

# Individual differences beyond temperament: Expanding the boundaries of personality

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- ▶ The traditional study of individual differences
- ▶ A proposal for integration
- ▶ Preliminary results

- 1 ▶ The traditional study of individual differences
- 2 ▶ A proposal for integration
- 3 ▶ Preliminary results



## The traditional study of individual differences

Thanks to British Individual Differences Psychologists

### 1 Temperament

- Temperament: What we normally do
- Validity studies of Temperament

### 2 Ability

- Ability: What we can do
- Validity studies of Ability

### 3 Interests

- Interests: What we want to do
- Validity studies of Interest

### 4 Character

- Character: Doing what we should do
- An ignored part of individual differences



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  - Spearman (1904a,b, 1907, 1910, 1946)



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- ② For developing testable theories of personality and individual differences
  - Cattell (1943, 1946a,b, 1945, 1966b)
  - Eysenck & Himmelweit (1947); Eysenck (1952, 1967a, 1965)



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  - Eysenck & Himmelmweit (1947); Eysenck (1952, 1967a, 1965)
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  - Eysenck & Eysenck (1985a); Eysenck (1997)
  - Gray (1970, 1981, 1982); Gray & McNaughton (2000)



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  - Gray (1970, 1981, 1982); Gray & McNaughton (2000)
- ④ For continuing in the grand tradition
  - Corr (2002, 2008b); Corr & Matthews (2009)
  - Deary et al. (2004, 2007, 2010)
  - Chamorro-Premuzic et al. (2011)



# Personality and Temperament

Hogan (1982) distinguishes between personality as identity and personality as reputation. To this we would add actions.

## ① Identity

- How we see ourselves
- Studies of the structure of self report

## ② Reputation

- How others see us
- Studies of the structure of peer report

## ③ Actions

- What we actually do
- Studies of the residues of our choices and our actions.





## Two broad approaches to temperament

- ① The European (particularly British) emphasis upon theory
  - Ray Cattell
  - Hans Eysenck
  - Jeffrey Gray
- ② The American emphasis upon description
  - Gordon Allport
  - Warren Norman
  - Lew Goldberg
- ③ Perhaps a reconciliation with more Americans discussing theory
  - Colin deYoung



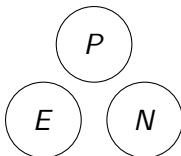
## The contributions of Hans Eysenck



### Early Eysenck model of temperament

- 1 Early theory of I/E was speed of conditioning
- 2 Later theory of I/E was arousal based Eysenck (1967b)
- 3 Original E was a mix of Impulsivity and Sociability (Eysenck & Eysenck, 1964; Rocklin & Revelle, 1981)
- 4 Systematic time of day by caffeine interactions for impulsivity but not sociability (Revelle, Humphreys, Simon & Gilliland, 1980)

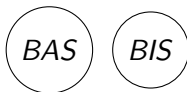
## The contributions of Hans Eysenck



### Later Eysenck model of temperament

- 1 Develop of Psychoticism scale and the EPQ (Eysenck, Eysenck & Barrett, 1985)
- 2 Some migration of impulsivity over to P, change of I/E to be primarily Sociability
- 3 Synthesis of correlational and experimental research (Eysenck & Eysenck, 1985b)
- 4 Growing evidence for heritability of all dimensions

## Gray's revisions to Eysenck model



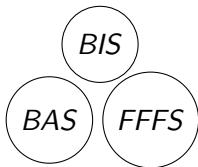
### Original "Gray model"

Jeffrey Gray explored the biological mechanisms behind a conceptual rotation of Hans Eysenck's of two dimensions of E and N to Impulsivity and Anxiety (Gray, 1970, 1981)

- 1 Emphasis upon sensitivity to cues for reward and punishment
- 2 Anxiety and the Behavioral Inhibition System (BIS)
- 3 Impulsivity and the Behavioral Activation System (BAS)



## Gray and Reinforcement Sensitivity Theory



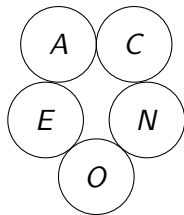
Subsequent revision now known as Reinforcement Sensitivity Theory (Gray & McNaughton, 2000; Corr, 2008a)

- ① Continued emphasis upon sensitivity to **cues** for reward and punishment
- ② Fear  $\neq$  Anxiety
- ③ Sensitivity of Fight Freeze Flight System (**FFFS**) to **cues** for punishment
- ④ Sensitivity of Behavioral Activation System for **cues** for reward (wanting vs. liking distinction)
- ⑤ Behavioral Inhibition System resolves FFFS/BAS conflict.



## Current “Consensus model” of Temperament – The “Big 5”

Temperament



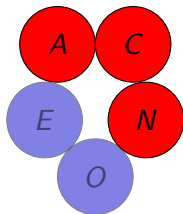
### Dimensions of Peer and self report

- ① Originally developed as structure of peer reports (Tupes & Christal, 1961; Norman, 1963; Digman, 1990; Goldberg, 1990)
- ② With elaboration of Galton's "lexical hypothesis" came also to be a structure of self report.
- ③ Now being extended into the dimensional approach to the DSMV.



## Perhaps not so much consensus

Temperament



### Alternatives to the Big 5

- 1 The HEXACO: a 6 factor model  
Ashton, Lee & Son (2000); Ashton & Lee (2005)
- 2 Two higher order factors:  $\alpha$  and  $\beta$   
(or stability and plasticity)  
(Digman, 1997; DeYoung, Peterson & Higgins, 2002; DeYoung, 2010)
- 3 A proposed General Factor of Personality  
Musek (Musek, 2007; Rushton & Irwing, 2008, 2009)

## Heritability of Temperament

- ① Turkheimer's laws (Turkheimer, 2000)
  - First Law. All human behavioral traits are heritable.
  - Second Law. The effect of being raised in the same family is smaller than the effect of genes.
  - Third Law. A substantial portion of the variation in complex human behavioral traits is not accounted for by the effects of genes or families.
- ② Johnson's laws (Johnson, 2010)
  - Many small genes
  - Heritability does not imply immutability
- ③ Heritable does not imply evolutionary importance.
  - Heritability of watching TV is roughly the same as that of Extraversion.
  - Are heritable personality traits just genetic junk?
  - Heritability does not imply simple biological system





## The conventional US model: with some behavioral correlates

*Traits*

*Behaviors*

Neuroticism

Traits are stable and have predictive power over the lifespan

Agreeableness

*Getting along*

Conscientiousness

Roberts and DelVecchio (2000)

Extraversion

*Getting ahead*

Caspi, Roberts and Shiner (2005)

