Educational Accelerative Dose: A 25-Year Longitudinal Study

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Just as Cronbach (1957) emphasized the importance of different learning opportunities based on individual differences in aptitude, precocious students with potential for STEM innovation need opportunities different from those required by typically developing students. In addition to this, the identification and encouragement of STEM talent has become a national agenda for the United States (American Academy of Arts and Sciences, 2008; American Competitiveness Initiative, 2006; National Academy of Sciences, 2005). In this investigation, pre-collegiate STEM educational opportunities beyond the normal educational fare were quantified as a "dose concept." The relationship of STEM educational dose and its impact on STEM creative achievement (i.e., STEM PhD, STEM tenure, STEM publication and patent) above and beyond ability was assessed longitudinally for over a quarter century, following three cohorts of intellectually talented participants identified as the top 1 in 200 by scoring SAT-M $\geq$ 500 before age 13 (N > 2,500). These findings support the idea that when students are provided with learning opportunities based on their individual differences in aptitude, the accumulation of educational advantage builds over time and eventuates in impressive creative achievements above and beyond what would be predicted by ability alone.

Working Memory and Fluid Intelligence: Alternative Models, Conflicting Conclusions

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Over the past 15 years or so, research on working memory has increased remarkably, representing an area of keen professional interest. Based on seminal work by Baddeley, the working memory system is usually considered to consist of two "slave" systems (a phonological loop and a visuo-spatial sketchpad) that can be used to maintain information in a relatively short term store and a third component – the central executive – that coordinates the flow of information and ensures the retention of key information in the short-term slave system stores.

Beginning about 10 years ago, several research groups have demonstrated the empirical separability of span memory and working memory dimensions. Span memory refers to single task performance, such as digit span forward or digit span backward, in which the participant is provided with a series of stimuli and is asked to report these stimuli back in the same (or reversed) order. In contrast, working memory measures in current use are dual-task procedures. For example, a participant may be required to read a sentence, indicate whether the sentence is correct as stated, and then remember the last word of the sentence. After reading and verifying the correctness of a series of sentences (between 1 and 7 sentences), the participant is asked to report the last word of each sentence in the order in which the sentences were presented. Thus, span memory tasks – consisting of a single task set – are rather simpler than the dual-task approach taken to assess working memory. If three or more span memory tasks and three or more working memory tasks are administered to a sample of participants, two latent variables are required to represent the covariances among measures, and these two dimensions are identified as Span Memory and Working Memory. In theory, Working Memory should be subject to a variance decomposition, consisting of variance due to Span Memory (or simple retention of information in a short-term store) and variance due to the central executive.

Given the preceding, several studies have investigated the relations of Span Memory and Working Memory to Fluid Intelligence. These studies have predicted Fluid Intelligence from a dimension that is common to Span Memory and Working Memory and then found that Working Memory has an extra, or added, relation to Fluid Intelligence. This empirical finding is then interpreted as demonstrating that Working Memory – with its additional variance due to the central executive – is a core component of Fluid Intelligence.

In the current presentation, I discuss the specification and testing of the latent variable models for Span Memory, Working Memory, and Fluid Intelligence. Alternative models can be developed easily for many of the previously published data sets, alternative models that support conclusions that conflict directly with the hypothesis that Working Memory is a key component of Fluid Intelligence. In fact, the reverse direction of influence – that Fluid Intelligence is a key component of Working Memory performance – can often be supported just as well as the previously published findings – often with models that have the same degrees of freedom and the same fit of the model to the data. The upshot is that most work published to date on the relations among Span Memory, Working Memory, and Fluid Intelligence do not provide unique support for the conclusion that Working Memory is a central component of Fluid Intelligence. I will discuss study design and analysis options that could distinguish between competing interpretations of the relations between Working Memory and Fluid Intelligence.

Patterns of Cognitive Ability in Impaired Adults

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Knowledge about the patterns of cognitive strengths and weaknesses associated with various clinical diagnoses, including site of lesion, is informative for both clinicians and those conducting research with these populations. This report summarizes some varied patterns of cognitive strengths and weaknesses observed in 1755 adult subjects, age 19 to 95, with diagnoses across 34 clinical areas (*e.g.*, closed head injury, dementia, seizures, anxiety). Additionally, 472 of these subjects present with brain lesions identified in one or more locations (*e.g.*, bilateral anterior, right frontal, left temporal).

Data is based on scores from various subsets of the 53 Woodcock-Johnson cognitive and achievement tests. Some data are based on scores from the Woodcock-Johnson III (2001) battery, other data are based on scores from the Woodcock-Johnson Revised (1989) battery. WJ-R scores were transformed into equivalent WJ III scores, then merged into the WJ III clinical data set. Results are reported in units of the *W* transformation of the Rasch logits scale. Rasch scaling allows reporting, along an equal interval scale, of differences in quality of performance between a clinical group and a demographically-matched control sample. Findings are discussed in the context of broad and narrow CHC (Cattell-Horn-Carroll) abilities.

The first research question addresses whether a single subset of tests can be identified that is generally sensitive to the presence of cognitive impairments across a wide range of clinical groups. It is proposed that the following four tests may serve this purpose: Rapid Picture Naming (*Gs*/NA), Auditory Working Memory (*Gsm*/WM), Visual-Auditory Learning (*Glr*/MA), and Number Matrices (*Gf*/RQ).

The second research question addresses the differential patterns of cognitive strengths and weaknesses associated with specific clinical groups. Results are reported for several groups, including some with an identified site of lesion. It will be noted that the four tests listed above as the most sensitive across the clinical spectrum are generally the most sensitive for any narrow clinical condition. Implications of these finding will be discussed.

Symposia

Symposium (Thursday, 8:20-10:00) Working Memory
Organizer: Randall Engle

The Neural Bases of Working Memory Span Performance

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Working memory (WM) span tasks are reliable and valid measures of WM capacity, which is strongly related to general fluid intelligence. Here we explored the neural bases of both verbal and spatial WM span performance using fMRI. Results suggest that brain regions typically associated with attention control (prefrontal cortex, anterior cingulate cortex, and parietal regions) were engaged during the encoding and maintenance stage of WM span, while areas associated with memory retrieval (prefrontal cortex and hippocampus) were engaged during the recall stage. Moreover, the same regions were active in both verbal and spatial WM span, suggesting they support domain-general processes.