Openness

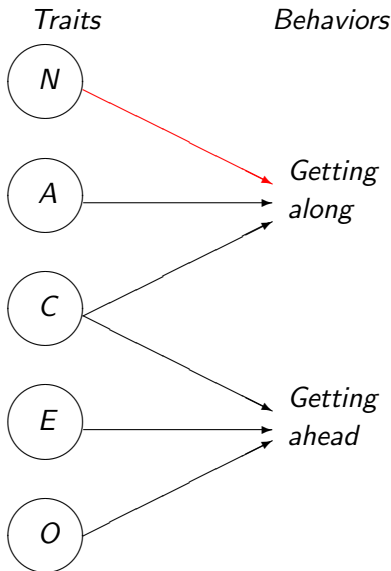


## The conventional model: with some predictive powers

Traits are stable and have predictive power over lifespan

Mortality  
Divorce  
Employment

Roberts, Kuncel, Shiner,  
Caspi and Goldberg, (2007)



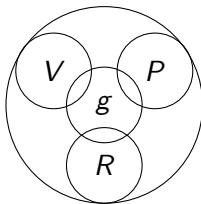
## General factor model of Ability



### A general factor of ability

- 1 Spearman (1904a, 1946) proposed a single factor to account for the positive manifold of ability tests.
- 2 Thomson (1935, 1951) argued that the positive manifold did not imply a general factor
- 3 Bartholomew, Deary & Lawn (2009) and Van Der Maas, Dolan, Grasman, Wicherts, Huizenga & Raijmakers (2006) have continued the critique of a general factor as an explanatory concept.

## Traditional model of Abilities



### Hierarchical models of intelligence

- 1 Horn & Cattell (1966, 1982)  $g_f - g_c$  model
- 2 Carroll (1993, 2005) proposed a three stratum model
- 3 McGrew (2009) proposed an integrative model
- 4 Johnson & Bouchard Jr. (2005) VPR model as alternative to  $g_f - g_c$

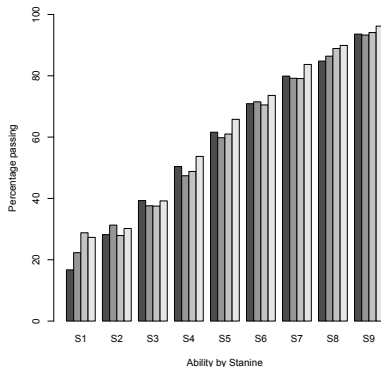
## Predictive power of ability

- ① Life as an intelligence test (Gottfredson, 1997)
  - life tasks differ in difficulty
  - the harder the task, the more g required
- ② IQ predicts even at the very high end (Arneson, Sackett & Beatty, 2011; Lubinski, Webb, Morelock & Benbow, 2001; Lubinski & Benbow, 2006)
  - It is not that ability does not predict the performance of the very high, it is just that the tests need to be given early enough.
- ③ Intelligence, health, and mortality:
  - Cognitive epidemiology (Deary & Batty, 2007; Deary, 2009)
  - Is “health literacy” anything more than “g”? (Litcog project at NUMS) <http://www.healthliteracy.northwestern.edu/>



## The power of ability: Army Airforce Selection

Army airforce selection study: predicting passing training based upon stanine of screening battery. Multiple R  $\approx$  .42



This is an interesting way to convince generals of the power of a correlation for selection purposes.



## The power of ability continues to high levels

Project A(rmy), N=5,296, College Board (N= 150,294), Project Talent (N = 15,040), National Education Longitudinal Study of the Class of 1988 (N = 6,656)

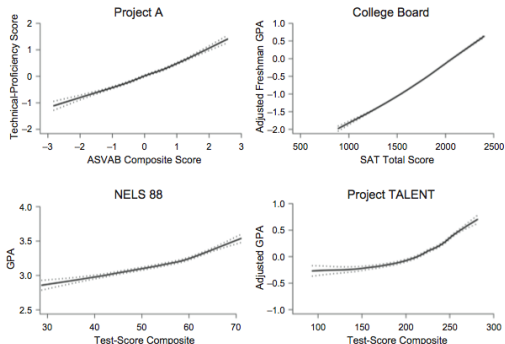


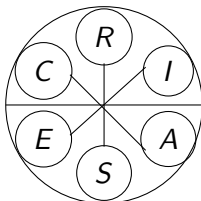
Fig. 1. Lowess-smoothed plots (with 95% confidence intervals) of the ability-performance relationship in each of the four data sets. ASVAB = Armed Services Vocational Aptitude Battery; GPA = grade point average; NELS 88 = National Education Longitudinal Study of the Class of 1988.

Ability-Performance Relationships in Education and Employment Settings: Critical Tests of the More-Is-Better and the Good-Enough Hypotheses (Arneson et al., 2011)



## Interests as an aspect of vocational counseling

- ① Early work by Strong (1927)
- ② Holland (1959, 1996) and the RIASEC model
  - Realistic
  - Investigative
  - Artistic
  - Social
  - Enterprising
  - Conventional





## Character: Doing what we should do

“John Adams and his wife Abigail through **character and personality** did much to create understanding between the two English speaking countries” (Colonial Dames of America, 1983, plaque on Adams House, Duke Street and Grovener Square)



## An integrative proposal

### 5 Previous integrative work

- Integrating temperament, ability and interests
- Temperament and Ability
- Ability and Interests
- Temperament and interests

### 6 A new organization

- Prior demonstrations of the power of temperament, abilities and interest
- A need for integrative studies
- SAPA: A new methodology



## Integrating temperament, ability and interests

- Personality theorists from the 1920s to late 1940s included ability and interests in personality formulations (e.g., Kelly & Fiske, 1950).
- Perhaps in a desire to be theoretical rather than applied, and not to discuss the socially dangerous idea of intelligence, American personality psychologists from the 1950s until the present have avoided or ignored the study of ability and interests.
  - Exceptions include Lubinski & Benbow (2000); Lubinski et al. (2001); Lubinski & Benbow (2006)
  - Ackerman (1997), Ackerman & Heggestad (1997)
  - Kuncel, Campbell & Ones (1998); Kuncel, Hezlett & Ones (2001); Kuncel, Crede & Thomas (2005)
- Ability was left to school psychologists, interests to counseling psychology. However, both were included in I/O psychology.
- It is time to rectify that oversight. What follows is a tentative proposal.



## Ackerman: Integrating temperament, ability and interests

- ① Looking for common threads in temperament, ability and interests
  - Ackerman & Heggestad (1997); Ackerman (1997) examined the commonality of the three domains
- ② Emphasis upon what they have in common



## Integrating Ability and Interests

- Camilla Benbow and David Lubinski's Study of Mathematically Precocious Youth (SMPY) has yielded important results about the effect of the "tilt" between Verbal and Quantitative reasoning.
  - High Q and V leads to success
  - Quant > Verbal leads to patents and success in science
  - Verbal > Quant leads to novels and a career in the arts



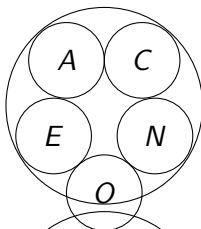
## Integrating Temperament and Interests

- Primary analysis has been to examine the correlations between domains of interest and those of the Big 5
  - Metanalysis of RIASEC and NEO Larson, Rottinghaus & Borgen (2002)
- Some have looked at facet level correlations
  - Armstrong & Anthony (2009) examined facet level correlations between RIASEC and NEO facets