Symposium (Thursday, 8:20-10:00) Working Memory
Organizer: Randall Engle

Working Memory Capacity, Attention Control, and Mind Wandering

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Prior research indicates that WMC variation predicts executive-control task performance because lower WMC individuals fail to keep novel goals accessible in the face of competition from habit. Here we explored whether such "goal neglect" results from failures to keep conscious thoughts on task goals, which subjects experience as mind wandering. In both laboratory and daily-life studies, we probed subjects' thoughts at random intervals and found that WMC predicts mind wandering and that, in accord with executive-attention theory (e.g., Engle & Kane, 2004), this association is partially responsible for the WMC-executive control relationship.

Symposium (Thursday, 8:20-10:00) Working Memory
Organizer: Randall Engle

Individual and Age Differences in Working Memory Capacity, Processing Speed, and Intelligence: Insight from Eye-Movement and Psychometric Analyses

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Research has focused on the potential cognitive determinants of individual and developmental differences in intelligence. Two competing views influenced by information-processing theory propose important roles for the constructs of working memory capacity and perceptual speed, respectively. Evidence for the importance of working memory capacity is based primarily upon differential research in young adults, whereas developmental research has provided most of the support for proponents of the processing speed view. The studies reported here aimed to clarify the relationship between these constructs in a number of different ways.

First, although paper-and-pencil processing speed tasks have been prominently used for nearly a century, very little is known about the processes that are actually important for performance on these tasks. We developed computerized versions of comparison tasks that are commonly used as processing speed measures. During performance of the tasks, eye movements were recorded from each participant. Older adults responded slower than young adults did, even when comparing one letter. The eye-movement data corroborated this finding, with older adults exhibiting longer fixation durations than young adults while performing the processing speed task.

In addition, individual differences in working memory capacity within young adults were examined. Previous research with paper-and-pencil processing speed tasks has provided inconsistent results in regards to the interrelationships of working memory capacity, processing speed, and intelligence, and few studies have examined these constructs specifically within young adults only. The results indicated that individual differences in working memory capacity were not important for performance of the computerized processing speed task using a presentation similar to that of the paper-and-pencil versions. However, when distractors were introduced among the items to compare, individuals low in working memory capacity responded slower than individuals high in working memory capacity. In addition, those low in working memory capacity made more fixations and more back-and-forth switches between the comparison stimuli. These results indicated that working memory capacity and processing speed were related only when selective attention was necessary to deal with the interfering distractors.

Finally, tasks containing verbal, numerical, and spatial content were used as indicators of working memory capacity, processing speed, and intelligence constructs in a large sample of young adults. These analyses indicated that working memory capacity and processing speed make unique contributions in predicting intelligence, despite previous research suggesting that processing speed mediates the working memory-intelligence relationship. The discussion will focus on the importance of the sample tested, the cognitive processes involved in the measures utilized, and the implications of this research for both differential and developmental psychology.

Symposium (Thursday, 8:20-10:00) Working Memory
Organizer: Randall Engle

The Role of Working Memory Capacity in Skilled Performance

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There is ample evidence that a high level of working memory capacity (WMC) is a key ingredient for success in a wide range of laboratory tasks, both complex and simple. However, little is known about the role of WMC in performance of tasks where knowledge plays an important role. We report evidence from two studies that the predictive power of WMC is not limited to novel tasks, but rather it predicts success at high levels of skill, even among performers with thousands of hours of practice in a given domain.

Symposium (Friday, 8:00-10:00) The Flynn Effect
Organizer: Jan te Nijenhuis

Overview: Recent Advances in Research on the Flynn Effect

Secular score gains in IQ test scores are one of the most intriguing and controversial findings in the recent psychology research literature. This symposium includes some of the latest findings from studies on the Flynn effect, with studies from Germany, South Africa, South Korea, Norway, Great-Britain, and the U.S.

Jan te Nijenhuis, Sunhee Cho, Raegan Murphy, and Kunho Lee are the first to present a large number of studies from South Korea, showing a strong secular score gain. Tests used were Korean adaptations of well-known U.S. tests. They also present data showing that at the same period the secular gains in length were large, as were the secular gains in education.

Raegan Murphy, Jan te Nijenhuis, and van Renee Eeden are the first to present a large number of studies from South Africa. Of specific interest is a comparison between the test scores of Afrikaans-speaking and English-speaking Whites, going back to people born in the 1890s.

Siew Ang and Joe Rodgers' research involved using the NLSY-Children data (N = 12,000). They have expert ratings of the content of the 84 PIAT-Math items, and correlate this content with the size of the Flynn Effect in the items themselves.

Alex Beaujean and Yanyan Sheng are looking at the Flynn Effect in the vocabulary section of the General Social Survey (GSS). Since the GSS gives item data, they are examining parameter drift (invariance) across about a decade or so of data. Then the latent trait scores are compared with the manifest (summed) scores.

James Flynn's recent book on secular score gains is strongly influenced by the work of the German sociologist Georg Oesterdiefhoff. Oesterdiekhoff studies the Flynn effect from a Piagetian perspective, suggesting that mean IQ scores in 17th century France, Britain, the Netherlands, and Germany were 50, implying that secular score gains are much stronger than once thought. The theory is illustrated with various examples.

Mike Mingroni will discuss heterosis as a cause of the Flynn effect. It will be shown through stochastic modeling that there is currently no theoretical upper limit on the potential contribution of heterosis on IQ gains. The models build on those presented in Mingroni (2007), with a new emphasis on the critical distinction between within-community and between-community phenomena.

Jim Flynn tries to make sense out of the recent IQ trends in the United Kingdom on the Raven's, Piagetian tests, and the WISC. The fascinating thing about the pattern of the Raven's gains is that, as children age, they appear at the top and slowly spread over more and more of the curve. This seems to signal the spread of a "habit of mind" from the brightest to the whole population.

Richard Lynn will serve as a discussant.

ISIR, 2008

Symposium (Friday, 8:00-10:00) The Flynn Effect
Organizer: Jan te Nijenhuis

The Flynn Effect in Korea

Jan te Nijenhuis[1], Sun Hee Cho[2] , Raegan Murphy[3], and Kun Ho Lee[4]

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Secular score gains have been studied thoroughly in Western countries, but only in a few Asian countries, namely China and Japan. Te Nijenhuis, Cho, Murphy, and Lee are the first to present a large number of studies from South Korea. Although the Dutch have shown the largest Flynn gain in the world on Raven's Progressive Matrices (Flynn, 1987), the largest gains in the world on a broad IQ battery are recorded in Japan, shortly after World War 2 (Lynn & Hampson, 1986). Are the gains in Korea comparable to the gains in Japan?

Many samples were collected. Tests used were Korean adaptations of well-known U.S. tests. The Kodae-Binet (1971) is based on the Stanford-Binet, the KWIS (1963) is based on the WAIS, the K-WAIS (1992) is based on the WAIS-R, the KEDI-WISC (1986) is based on the WISC-R, and the K-WISC-III (2001) is based on the WISC III.

The combined data show a strong secular score gain, about twice the size as the gains in Western countries. We will also present data showing that at the same period the secular gains in length were large, as were the secular gains in education. South Koreans are still gaining in length, which might mean that IQ gains are still continuing.

Symposium (Friday, 8:00-10:00) The Flynn Effect
Organizer: Jan te Nijenhuis

The Flynn Effect in South Africa

Raegan Murphy[a], Jan te Nijenhuis[b], and Renee van Eeden[c]
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Secular score gains in IQ test scores provides a fertile area for investigation in an often contested research domain within intelligence assessment. Results from Africa are sparse when contrasted with global research. This study highlights the findings of score gains in South African datasets dating to cohorts born around the 1890s with particular emphasis on English- and Afrikaans-speaking people. South Africa's robust testing tradition has yielded high-quality datasets assessing all ages across all four cultural groupings in the country including sample sizes of up to 40,000. The data relies on representative samples from datasets utilized in norm studies of popular mainstream intelligence batteries such as the WAIS. The majority of test batteries sourced are locally developed and normed intelligence tests widely used in South Africa. The heterogeneous demographic make-up of samples used makes for an enriched database from which preliminary conclusions indicate a Flynn effect. Datasets were classified according to modified criteria as originally specified by Flynn in terms of usability and were analyzed in two ways: studies where two different groups take the same test, with several years in between, using representative or comparable samples and studies where the same group takes two different test batteries at a specific time. The Flynn effect in South Africa parallels findings from studies in both Western and non-Western countries showing a marked trend towards increasing score gains across the decades. The findings from English- and Afrikaans-speaking people evidence a leveling out of differences in score gains across time.

Symposium (Friday, 8:00-10:00) The Flynn Effect
Organizer: Jan te Nijenhuis

Putting the Flynn Effect Under the Microscope: Item-Level Patterns in the NLSY PIAT-Math Scores

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The Flynn Effect (Flynn, 1984, *Psychological Bulletin*) refers to systematically increasing IQ scores over time, a phenomenon identified in many developed (and some underdeveloped) countries over the past century. Rodgers and Wanstrom (2007, *Intelligence*) identified a Flynn Effect in the PIAT-Math scores from the NLSY-Children (NSLY-C) dataset from the U.S., for nine different ages over the period from 1986 to 2002. This finding supports more specific investigation of the Flynn Effect in the NLSY.

In the current paper we evaluate the Flynn Effect at the item level in the PIAT-Math scores. Items are scaled in terms of their Flynn Effect pattern. A number of items show the Flynn Effect, and some do not; the item-level unstandardized regression slopes are indicators of the size of the Flynn Effect, measured for nine different ages for each of the 84 PIAT-Math items. Following, the Flynn Effect slopes are correlated with expert ratings of the item domains in relation to matching, recall, computation, spatial orientation, reasoning, geometry, algebra, and counting. Flynn Effect patterns correlate most strongly with reasoning and counting domains. The reasoning domain referred to items that involved real-world application of quantitative reasoning. Examples of Flynn Effect items, and of negative Flynn Effect items, are presented for inspection in relation to several of these item domains.

ISIR, 2008 Symposium (Friday, 8:00-10:00) The Flynn Effect
Organizer: Jan te Nijenhuis

Examining the Flynn Effect in the General Social Survey via Latent Variable Modeling

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The Flynn Effect (FE) has been a source of interest for intelligence researchers for almost three decades. During that time, much research has shown that cognitive ability has shown a general increase over much of the 20th century. However, most of these studies utilized classical test theory (CTT) measurement, which might not be adequate (Borsboom, 2005), especially when investigating the FE. Not only does CTT not allow for an assessment of invariance across cohorts, but it cannot tease apart if the change in group means is due to a change in the people taking the tests, a change in the instrument's properties, or perhaps a change in both.

Latent variable modeling of cognitive ability measures, however, allows the researcher to transcend the issues inherent in CTT. To date, there has been very little investigation of the FE using latent variable modeling (e.g., Beaujean & Osterlind, 2008; Must, te Nijenhuis, Must, & van Vianen, in press; Wicherts et al., 2005). What they have found is that assuming cognitive ability instruments are invariant over time is not tenable. Moreover, although not an ubiquitous finding across all studies, Beaujean and Osterlind found that, once their model accounted for item bias, the FE all but went away. Consequently, there is a need to do more investigation into the FE via latent variable modeling.

The current project will examine the FE in the Vocabulary test of the General Social Survey (GSS) across four decades (1970's-2000's). The GSS is an interview conducted on a randomly-selected sample of non-institutionalized adults in the United States. We will apply a latent variable model to the data and compare the latent trait scores and the manifest scores across the four decades. In addition, we will examine the individual items to see if there are any discernable patterns in item properties across time.

Beaujean, A. A. & Osterlind, S. J. (2008). Using Item Response Theory to assess the Lynn-Flynn Effect. *Intelligence*, 36, 455–463.

Borsboom, D. (2005). *Measuring the mind: Conceptual issues in contemporary psychometrics*. Cambridge: Cambridge University Press.

Must, O., te Nijenhuis, J., Must, A., & van Vianen, A. (in press). Comparability of IQ scores over time. *Intelligence*.