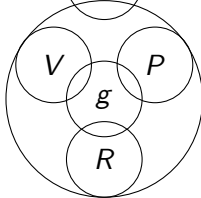


# Traditional model of Temperament, Abilities, and Interests

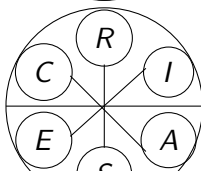
Temperament



Abilities



Interests



## Temperament

2- 5 dimensions reflecting individual differences in Affect, Behavior, Cognition, Desire

## Ability

- ①  $g$
- ②  $g_f g_c$

## Interests

2 broad dimensions organizing 6-8 specific interests

- ① People vs. Things
- ② Facts vs Ideas

## Temperament, ability, interests: Kelly and Fiske (1950)

- A classic study of graduate school success showed how temperament, ability, and interests all predicted performance equally well (Kelly & Fiske, 1950).
- Graduate students enrolled in 40 different clinical psychology programs in 1946 were evaluated by  $\approx 75$  psychologists at UM
- Criteria included ratings of clinical diagnosis, skill at individual therapy, research skills, preference for hiring
- Predictive measures that worked included
  - Ability: Millers analogy test
  - Temperament: Measures of neuroticism
  - Interests: Measures of psychological mindedness in interests
- “The most efficient clinical predictions, in terms of both validity and economy of data, are those based only on the materials contained in the credentials file and in the objective test profiles. The addition of autobiographical and projective test data appears to have contributed little or nothing to the validities of the assessment ratings.”





## A need for integrative studies

- Prior work has shown that there is a need to integrate Temperament, Abilities and Interests.
- But how to do it?
- To integrate the areas requires large sample sizes, ease of data collection, and a diverse subject population.
- Some do this through meta analysis, some use broad based national samples.
- Is it possible for single labs to do integrative studies?



## How to do integrative studies?

- Problem of small samples sizes based upon college undergraduates. Typical subject pools are neither large enough nor diverse enough.
- Expensive to get access to large and diverse populations
  - Exceptions include national and international survey samples using preselected items:
    - National Longitudinal Study of Youth (NLSY)
    - Program for International Student Assessment (PISA)
    - German Socio-Economic Panel
- Is it possible to do large based sampling with tailored items?
- Yes, use the web.



## Synthetic Aperture Personality Assessment (SAPA)

- Using the web to collect data on temperament, ability and interests
  - Synthetically form large covariance matrices from smaller subsets of items
  - Each subject given  $\approx 50$  personality, 10 interest, and 14 ability items sampled from the larger pool.
  - Total pool of items  $> 500$ 
    - $\approx 400$  personality items primarily from International Personality Item Pool Goldberg (1999)
    - 92 interest items for Oregon Vocational Interest Scales (Pozzebon, Visser, Ashton, Lee & Goldberg, 2010)
    - 56 ability items (home brewed at NU)
    - Demographic items include age, sex, education, race, country, college major, occupation (if appropriate)
    - Resulting sample sizes  $> 50,000 - 100,000$
- College major, occupational status and interest items added in 9/10
- Data to be summarized include  $\approx 30,000$  participants (Sept 2010-July 2011).



## SAPA: what the subject sees

A			
ab	B		

## SAPA: what the subject sees

A			
ac		C	

## SAPA: what the subject sees

A			
ad			D

## SAPA: what the subject sees

	B		
	bc	C	

## SAPA: what the subject sees

	B		
	bd		D





## SAPA: what the subject sees

		C	
		cd	D



## SAPA: what the experimenter sees: A Synthetic matrix

A			
ab	B		
ac	bc	C	
ad	bd	cd	D



## SAPA: Technical overview

- ①  $n \times n$  synthetic covariance matrices are formed by giving  $p$  items to  $Np$  subjects

$N$  Total number of subjects

$n$  Total number of items in synthetic matrix

$p$  Probability of any item being given

$pN$  Number of subjects taking any one item

$p^2N$  Number of subjects for any pair of items

- ② Basic statistics

- Data are Massively Missing at Random
- Means and Variances are based upon  $pN$  subjects
- Covariances are based upon  $p^2N$  subjects

- ③ Power of large samples and sampling of items

- 100-150 people per day  $\Rightarrow$  40,000 subjects per year
- 700-1000 subjects/week
- By varying  $p$ , one can prototype items rapidly.



## Preliminary results

7 Method: Synthetic Aperture Personality Assessment–SAPA

8 Results

9 Conclusions



## Method

- ① Synthetic Aperture Personality Assessment (Revelle, Wilt & Rosenthal, 2010) forms large covariance matrices by sampling items across people
  - $\approx 120/\text{day}$  participants are recruited to `test.personality-project.org`
  - Each participant is given 60-70 items
  - Total set of items being analyzed  $> 400$
- ② Item content being sampled
  - 100 “IPIP” Big 5 items
  - $\approx 200$  other temperamental items
  - 54-75 home brewed ability items (Lieberman, 2006; Condon, 2011 and continuing)
  - 92 Oregon Vocational Interest items (ORVIS)
- ③ Although  $> 200,000$  participants have been run in all, we will report only those data from the last 30,000
- ④ Demographic information included
  - Age, Gender
  - Level of education
  - College major and broad field (if appropriate)



## Oregon Vocational Interest Scales: sample items

**Adventure** Would like to be a professional athlete.

**Altruism** Like to care for sick people.

**Analytic** Would like to be a chemist.

**Artistic** Create works of art.

**Erudition** Would like to be a translator or interpreter.

**Leadership** Like to make important things happen.

**Organization** Would like to be the financial officer for a company.

**Practical** Would like to care for cattle or horses.



## Analytical approach: All analyses done in R

- ① R: An international collaboration <http://R-cran.org>
- ② R: The open source - public domain version of S+
- ③ R: Written by statistician (and all of us) for statisticians (and the rest of us)
- ④ R: Not just a statistics system, also an extensible language.
  - This means that as new statistics are developed they tend to appear in R far sooner than elsewhere.
  - For example, a recent issue of *Psychological Methods* had at least three articles with examples or supplementary work done in R
  - R facilitates asking questions that have not already been asked.
- ⑤ Special functions for SAPA have been written in R and are included in the **psych** package.



## Analytical reporting

- ① Given the sample sizes, statistical significance is not an issue, but rather the size of the effects.
- ② Correlation is an appropriate effect size measure
  - Correlations between continuous variables are reported as Pearson  $r$
  - Correlations between dichotomous variables are reported as tetrachoric correlations
  - Correlations between continuous and dichotomous are reported as biserial
  - These last two correlations make assumptions of normal distributions of latent traits
- ③ Data displays are graphical techniques for showing the complex, multivariate structure of the data
  - Correlation strength reported as a “heat map” with positive correlations shaded as progressively darker shades of blue, negative correlations as darker shades of red.
  - Patterns of correlations will be shown as “spider” or “radar” images, with line length reflecting the correlation.