Wicherts, J.M., Dolan, C.V., Hessen, D.J., Oosterveld, P., Baal, G.C.M. van, Boomsma, D.I., & Span, M.M. (2004). Are intelligence tests measurement invariant over time? Investigating the nature of the Flynn effect. *Intelligence, 32,* 509-537.

Symposium (Friday, 8:00-10:00) The Flynn Effect
Organizer: Jan te Nijenhuis

The Flynn Effect has Deeper Grounds and More Consequences Than Uusually Assumed

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Two approaches can be distinguished in intelligence research, namely psychometric intelligence research and developmental psychology. First, cross-cultural intelligence research of the past 100 years found out that the intelligence of pre-modern populations lies in a range between 50 and 70 no matter whether they come from Africa, Asia, America, Australia or Europe. Secondly, more than 1000 empirical studies, carried out in the frame of Piagetian Cross-Cultural Psychology of the past 70 years, failed in identifying formal-operational structures among pre-modern populations living in remote and illiterate milieus in developing countries. Preoperational and concrete-operational structures describe the top of the psychic-cognitive development of pre-modern populations. Thus, both main approaches of intelligence research come to the conclusion that the cognitive maturation of pre-modern populations stops at qualitative levels typical for children around the globe. All peculiarities and characteristics of children´s cognitions, approximately between their fifth and tenth year of age, are also the prevailing elements among pre-modern adults across the continents and world cultures. Children and pre-modern adults share their adherence to animism, magic, witchcraft, religion, and artificialism, have the same concepts of time, space and further physical concepts, and reveal the same deficiencies in social and moral attitudes and behaviour. For example, the cruel customs and manners within the punishment law across all pre-modern societies stem from immature cognitive structures. Phenomena such as cannibalism, the Roman games, slavery, the belief in witches and sorcerers, and the superstitious customs and religious rituals of ancient societies must be understood in terms of preoperational concepts developmental psychology has described to be typical for children. On the contrary, the rise of the physical sciences, the era of enlightenment, and the breakthrough of modern industrial societies correspond to the cognitive maturation of humankind that both approaches of intelligence research have described. Thus the Flynn effect refers not only to the rise of IQ scores but also to the historical evolution of formal operations. It is the same story measured by two different approaches which confirm each other.

The childlike psyche and respectively the lower forms of intelligence across pre-modern cultures account for the strange customs and manners, practices and ideologies ethnography and history have described. Intelligence research therefore has a much higher capacity to explain social structures and patterns of cultural and world history than social sciences really know. The preoperational structures illuminate so many social, cultural, and ideological patterns of pre-modern cultures that it is astonishing to observe how social sciences and history have overlooked the role of developmental psychology and intelligence research so far. Additionally, only these cognitive approaches can explain us the very nature and the decisive causes for the rise of modern industrial societies. Their rise is systematically linked to the cognitive maturation of humankind. The historical importance of the maturation of intelligence and personality can´t be exaggerated.

Symposium (Friday, 8:00-10:00) The Flynn Effect
Organizer: Jan te Nijenhuis

Heterosis as a Cause of the Flynn Effect

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The genetic factor heterosis has been mentioned as a possible partial cause of the Flynn effect by numerous researchers. Several characteristics of the Flynn effect give it a profile that is incompatible with environmental change, making heterosis the ideal causal factor. It will be shown through stochastic modeling that there is currently no theoretical upper limit on the potential contribution of heterosis on IQ gains. In particular, the relatively small effect of inbreeding on IQ (3 points in the offspring of first cousins) places no definitive limit on the potential effect of heterosis because inbreeding studies are essentially within-community studies, while heterosis results from between-community mating. That is, genetic differences among communities could be large relative to within-community differences. The models build on those presented in Mingroni (2007), with a new emphasis on the critical distinction between within-community and between-community phenomena. Approaches to testing the heterosis hypothesis are discussed.

Mingroni, M. A. (2007). Resolving the IQ paradox: heterosis as a cause of the Flynn effect and other trends. *Psychological Review, 114*(3), 806-829.

Symposium (Friday, 8:00-10:00) The Flynn Effect
Organizer: Jan te Nijenhuis

Recent IQ Trends in the United Kingdom: Making Sense out of Raven's, Piagetian Tests, and the WISC

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The fascinating thing about the pattern of the Raven's gains is that, as children age, they appear at the top and slowly spread over more and more of the curve. This seems to signal the spread of a "habit of mind" from the brightest to the whole population. Britain joins the US, Argentina, and Estonia as developed nations in which IQ gains are still robust, in contrast to Scandinavia where they have ended. It also drives home the general message that cognitive tends need not go in tandem. Both WISC subtests and Piagetian tasks show a combination of gains and losses. Finally, the peculiar pattern of trends in the UK should set off some alarm bells about the future of mathematical reasoning.

Symposium (Saturday, 1:30-3:15) Causal Models that Integrate Literacy, *g*, and Health Outcomes: A Practical Guide to More Effective Disease Prevention and Health Promotion?
Organizer: Linda Gottfredson

Symposium Overview

Low health literacy is now recognized as an important barrier to good health (e.g., *Surgeon General's workshop on Improving Health Literacy*, 2006). Moreover, the U.S. Department of Education's surveys of functional literacy (Kirsch, Jungeblut, Jenkins, & Kolstad, 1993), including health literacy (Rudd, 2006), suggest that about half of American adults are severely challenged by the literacy demands of modern life and modern health care. Research on the relation of health literacy to morbidity, mortality, and health costs has confirmed that individuals with lower literacy have poorer health and higher health care costs, all else equal (Davis, 2006). Literacy is correlated with a variety of other risk factors, such as poverty, but it appears to have independent causal importance. Various federal agencies have therefore undertaken projects to improve patient literacy and to craft communication strategies that better serve the needs of low-literacy citizens.

Health literacy is "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions" (*Health People 2010*). It is a species of functional literacy—"complex information-processing skills" (Campbell, Kirsch, & Kolstad, 1992) or "the ability to understand, analyze, interpret, and evaluate written information and apply fundamental principles and concepts" (Baldwin, Kirsch, Rock, & Yamamoto, 1995)—for preventing illness and injury, managing illnesses and injuries when they occur, and adhering to treatment. That is, it is a highly general cognitive capability. In this respect, literacy closely resembles the general mental ability factor ("*g* factor"), discovered by psychologists because it, too, represents a general proficiency at learning, reasoning, and problem solving, almost without regard to content.

Individual differences in *g* are captured well by many tests of cognitive ability, but especially tests of general intelligence. Decades of research have shown that cognitive ability, in turn, is a consistent and moderately strong predictor of learning and achievement in school and jobs, especially when the tasks to be performed are more complex (Hunt, 1995; Schmidt & Hunter, 1998). More recently, cognitive epidemiologists have also been documenting pervasive correlations for IQ with healthier behavior, less morbidity, and longer life. At the same time, literacy surveys have been showing that functional literacy predicts many everyday outcomes (e.g., occupation, poverty) in a pattern mirroring that for IQ.

The apparent conceptual and functional overlap of the two phenomena, health literacy and *g*, suggests that the insights generated by their distinctive literatures might be synergistic. This symposium explores that promise. First, a leading researcher from each tradition will summarize evidence on the causal importance of their field's core cognitive construct (literacy or *g*) and the possible mechanisms by which it would influence health. Next, a second researcher from each tradition will describe how their field's understanding of such causal processes are being used, or could be, to lower the cognitive barriers to good health that put less literate individuals at special risk today. All presenters will speak to possible synergies in approach. Intervention strategies discussed will range from changing patients (improve learning and literacy), changing the self-care tasks they must perform (reduce task complexity), and providing supplementary cognitive assistance to bridge risky gaps between patient capacity and task demands (more instruction, monitoring, feedback, and follow-up).

Symposium (Saturday, 1:30-3:15) Causal Models that Integrate Literacy, *g*, and Health Outcomes: A Practical Guide to More Effective Disease Prevention and Health Promotion?
Organizer: Linda Gottfredson

Literacy and its Impact on Health: An Overview

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Health literacy has been defined by the Institute of Medicine and National Library of Medicine in the United States as the "degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions." While this definition and that of functional literacy skills clearly suggests that health literacy is a multifaceted concept, reading ability has implicitly, if not explicitly been viewed as its most fundamental component in healthcare research. The term itself arrived and became part of the U.S. public health lexicon during the 1990's, although investigations of whether patients possess the necessary skills to process, comprehend, and act on available health information had been conducted for some time before then. What began as a handful of studies evaluating associations between poor reading ability and health knowledge and behaviors since has expanded to an independent field of study. Currently, there are now approximately 1,600 health literacy-related publications; although a large proportion of these simply address the high readability of health materials. In the United States, where the term was conceived and the clear majority of research performed, the federal government has identified improving the *health literacy* of Americans as a priority for national public health efforts.

In this presentation, the body of research defining health literacy, comprising the various associations between adult literacy skills and health outcomes, is broadly reviewed. Specifically, brief measures of reading fluency and health vocabulary have been linked to problems with the use of preventive services, delayed diagnoses, understanding of one's medical condition, adherence to medical instructions, self management skills, physical and mental health, and increased mortality risk. The nature of these relationships will be examined in detail and likely causal pathways discussed.

Many investigators are also now beginning to question whether the most commonly used tests in health literacy research are actually measuring cognitive abilities, and if cognition may be the actual causal factor that adversely affects health behaviors and outcomes. Parallels will be drawn linking the extent and associations of health literacy research to the evidence gathered in the field of cognitive epidemiology.

Symposium (Saturday, 1:30-3:15) Causal Models that Integrate Literacy, *g*, and Health Outcomes: A Practical Guide to More Effective Disease Prevention and Health Promotion?
Organizer: Linda Gottfredson

Designing Interventions to Mitigate the Relationship Between Literacy and Health.

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Lower literacy is associated with worse health in a variety of different illnesses and contexts. However, literacy is strongly associated with several other characteristics that are also associated with worse health, such as socioeconomic status, insurance status, difficult competing life demands, and ability to complete complex tasks. Moreover, literacy can affect several steps in the process needed to produce good health outcomes. For example, a person with diabetes needs to learn several self-care tasks, obtain health and medication insurance benefits, arrange for visits to the physician, and carry out all their normal life tasks. Having low literacy can make all of those steps more difficult and more prone to error.

Much of the advocacy for interventions for people with low literacy aims toward making written materials easier to read. Although this is important, it is critical that we address the underlying tasks needed to succeed in the health care environment. Rather than just rewriting information in a form that uses more common words or translating written words to videos, we must distill tasks to the bare essentials and create simplified algorithms. Often times, we have found that health care tasks are made unreasonably complex and they create too many opportunities for error.

Once the task is adequately simplified, the role of the health care system is to adequately train an individual patient to carry out the task with low error rates. We have found that such support requires repetition and reinforcement of skills-based education. We often refer to this approach as teach-to-goal where the goal is demonstrated knowledge and ability to carry out the task.

In this presentation, I will review interventions that mitigate the effects of low literacy on health outcomes, and give examples of interventions that appear successful in the contexts of diabetes and heart failure. Interventions described in this presentation represent multifaceted approaches to improving outcomes.

Symposium (Saturday, 1:30-3:15) Causal Models that Integrate Literacy, *g*, and Health Outcomes: A Practical Guide to More Effective Disease Prevention and Health Promotion?
Organizer: Linda Gottfredson

Next Steps in Charting the Influence of Intelligence on Health: Intelligence, Neuroticism, and Mortality in Vietnam-era Veterans

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A recent meta-analysis indicated that higher intelligence is related to longevity and that these findings cannot be explained by reverse causality. Moreover, this meta-analysis found mixed evidence for the mediation of these effects by socioeconomic status. A recent literature review indicates that, while not true for all studies, Neuroticism, a personality trait related to depression, anxiety, and negative affect, is related to mortality. Given the impact of intelligence and personality on longevity, it is surprising that few studies have examined both variables and that no study has considered the possibility of interaction effects. In the present study, we used covariate structure modeling to test whether intelligence, Neuroticism, or their interaction were related to mortality. We also tested whether intelligence or Neuroticism effects were mediated by socioeconomic status, physical health, mental health, or health behaviors. Participants were 4,200 male Vietnam-era veterans who took part in telephone interviews, medical examinations, and psychological evaluations. Intelligence was measured at induction via the Army General Technical Test and 17 years later during the psychological examination via the two Wechsler Adult Intelligence Scale subtests. Neuroticism was derived from responses on the Minnesota Multiphasic Personality Inventory, also measured during the psychological evaluation. Participants were followed up for over 15 years. After adjusting for age, ethnicity and marital status, high Neuroticism and low intelligence were risk factors. Moreover, participants high in Neuroticism and low in intelligence were particularly at risk. We then examined possible mediator effects and found that socioeconomic status and physical health variables attenuated the effect of intelligence but not Neuroticism. In a final set of models we found that intelligence was related to mortality solely via its effects on health, income, and education.