## Analysis of Temperament, Ability, Interests

- ① Big 5 scale scores used an Item Response Theory (IRT) algorithm
  - With complete data, IRT and simple sum scores are almost identical.
  - SAPA data are Massively Missing at Random and are better estimated using IRT techniques.
    - Two parameter model: item difficulty, item location
    - One parameter model: item difficulty
- ② Ability measures
  - SATV, SATQ, SATW and ACT were self reported
  - iq measure was based upon IRT analysis and scoring



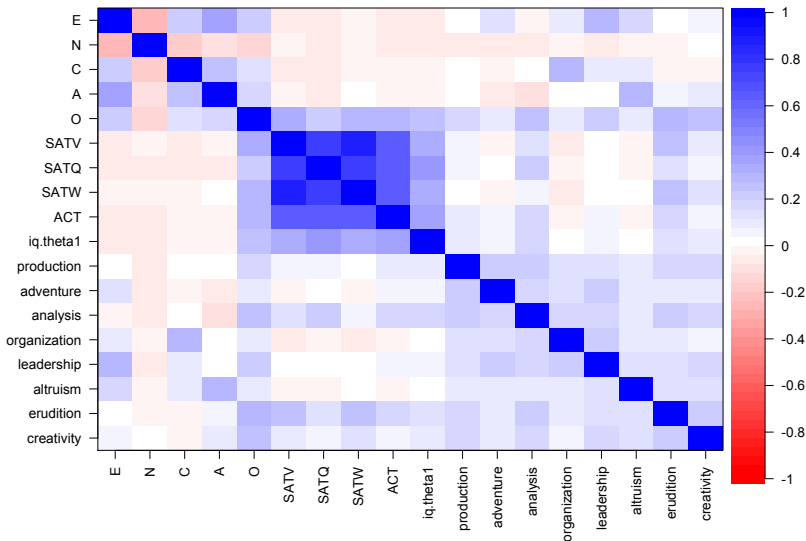
## 4 sets of results

- ❶ Intercorrelation of Temperament, Ability and Interests
  - Reported for all subjects
  - Broken down by gender
- ❷ Temperament, Ability and Interests: correlations with college major
  - Reported for all subjects
  - Broken down by gender
- ❸ Temperament, Ability and Interests: correlation with occupation
  - Reported for all subjects
  - Broken down by gender
- ❹ “Spider plots” of various college majors



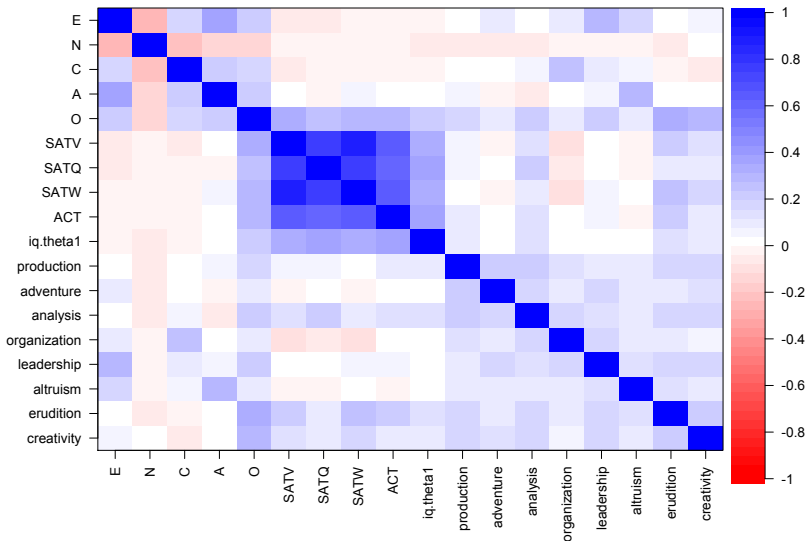
# Three domains: Temperament, Ability and Interests

Correlations of Temperament, Ability and Interests



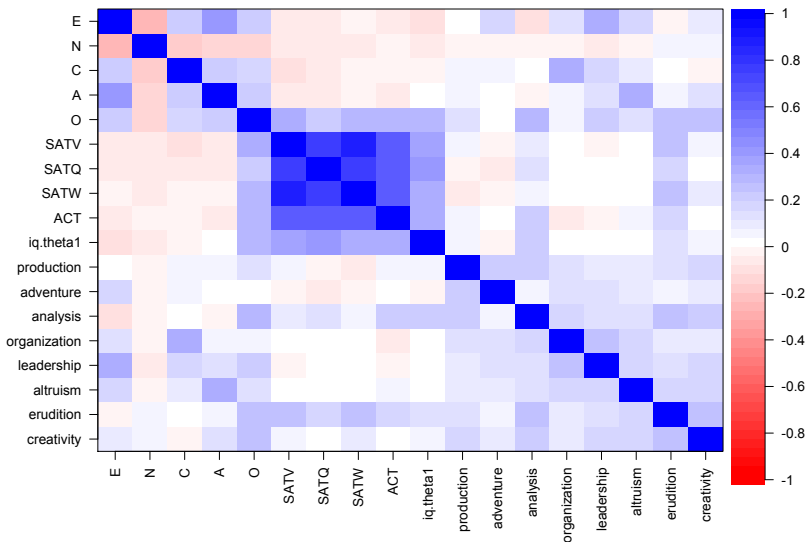
# Three domains: Temperament, Ability and Interests – Females only

Females only -- Correlations of Temperament, Ability and Interests



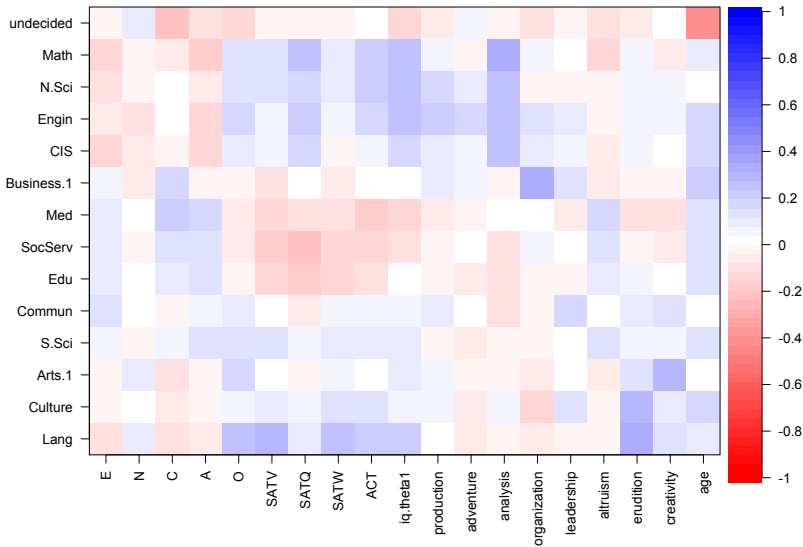
# Three domains: Temperament, Ability and Interests – Males only