Symposium (Saturday, 1:30-3:15) Causal Models that Integrate Literacy, *g*, and Health Outcomes: A Practical Guide to More Effective Disease Prevention and Health Promotion?
Organizer: Linda Gottfredson

How Intelligence Research Can Guide Interventions to Reduce Error Rates in Health Self-Management

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Scientists know a lot about how individuals differ in cognitive ability as well as how those ability differences correlate with the other sorts of variation difference among them: family background, specific talents and behaviors, cumulative life achievements, and more. The resulting pattern of correlations is not only highly regular but also essentially the same no matter how cognitive ability is measured: functional literacy, work literacy, health literacy, intelligence, or some other indicator of overall learning and reasoning ability. This convergence of results is as extraordinary as it was unexpected, because the three bodies of literacy research emerged independently of each other and of intelligence research. It points to some very general, deep, and enduring phenomena at work. Although intelligence researchers have only recently begun to look into health outcomes, the field's thick nomological network of evidence in other realms of life yields law-like empirical regularities that, if exploited, could quickly advance research and intervention for improving self-care.
Two such "deep" patterns are relevant to health research: (1) the relatively simple structure underlying the seemingly myriad differences among us in specific knowledge, skills, and abilities (KSAa), and (2) the even simpler structure of how life tasks differ in their requirements for cognitive ability. Discovery #1 concerns how *persons* differ in cognitive ability: primarily in a domain-general aptness in learning, reasoning, and processing information of all types (*g*). All cognitive tests can be ordered by how well they correlate with this core ability (how "*g* loaded" they are). Discovery #2 concerns how *tasks* differ in cognitive difficulty: primarily in the complexity of the information that must be accurately processed, (amount of information to be integrated, inferences required, ambiguity, etc.), not in its manifest content (verbal, spatial, etc.) or mode of delivery (written, spoken, observed).

Together, these two generalizations can be used to predict the matrix of likely error gradients in any task domain: error rates steadily rise, for any given task (e.g., A1c control), at successively lower levels of patient learning-reasoning ability, and error rates steadily rise in any given population (e.g., average literacy) as task complexities increase. Stated another way, cognitive ability influences *susceptibility* to error, and task complexity increases *cognitive load* and hence incidence of error. Importantly, the relative risks for low-ability individuals rise dramatically as cognitive load increases. Health self-care and self-management of chronic disease can all be conceptualized—like jobs are—as ever-evolving constellations of tasks which patients must perform satisfactorily to prosper. Conducting complexity audits of diabetes self-management and other such "jobs" in self-care might help providers and policy makers target scarce resources at the most prevalent, costly, or deadly cognitive errors in patient populations of different average literacy levels.

Symposium (Saturday, 10:20-12:00) Three Perspectives on Sex Differences in Cognitive Abilities
Organizer: Wendy Johnson

Symposium Overview

Controversy about the existence and interpretation of sex differences in cognitive abilities has persisted since the earliest empirical research on individual differences. Despite massive change in the role of women in society during the last 100 years and evidence that males and females show declining or negligible mean differences in overall ability, there are persistent sex differences in specific abilities and women continue to be underrepresented in the most selective math and science fields and among those receiving very high scores on ability tests. This fuels both suggestions that there may be hard-wired biological differences between the sexes that contribute to sex differences in abilities and charges of continued discrimination against women. This symposium will address the question of sex differences in cognitive abilities from three perspectives. Joni Lakin will present data from the 1984, 1992, and 2000 standardization samples of the Cognitive Abilities Test that show very consistent patterns of sex differences in variability for specific aspects of ability and discuss how the may be affected by peculiarities of test construction. Sheri Berenbaum will discuss how sex hormones may affect various kinds of cognitive abilities at different points in the lifespan. Diane Halpern will discuss how different perspectives and theoretical orientations affect psychologists' evaluations of sex differences data that are often subject to multiple interpretations. Wendy Johnson will summarize and conclude, drawing from evolutionary explanations for greater male than female variability as well as recent psychometric studies demonstrating the difficulty of establishing measurement invariance in batteries of intelligence tests not just by sex but also by dimensions of abilities such as verbal-spatial and focus-diffusion.

Symposium (Saturday, 10:20-12:00) Three Perspectives on Sex Differences in Cognitive Abilities
Organizer: Wendy Johnson

Sex Differences in Variability on the Cognitive Abilities Test: Real or the Result of Test Construction?

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We investigated sex differences in the distribution of cognitive abilities using national standardization data for the 1984, 1992, and 2000 forms of the Cognitive Abilities Test (CogAT). We expected sex differences in the proportion of examinees with extremely high scores to decrease across the three cohorts, consistent with observed trends in achievement. Within each of these cohorts, we also expected to see increases in male/female variance ratios and/or increases in sex differences in mean quantitative and nonverbal reasoning throughout adolescence (also similar to what is seen for achievement tests). Contrary to our expectations, we concluded that there was surprising consistency in score distributions across the three standardization samples and across grades within each sample. Moreover, our results were very consistent with those of a previous study using the British version of this test in the UK. The consistently greater male variability resulted in the overrepresentation of males at both extremes of the ability distribution across grades and standardization cohorts.

We investigated how test development might impact the observed pattern of sex differences. The issues considered included the range of item difficulty across grade levels, the impact of differential rates of cognitive development on test norms, and the specific types of skills required by the tests. Although the nuances of test construction are usually overlooked in research on sex differences, how tests are built can mask or exaggerate differences in the performance of males and females. Discovering whether the peculiarities of test development contribute to observed patterns of sex differences is important to uncovering substantive differences in abilities between males and females.