Males only -- Correlations of Temperament, Ability and Interests



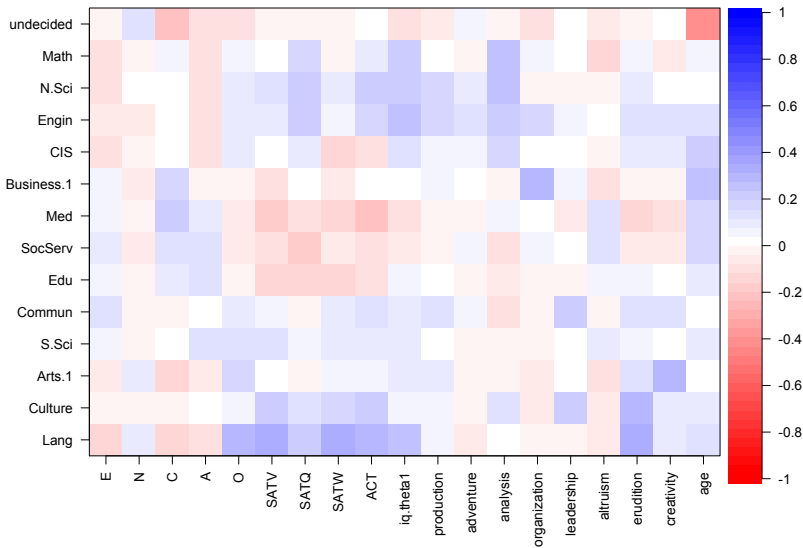
# College major by Temperament, Ability and Interests

Temperament, Ability and Interest: College major



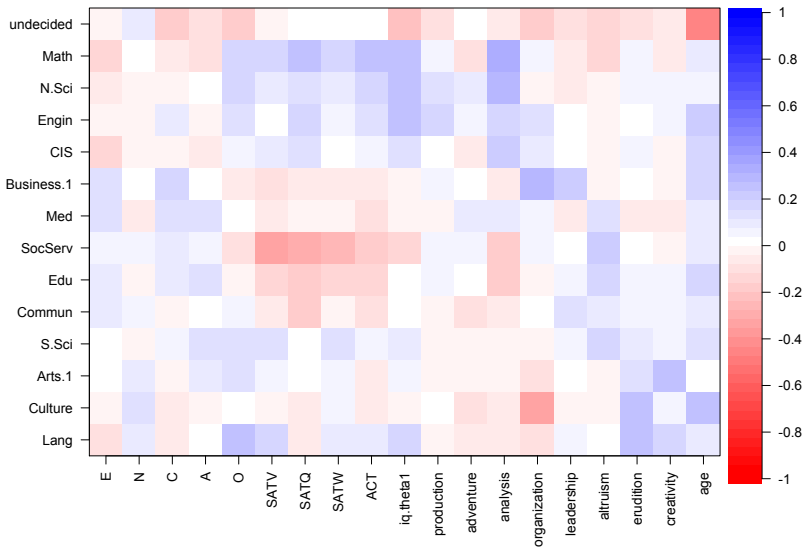
# College major by Temperament, Ability and Interests- Females only

Temperament, Ability and Interest: College major -- Female only



# College major by Temperament, Ability and Interests- Females only

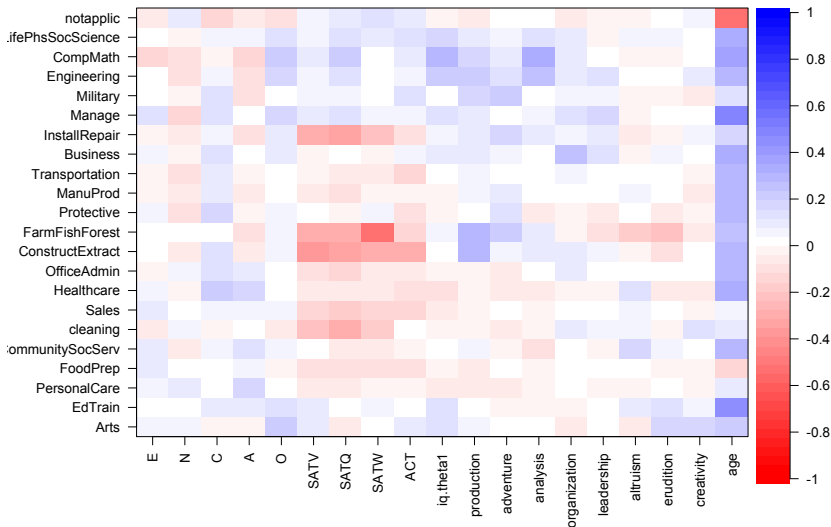
Temperament, Ability and Interest: College major -- Male only





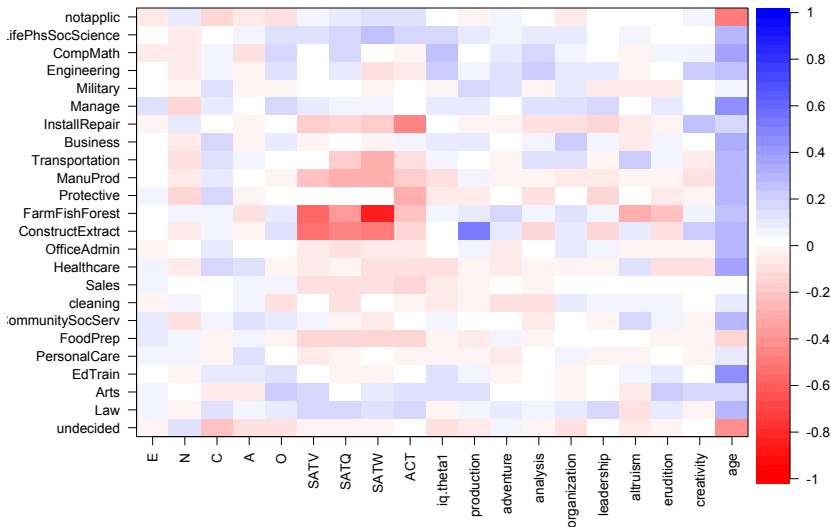
# Occupation by Temperament, Ability and Interests – All participants

Temperament, Ability and Interest: Occupation



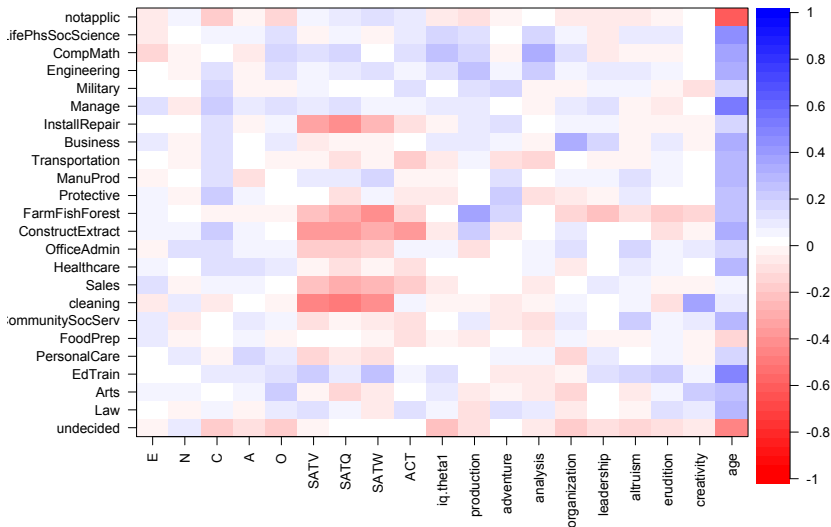
# Occupation by Temperament, Ability and Interests- Females only

Females only --Temperament, Ability and Interest: Occupation



# Occupation by Temperament, Ability and Interests- Males only

Males only --Temperament, Ability and Interest: Occupation



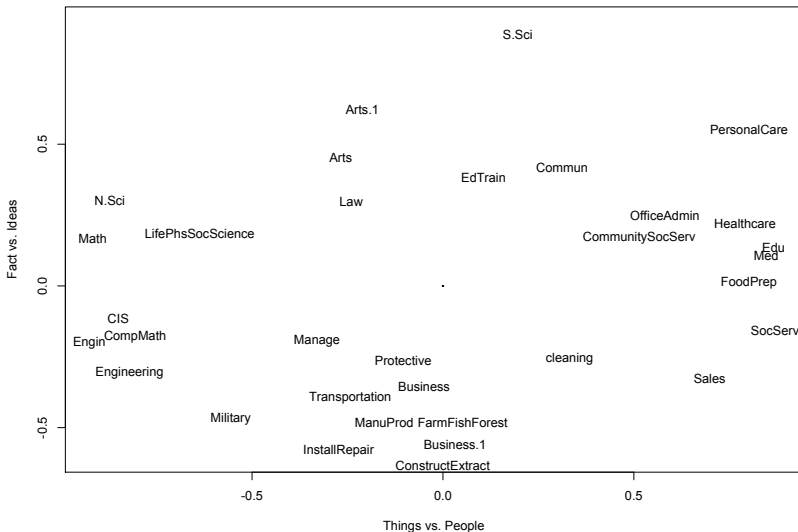
## Converting variable oriented data to person oriented data

- ① The correlations between Temperament, Ability and Interests are taken over all occupations
  - This is the conventional way of analyzing data
- ② Can compare occupations and majors in terms of their pattern over the TAI variables
  - Less frequently done, this amounts to a Q analysis (Cattell, 1966a)
  - This correlation of majors and occupations across TAI measures is a  $34 \times 13$  Q analysis
  - Convert the correlations to distances and then do a multidimensional scaling of the resulting matrix
  - Varimax rotation of the resulting dimensions.



# A multi dimensional scaling of majors and occupations.

2 dimensional Multi Dimensional Scaling

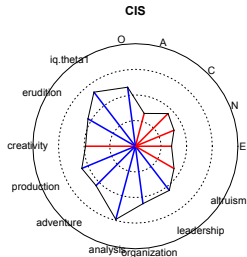
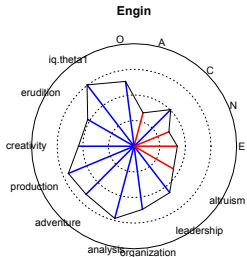
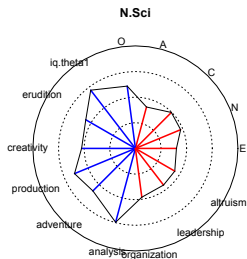
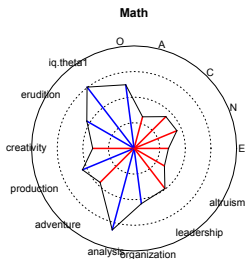


## “Spider plots” show patterns within groups across TAI variables

- ① This is simply a way of showing correlations for multiple variables for different groups.
  - Just another way of showing correlational strength
- ② Spider plots are particularly useful for showing structural differences across groups.

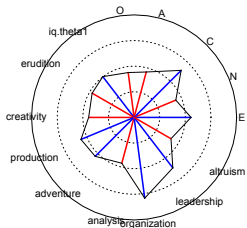


# Temperament, Ability and Interests – Science orientation

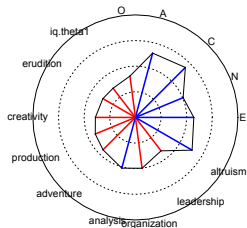


# Temperament, Ability and Interests- Business orientation

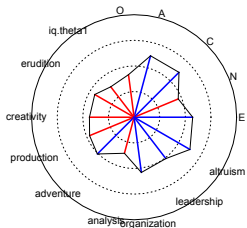
**Business.1**



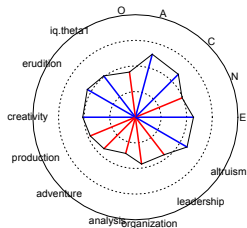
**Med**



**SocServ**

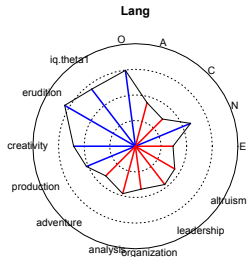
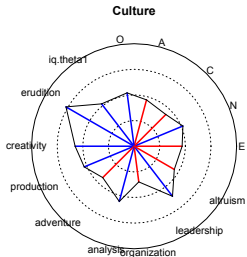
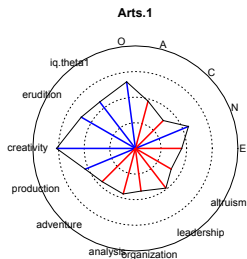
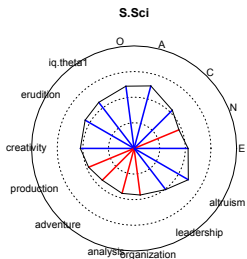


**Edu**





# Temperament, Ability and Interests- Arts orientation



## Tentative conclusion

- ① Temperament, Ability and Interests are important sources of individual differences
  - Share some but not much common variance
  - Openness/Intellect and cognitive skills
  - Interests reflect some temperamental differences
- ② Better to use all three domains as predictors of real world consequences
  - More to be gained by using all three domains rather than forcing into artificial synthesis
- ③ The study of individual differences is alive and well



- ▶ The traditional study of individual differences
- ▶ A proposal for integration
- ▶ Preliminary results

1

▶ The traditional study of individual differences

2

▶ A proposal for integration

3

▶ Preliminary results



- Ackerman, P. L. (1997). Personality, self-concept, interests, and intelligence: Which construct doesn't fit? *Journal of Personality*, 65(2), 171–204.
- Ackerman, P. L. & Heggestad, E. D. (1997). Intelligence, personality, and interests: Evidence for overlapping traits. *Psychological Bulletin*, 121(2), 219–245.
- Armstrong, P. I. & Anthoney, S. F. (2009). Personality facets and riasec interests: An integrated model. *Journal of Vocational Behavior*, 75(3), 346 – 359.
- Arneson, J. J., Sackett, P. R., & Beatty, A. S. (2011). Ability-performance relationships in education and employment settings. *Psychological Science*.
- Ashton, M. C. & Lee, K. (2005). Honesty-humility, the big five, and the five-factor model. *Journal of Personality*, 73(5), 1321–1353.
- Ashton, M. C., Lee, K., & Son, C. (2000). Honesty as the sixth factor of personality: Correlations with machiavellianism,



primary psychopathy, and social adroitness. *European Journal of Personality*, 14(4), 359–369.