Symposium (Saturday, 10:20-12:00) Three Perspectives on Sex Differences in Cognitive Abilities
Organizer: Wendy Johnson

Sex Hormones and Cognitive Sex Differences

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Sex hormones (androgens and estrogens) contribute to cognitive abilities that show sex differences. The cognitive effects of sex hormones in human beings parallel effects reported in other mammalian species. Hormones influence cognition in two primary ways: by producing permanent (organizational) changes to the brain during prenatal and neonatal life (and perhaps also in adolescence), and by producing temporary (activational) alterations to neural circuitry in adulthood.

Hormone effects on cognition are studied in both clinical samples, such as individuals with endocrine disorders, and samples of normal individuals with variations in hormones, such as those associated with the menstrual cycle or with hormone replacement. Converging evidence shows that cognition is affected by hormones acting both early in development and later in life, with different aspects of cognition affected by different hormones at different times. Spatial abilities are enhanced by moderately high levels of androgens present during early life and then again throughout adulthood, whereas verbal memory and fine motor skills are enhanced by high levels of estrogens, especially in adulthood. Effects are generally small-to-moderate in size, and may be mediated and moderated by social experiences.

Cognitive effects of early androgens are illustrated by data from an ongoing study of females and males with congenital adrenal hyperplasia (CAH) and their unaffected siblings aged 16-26. Compared to their unaffected sisters, females with CAH scored higher on tests of 3D mental rotations, geography, and mechanical knowledge (*d*'s=.7, 1.0, .8). Differences on the latter two tests in particular suggest that androgen effects on spatial ability are mediated by experiences, and preliminary results indeed suggest that androgen effects on spatial ability are mediated by effects on male-typed activities.

The neural circuitry underlying the cognitive effects of sex hormones is the subject of active investigation. There is currently little evidence about the neural substrates of early androgen influences on spatial ability. Circulating hormones in adulthood appear to affect cognition through changes in the hippocampus and prefrontal cortex. But, the brain changes in response to experiences, so associations among hormones, brain, and cognition are not deterministic

Symposium (Saturday, 10:20-12:00) Three Perspectives on Sex Differences in Cognitive Abilities
Organizer: Wendy Johnson

Data Don't Speak: Interpreting Data Regarding Cognitive Sex Differences

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Few areas of study engender as much controversy and acrimony as the questions about sex differences in cognitive abilities because the answers are used to explain why men and women predominate in different spheres of life. Everyone has a personal interest in this topic and everyone has the kind of expertise that results from a lifetime of experiences. There are no disinterested parties when researchers come together to consider the ways in which men and women are different and the same. In a recent review for *Psychological Science in the Public Interest*, six psychologists from diverse backgrounds and theoretical orientations in psychology met as a group to write a consensus statement about "The Science of Sex Differences in Science and Mathematics." Not surprisingly, we spent most of our time together discussing data, but what was surprising were the disagreements over which data are valid and how to interpret findings from research.

Some of the controversies included: (a) data from the SATs and other standardized examinations, which were favored by some for their large sample size and the sound psychometric properties of the tests and loathed by others because the nature of the sample is not known and a larger number of women take these exams, thereby lowering their mean scores in ways that are difficult to predict; (b) data derived from meta-analyses, which summarize a large number of studies, but focus on average group differences when many researchers are concerned primarily with differences in the tails of distributions; (c) data that come from legal proceedings in which the evidence has met the legal criteria for demonstrating discrimination, but not necessarily the level of peer-reviewed research; (d) data on effect sizes, with differences among committee members over when an effect size is large enough to be meaningful. I will discuss ways in which our personal perspectives influence the way we interpret data and how we think about research findings about the cognitive abilities of women and men.

Symposium (Saturday, 1:30-3:15) Cognitive Investment, Domain Knowledge, and Intellectual Ability
Organizer: Phillip L. Ackerman

Symposium Overview

In the past decade, there has been a resurgence of interest among intelligence researchers and theorists to consider the active components of intellectual development. Specifically, the main concerns involve the determinants of development and change in intellectual abilities that occur as a function of the individual's investment of time and effort to acquire knowledge and skills, especially during the period from late adolescence to middle-to-late adulthood. Specifically, researchers have focused on what happens to intellectual abilities once individuals transition from a common core curriculum (in elementary and middle school environments) to situations where people have more latitude to attend to intellectual activities (or not).

Papers in this symposium will review the historical and current theoretical basis for considering intellectual development among late adolescents and adults, and will provide descriptions of recent and ongoing empirical research on the ability and non-ability determinants of the acquisition of domain knowledge. Implications of these approaches to understanding adult intellect will be discussed in the context of educational, occupational, and avocational situations.

Symposium (Saturday, 1:30-3:15) Cognitive Investment, Domain Knowledge, and Intellectual Ability
Organizer: Phillip L. Ackerman

The Role of Gc in Real-World Learning

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Knowledge is necessary for success in the world. Many occupations require a person to demonstrate a certain level of specialized knowledge for licensure: One must pass the real estate exam to become a realtor, the bar exam to become an attorney, or a medical board exam to become a physician. And while there is no exam one must pass to pursue a hobby like woodworking, gardening, or bridge, knowledge is the key to success, if not enjoyment. Of course, knowledge is also called upon in all sorts of tasks encountered between work and play: repairing a car, cooking a meal, financial planning, and so on. Accordingly, the importance of knowledge has been emphasized in a number of recent theories of intelligence (e.g., Ackerman, Ceci, Sternberg).

The most obvious requirement for acquiring knowledge is some form of exposure to information. This exposure can be incidental, but intentional exposure is necessary to acquire a substantial amount of knowledge about most topics. A person must engage in a learning activity like reading a book or taking a course with the goal of learning something new. With this as the starting point, we focus on the question of what influences whether a person will seek out knowledge through such activities, and what determines how much knowledge he or she will acquire while doing so.