Bartholomew, D., Deary, I., & Lawn, M. (2009). A new lease of life for Thomson's bonds model of intelligence. *Psychological review*, 116(3), 567–579.

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor-analytic studies*. New York, NY, US: Cambridge University Press.

Carroll, J. B. (2005). The three-stratum theory of cognitive abilities. In D. P. Flanagan & P. L. Harrison (Eds.), *Contemporary Intellectual Assessment: Theories, Tests, and Issues* (pp. 69–76). New York, NY: Guilford Press.

Cattell, R. B. (1943). The description of personality. I. Foundations of trait measurement. *Psychological Review*, 50(6), 559–594.

Cattell, R. B. (1945). Psychological measurement: normative, ipsative, interactive. *Psychological Review*, 51, 292–303.



- Cattell, R. B. (1946a). Personality structure and measurement. I. The operational determination of trait unities. *British Journal of Psychology*, 36, 88–102.
- Cattell, R. B. (1946b). Personality structure and measurement. II. The determination and utility of trait modality. *British Journal of Psychology*, 36, 159–174.
- Cattell, R. B. (1966a). The data box: Its ordering of total resources in terms of possible relational systems. In R. B. Cattell (Ed.), *Handbook of multivariate experimental psychology* (pp. 67–128). Chicago: Rand-McNally.
- Cattell, R. B. (1966b). *The scientific analysis of personality*. Chicago,: Aldine Pub. Co.
- Chamorro-Premuzic, T., Furnham, A. F., & von Stumm, S. (Eds.). (2011). *The Wiley-Blackwell Handbook of Individual Differences*. Wiley-Blackwell.
- Corr, P. J. (2002). J. A. Gray's reinforcement sensitivity theory and frustrative nonreward: A theoretical note on expectancies in



reactions to rewarding stimuli. *Personality and Individual Differences*, 32(7), 1247–1253.

Corr, P. J. (2008a). *The Reinforcement sensitivity theory of personality*. Cambridge: Cambridge University Press.

Corr, P. J. (2008b). *Reinforcement Sensitivity Theory (RST): Introduction*. Cambridge: Cambridge University Press.

Corr, P. J. & Matthews, G. (Eds.). (2009). *The Cambridge Handbook of Personality Psychology*. Cambridge: Cambridge University Press.

Deary, I., Penke, L., & Johnson, W. (2010). The neuroscience of human intelligence differences. *Nature Reviews Neuroscience*, 11(3), 201–211.

Deary, I. J. (2009). Introduction to the special issue on cognitive epidemiology. *Intelligence*, 37, 517–519.

Deary, I. J. & Batty, G. D. (2007). Cognitive epidemiology. *British Medical Journal*, 61(5), 378–384.



- Deary, I. J., Strand, S., Smith, P., & Fernandes, C. (2007). Intelligence and educational achievement. *Intelligence*, 35(1), 13–21.
- Deary, I. J., Whiteman, M., Starr, J., Whalley, L., & Fox, H. (2004). The impact of childhood intelligence on later life: following up the Scottish mental surveys of 1932 and 1947. *Journal of Personality and Social Psychology*, 86(1), 130–147.
- DeYoung, C. G. (2010). Toward a theory of the big five. *Psychological Inquiry: An International Journal for the Advancement of Psychological Theory*, 21(1), 26 – 33.
- DeYoung, C. G., Peterson, J. B., & Higgins, D. M. (2002). Higher-order factors of the big five predict conformity: Are there neuroses of health? *Personality and Individual Differences*, 33(4), 533–552.
- Digman, J. M. (1990). Personality structure: Emergence of the five-factor model. *Annual Review of Psychology*, 41, 417–440.
- Digman, J. M. (1997). Higher-order factors of the big five. *Journal of Personality and Social Psychology*, 73, 1246–1256.





- Eysenck, H. J. (1952). *The scientific study of personality*. London,: Routledge & K. Paul.
- Eysenck, H. J. (1965). *Fact and fiction in psychology*. Baltimore,: Penguin Books.
- Eysenck, H. J. (1967a). *The biological basis of personality*. Springfield: Thomas.
- Eysenck, H. J. (1967b). *The biological basis of personality*. Springfield, IL.: Thomas.
- Eysenck, H. J. (1997). Personality and experimental psychology: The unification of psychology and the possibility of a paradigm. *Journal of Personality and Social Psychology*, 73(6), 1224–1237.
- Eysenck, H. J. & Eysenck, M. W. (1985a). *Personality and individual differences: a natural science approach*. New York: Plenum Press.
- Eysenck, H. J. & Eysenck, M. W. (1985b). *Personality and Individual Differences: A natural science approach*. New York: Plenum.



- Eysenck, H. J. & Eysenck, S. B. G. (1964). *Eysenck Personality Inventory*. San Diego, California: Educational and Industrial Testing Service.
- Eysenck, H. J. & Himmelweit, H. T. (1947). *Dimensions of personality; a record of research carried out in collaboration with H.T. Himmelweit [and others]*. London: K. Paul, Trench.
- Eysenck, S. B. G., Eysenck, H. J., & Barrett, P. (1985). A revised version of the psychoticism scale. *Personality and Individual Differences*, 6(1), 21 – 29.
- Galton, F. (1865). Hereditary talent and character. *Macmillan's Magazine*, 12, 157–166.
- Galton, F. (1874). On a proposed statistical scale (letter to the editor). *Nature*, 9, 342–343.
- Galton, F. (1877). Typical laws of heredity in man.
- Galton, F. (1879). Psychometric experiments. *Brain*, 2, 149–162.
- Galton, F. (1884). Measurement of character. *Fortnightly Review*, 36, 179–185.



- Galton, F. (1888). Co-relations and their measurement. *Proceedings of the Royal Society. London Series*, 45, 135–145.
- Galton, F. (1889). *Natural Inheritance*. London: Macmillan.
- Galton, F. (1892). *Hereditary genius: an inquiry into its laws and consequences* (2nd ed.). London: Macmillan and Co.
- Goldberg, L. R. (1990). An alternative “description of personality”: The big-five factor structure. *Journal of Personality and Social Psychology*, 59(6), 1216–1229.
- Goldberg, L. R. (1999). A broad-bandwidth, public domain, personality inventory measuring the lower-level facets of several five-factor models. In I. Mervielde, I. Deary, F. De Fruyt, & F. Ostendorf (Eds.), *Personality psychology in Europe*, volume 7 (pp. 7–28). Tilburg, The Netherlands: Tilburg University Press.
- Gottfredson, L. S. (1997). Why g matters: The complexity of everyday life. *Intelligence*, 24(1), 79 – 132.
- Gray, J. A. (1970). The psychophysiological basis of introversion-extraversion. *Behaviour Research and Therapy*, 8(3), 249–266.



- Gray, J. A. (1981). A critique of Eysenck's theory of personality. In H. J. Eysenck (Ed.), *A Model for Personality* (pp. 246–277). Berlin: Springer.
- Gray, J. A. (1982). *Neuropsychological Theory of Anxiety: An investigation of the septal-hippocampal system*. Cambridge: Cambridge University Press.
- Gray, J. A. & McNaughton, N. (2000). *The Neuropsychology of anxiety: An enquiry into the functions of the septo-hippocampal system* (2nd ed.). Oxford: Oxford University Press.
- Hogan, R. (1982). A socioanalytic theory of personality. *Nebraska Symposium on Motivation* 1982, 55-89.
- Holland, J. L. (1959). A theory of vocational choice. *Journal of Counseling Psychology*, 6(1), 35 – 45.
- Holland, J. L. (1996). Exploring careers with a typology: What we have learned and some new directions. *American Psychologist*, 51(4), 397 – 406.



- Horn, J. L. & Cattell, R. B. (1966). Refinement and test of the theory of fluid and crystallized general intelligence. *Journal of Educational Psychology*, 57(5), 253–270.
- Horn, J. L. & Cattell, R. B. (1982). Whimsy and misunderstanding of gf-gc theory: A comment on Guilford. *Psychological Bulletin*, 91(3), 623–633.
- Johnson, W. (2010). Understanding the genetics of intelligence: Can height help? can corn oil. *Current Directions in Psychological Science*, 19(3), 177–182.
- Johnson, W. & Bouchard Jr., T. J. (2005). The structure of human intelligence: It is verbal, perceptual, and image rotation (vpr), not fluid and crystallized. *Intelligence*, 33(4), 393 – 416.
- Kelly, E. L. & Fiske, D. W. (1950). The prediction of success in the VA training program in clinical psychology. *American Psychologist*, 5(8), 395 – 406.
- Kuncel, N. R., Campbell, J. P., & Ones, D. S. (1998). Validity of the graduate record examination: Estimated or tacitly known? *American Psychologist*, 53(5), 567–568.



- Kuncel, N. R., Crede, M., & Thomas, L. L. (2005). The validity of self-reported grade point averages, class ranks, and test scores: A meta-analysis and review of the literature. *Review of Educational Research*, 75(1), 63–82.
- Kuncel, N. R., Hezlett, S. A., & Ones, D. S. (2001). A comprehensive meta-analysis of the predictive validity of the graduate record examinations: Implications for graduate student selection and performance. *Psychological Bulletin*, 127(1), 162 – 181.
- Larson, L. M., Rottinghaus, P. J., & Borgen, F. H. (2002). Meta-analyses of big six interests and big five personality factors. *Journal of Vocational Behavior*, 61(2), 217 – 239.
- Lubinski, D. & Benbow, C. P. (2000). States of excellence. *American Psychologist*, 55(1), 137 – 150.
- Lubinski, D. & Benbow, C. P. (2006). Study of mathematically precocious youth after 35 years: Uncovering antecedents for the development of math-science expertise. *Perspectives on Psychological Science*, 1(4), 316–345.



- Lubinski, D., Webb, R., Morelock, M., & Benbow, C. (2001). Top 1 in 10,000: A 10-year follow-up of the profoundly gifted. *Journal of applied Psychology, 86*(4), 718–729.
- McGrew, K. (2009). CHC theory and the human cognitive abilities project: Standing on the shoulders of the giants of psychometric intelligence research. *Intelligence, 37*(1), 1–10.
- Musek, J. (2007). A general factor of personality: Evidence for the big one in the five-factor model. *Journal of Research in Personality, 41*(6), 1213–1233.
- Norman, W. T. (1963). Toward an adequate taxonomy of personality attributes: Replicated factors structure in peer nomination personality ratings. *Journal of Abnormal and Social Psychology, 66*(6), 574–583.
- Pozzebon, J. A., Visser, B. A., Ashton, M. C., Lee, K., & Goldberg, L. R. (2010). Psychometric characteristics of a public-domain self-report measure of vocational interests: The oregon vocational interest scales. *Journal of Personality Assessment, 92*(2), 168–?



- Revelle, W., Humphreys, M. S., Simon, L., & Gilliland, K. (1980). Interactive effect of personality, time of day, and caffeine - test of the arousal model. *Journal of Experimental Psychology General*, 109(1), 1–31.
- Revelle, W., Wilt, J., & Rosenthal, A. (2010). Personality and cognition: The personality-cognition link. In A. Gruszka, G. Matthews, & B. Szymura (Eds.), *Handbook of Individual Differences in Cognition: Attention, Memory and Executive Control* chapter 2, (pp. 27–49). Springer.
- Rocklin, T. & Revelle, W. (1981). The measurement of extraversion: A comparison of the Eysenck Personality Inventory and the Eysenck Personality Questionnaire. *British Journal of Social Psychology*, 20(4), 279–284.
- Rushton, J. P. & Irwing, P. (2008). A general factor of personality (GFP) from two meta-analyses of the Big Five: Digman (1997) and Mount, Barrick, Scullen, and Rounds (2005). *Personality and Individual Differences*, 45(7), 679–683.





- Rushton, J. P. & Irwing, P. (2009). A general factor of personality in the comrey personality scales, the minnesota multiphasic personality inventory-2, and the multicultural personality questionnaire. *Personality and Individual Differences*, 46, 437–442.
- Spearman, C. (1904a). “general intelligence,” objectively determined and measured. *American Journal of Psychology*, 15(2), 201–292.
- Spearman, C. (1904b). The proof and measurement of association between two things. *The American Journal of Psychology*, 15(1), 72–101.
- Spearman, C. (1907). Demonstration of formulae for true measurement of correlation. *The American Journal of Psychology*, 18(2), 161–169.
- Spearman, C. (1910). Correlation calculated from faulty data. *British Journal of Psychology*, 3(3), 271–295.
- Spearman, C. (1946). Theory of general factor. *British Journal of Psychology*, 36(3), 117–131.



- Strong, E. K. (1927). Vocational interest test. *Educational Record*, 8(2), 107–121.
- Thomson, G. H. (1935). The definition and measurement of "g" (general intelligence). *Journal of Educational Psychology*, 26(4), 241 – 262.
- Thomson, S. (1951). *The factorial analysis of human ability* (5th ed.). University of London Press London.
- Tupes, E. C. & Christal, R. E. (1961). Recurrent personality factors based on trait ratings. Technical Report 61-97, USAF ASD Technical Report, Lackland Air Force Base.
- Turkheimer, E. (2000). Three laws of behavior genetics and what they mean. *Current Directions in Psychological Science*, 9(5), 160–164.
- Van Der Maas, H. L. J., Dolan, C. V., Grasman, R. P. P. P., Wicherts, J. M., Huizenga, H. M., & Raijmakers, M. E. J. (2006). A dynamical model of general intelligence: The positive manifold of intelligence by mutualism. *Psychological Review*, 113(4), 842 – 861.