We report evidence from three studies concerning these questions. In each study, a large sample of subjects (*N*s > 500) completed tests of fluid intelligence (Gf) and crystallized intelligence (Gc), along with tests to assess interest in learning, interest in specific domains, and recently acquired knowledge in these domains. Using structural equation modeling, we found evidence for both ability and non-ability influences on learning. Furthermore, in the ability pathway, we found that Gc correlated much more strongly with learning than did Gf, suggesting that after its initial acquisition, Gc develops into an intellectual power that plays an important role in certain types of learning independent of Gf. We discuss implications of our results for theories of adult intelligence, and especially for Cattell's (1971) investment theory.

Symposium (Saturday, 1:30-3:15) Cognitive Investment, Domain Knowledge, and Intellectual Ability
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Ability and Non-Ability Determinants of Knowledge Structure Development

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Investment theories of adult development highlight the importance of both cognitive and non-cognitive components as important in learning, and define intellectual development as the application of cognitive abilities (e.g., the processing and reasoning components of intelligence; Cattell, 1987) directed by non-ability traits (e.g., personality and interests) toward the development of crystallized abilities such as domain knowledge (Ackerman, 1996; Cattell, 1987). Multiple choice tests are commonly used to assess domain knowledge, which can be problematic due the idiosyncratic nature of knowledge possessed (e.g., an individual may know quite a lot about a domain, but not know the answer to a particular multiple choice item). An alternative is the measurement of knowledge organization (e.g., mental maps or knowledge structures).

The purpose of this study was to examine the development of knowledge structures (KS) as an index of learning over a 15 week course of instruction in a college course (N=57). The study was framed within an investment theory of intelligence: cognitive ability (SAT scores) and non-ability traits (personality traits including conscientiousness, openness to experience, and goal orientation) were examined as predictors of exam performance (consisting of multiple-choice items) and KS accuracy (derived through a comparison of the learner's knowledge structures with the KS of an expert using the Pathfinder algorithm; Schvaneveldt, 1990). KS were assessed at four time points: start of the semester and each subsequent five weeks (T1-T4). Exams were given every five weeks and corresponded to KS assessment (given the week after each exam). Ability and non-ability traits were assessed during T1.

We hypothesized that KS accuracy would increase throughout the semester (H1), that ability would be related to both exam performance and KS accuracy (H2), and that traits related to interest in learning and intellectual pursuits would be related to KS accuracy (e.g., learning goal orientation and openness to experience). We also expected that conscientiousness (associated with coming to class, taking notes) would be related to both exam performance and knowledge structure accuracy (H3). Furthermore, in line with investment theories, we expected that personality traits would account for incremental validity above ability (H4), mainly for KS accuracy.

We found that KS accuracy did significantly increase throughout the course of instruction, although there was not a significant difference between T3 and T4. Ability was consistently positively and significantly related to exam performance (avg r = .32) and KS accuracy (avg r = .27). We also found, as expected, that mastery orientation was significantly positively related to KS accuracy throughout the semester, and conscientiousness was positively significantly related to both exam performance (avg r = .35) and KS accuracy (avg r = .33). We did not find a significant correlation with Openness to Experience and KS accuracy, perhaps due to the more distal nature of this trait compared to learning orientation for learning within a classroom. We created composites of KS accuracy and exam performance to examine H4. Using hierarchical regression, we found that personality did account for significant variance over cognitive ability for both KS accuracy and Exam performance (SAT was entered first into the equation, all personality traits were entered second). For exam performance, R^2 Δ with the addition of personality in the regression equation was .24, for KS accuracy R^2 Δ it was .30.

These findings support the importance of both ability and non-ability traits for the development of knowledge structures. Although the context of the study limited the variables that could be meaningfully examined (i.e., because the study occurred in a pre-existing course of instruction, it is assumed that all learners would be interested in the material and, as such, interest was not examined), we did find that non-ability traits related to classroom learning such as goal orientation and conscientiousness accounted for significant incremental validity over cognitive ability for predicting both exam performance and KS accuracy, although these traits accounted for more variance in KS accuracy.

Symposium (Saturday, 1:30-3:15) Cognitive Investment, Domain Knowledge, and Intellectual Ability
Organizer: Phillip L. Ackerman

Investment, Trait Complexes, and Adult Intellectual Development

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Perhaps the most fundamental error made by Charles Spearman was the notion that intelligence is fixed throughout one's life. In his criticism of the Binet (and later Terman) approach to intelligence, he wrote: "Yet at bottom, nothing could theoretically be more unsound. For instance, it implies the absurd corollary that persons go on steadily improving in intelligence all their lives!" (Spearman, 1930, p. 568). Such a proposition was clearly contradicted by the extant evidence at the time, including findings from key longitudinal studies of intellectual abilities during childhood (see Thorndike, 1940 for an early review).

Over the past 80 or more years, it has been clear that intellectual abilities grow and decline over the lifespan, and they change at different rates for different individuals. With respect to development during adulthood, Cattell's (1971) "Investment Theory" stands as a stark contrast to Spearman's notion that intelligence is constant. Cattell's theory actually has its roots with earlier efforts to integrate Spearman's *g* and motivational traits (e.g., Alexander, 1935; Webb, 1915). Two prominent precursors to Cattell's theory, in terms of integrating conative/motivational influences with intellectual growth are those by McDougall (1933) and by Hayes (1962). Hayes, for example, suggested that among individuals with similar ability levels, those who invest more time and effort toward intellectual activities will be more likely to acquire more extensive vocabularies and "a larger store of linguistically transmitted information" than those individuals who have lower levels of interest and investment in reading and similar activities. McDougall suggested that there cognitive and conative processes are equally important for intellectual development, but Hayes suggested that motivational and experiential factors are even more important than the individual's initial level of intellectual ability. These various approaches all converge on the notion that investment of time and effort and the motivational processes that determine the individual's investment are critically important to attainment of the knowledge aspects of intelligence.

More recently, I (Ackerman, 1996) proposed a framework, called PPIK, that integrates various aspects of intelligence and trait complexes (made up of key personality, interests, and motivation traits) that lead to or away from development of domain knowledge throughout much of the adult lifespan. A review of theoretical and empirical research on the investment approach to intelligence will be presented. Ultimately, I argue that a focus on domain knowledge (a major component of Gc) is likely to provide a much more illuminating view of adult intelligence and the changes in adult intellect over a large portion of the adult lifespan than is a focus on Gf, for reasons to be discussed.

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