

Some Thoughts on the Nature of Adult Human Intelligence

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A bit of Background

We have yet to find g .

But the evidence indicates organization of a myriad of capabilities into clusters that are genetically, functionally, developmentally related.

Rather as Godfrey Thomson described in discussions with Spearman

Organization Indicated By Factors At The Second-order Among Tests

- ◆ Fluid Reasoning
- ◆ Crystallized Knowledge
- ◆ Short-Term Apprehension-Retrieval
- ◆ Visualizing Abilities
- ◆ Hearing Abilities
- ◆ Long-Term Retrieval Fluency
- ◆ Cognitive Speediness
- ◆ Decision Speed
- ◆ Quantitative Knowledge

Construct Validity Stems From Different Kinds of Evidence

- ◆ **Structural Evidence: Different Factors**
- ◆ **Developmental Evidence :Different Age Changes & Age Differences**
- ◆ **Neuro-physiological Evidence:Different Localization & Process Correlates**
- ◆ **Genetic Evidence: Different Heritabilities**
- ◆ **Achievement Prediction Evidence: Different as Predictors & Predicted**

Major Constructs

Fluid Reasoning: Gf

- ◆ The ability to inductively, deductively, conjunctively, sequentially comprehend relationships & draw conclusions –i.e., to reason-- to solve problems wherein the fundamentals are novel, which is to say, measured in ways that ensure minimal variance from individual differences in acculturated knowledge and skills

Gf Continued

- ◆ Facility in reasoning, particularly where adaptation to new situations is required and where, therefore, Gc skills are of no particular advantage (Snow, 1979)
- ◆ *The ability to reason and solve problems involving new information, without relying extensively on an explicit base of declarative knowledge derived from either schooling or previous experience (Carpenter et al, 1990)*
- ◆ Concerned with basic processes of reasoning and other mental activities that depend only minimally on learning and acculturation (Carroll, 1993)

Crystallized Knowledge: Gc

- ◆ *A measure of the extent to which an individual has appropriated, for personal use, the knowledge of a culture.*
- ◆ **Organized in verbal-linguistic terms, manifested in *vocabulary* & information**
- ◆ *Well-learned and well-practiced learning assemblies and strategies that facilitate acquisition of further knowledge.*

Gc Knowledge Usefully Regarded as Either Declarative or Procedural

- ◆ ***Declarative Knowledge:*** acquisition and retention of facts and recollection of prior experiences that are *explicit* -- available to conscious awareness, thus indicated by whether the knowledge can be verbally reported.
- ◆ ***Procedural Knowledge:*** acquisition and retention of performance skills, indicated by tasks in which learning and memory is expressed *implicitly* -- (i.e., without awareness), used in thinking without being accessible to consciousness.

Short-Term Apprehension- Retrieval: SAR

- ◆ The ability to hold information in immediate awareness and work with it –transform it, manipulate it– within a few seconds (up to less than a minute).

Long-Term Storage Retrieval: TSR (Long-term Memory)

- ◆ Fluency in retrieval of information consolidated in memory storage minutes, hours, days, months, years before. Whereas Gc indicates the breadth of knowledge, TSR indicates facility in retrieving knowledge.

Visualizing Abilities: Gv

- ◆ Measured in tasks involving visual closure, constancy, and fluency in recognizing the way objects appear in space as perspective changes when they are rotated, flip-flopped and obscured in various ways

Hearing Abilities: Ga

- ◆ Organization of processes involved in sound discrimination and localization, pattern recognition, detection of rhythm, and comprehending (filling in) degraded acoustical signals.

Cognitive Processing Speed: Gs

- ◆ Speediness of performance in a wide variety of speeded cognitive simple tasks in which people can perform at near perfect accuracy if the task is not speeded.
- ◆ It appears to be a temperamental trait at the manifest level, but it correlates positively with most measures of ability, including most notably Gf, which suggests that it is an aspect cognitive capability.

Quantitative Ability: Gq

- ◆ An individual's store of acquired quantitative information -- *knowledge of the system of numbers and a form of reasoning based on this knowledge*

Spearman's g

General Intelligence

Where is g?



Problems With Finding Spearman's g

◆ Carroll (1993) lists "...153 factors, in 146 datasets, classified as measuring 'general intelligence' or possibly Spearman's factor g ."

Problem is that although each of these general factors is the highest order factor among the ability measures of the battery in which it is calculated, the batteries sample different sections of the domain of cognitive abilities; so the general factor in one battery is different from the general factor in other batteries.

Fails the Test of Factor Invariance

- ◆ Carroll (1993) "...the G factor for a given dataset is dependent on what lower-order factors or variables are loaded on it."
- ◆ The factors classified as indicating G do not meet even the criteria of configural invariance, much less the criterion of metric invariance.
- ◆ Metric invariance is a necessary structural condition for construct validity. The same construct must be measurable under different conditions (in different samples, in the same samples on different occasions).

Spearman's $g = Gf$

- ◆ Gustafsson (1989) found a g -factor at the third-order that is indistinguishable from Gf -factor at the second-order.
- ◆ In major respects the concept of Gf is the same as the concept Spearman discussed in his writings of 1920-1930 as *Apprehension of fundamentals, education of relations and education of correlates*
- ◆ But the $g = Gf$ factor does not account for the variances of other second-order factors and thus does not describe the covariances among other variables indicative of intellectual capability. It is *a* factor, but not *the* factor, of human intelligence.

The g=Gf Factor Among Process Indicators Suggested by Spearman

		g=Gf	Add V	Add F	Add Z
Apprehension					
Focus Att.	Slow Tracing	.55	.56	.54	.53
Span App.	Recency+Primacy Memory	.48	.47	.46	.46
Speed App	Finding + Comparing	.63	.64	.61	.61
Eduction of Relations					
Spatial	Punched Holes	.33	.34	.34	.49c
Verbal	Common Word Analogies	.34	.44a	.33	.33
Eduction of Correlates					
Verbal	Remote Associations	.31	.36	.46b	.29
Symbolic	Letter Series	.70	.71	.69	.68
One Factor Model Fit With N=198		RMSSR			
Initial seven variable model		.034	Acceptable		
Add :	a = Verbal Comprehension	.081	Not acceptable		
	b = Ideational Fluency	.088	Not acceptable		
	c = Gestalt Closure	.086	Not acceptable		

Other Construct Validity Evidence: Different Patterns of Age Change

◆ Capabilities For Which There is Little or No Aging Decline

Gc: Knowledge

TSR: Tertiary Storage Retrieval

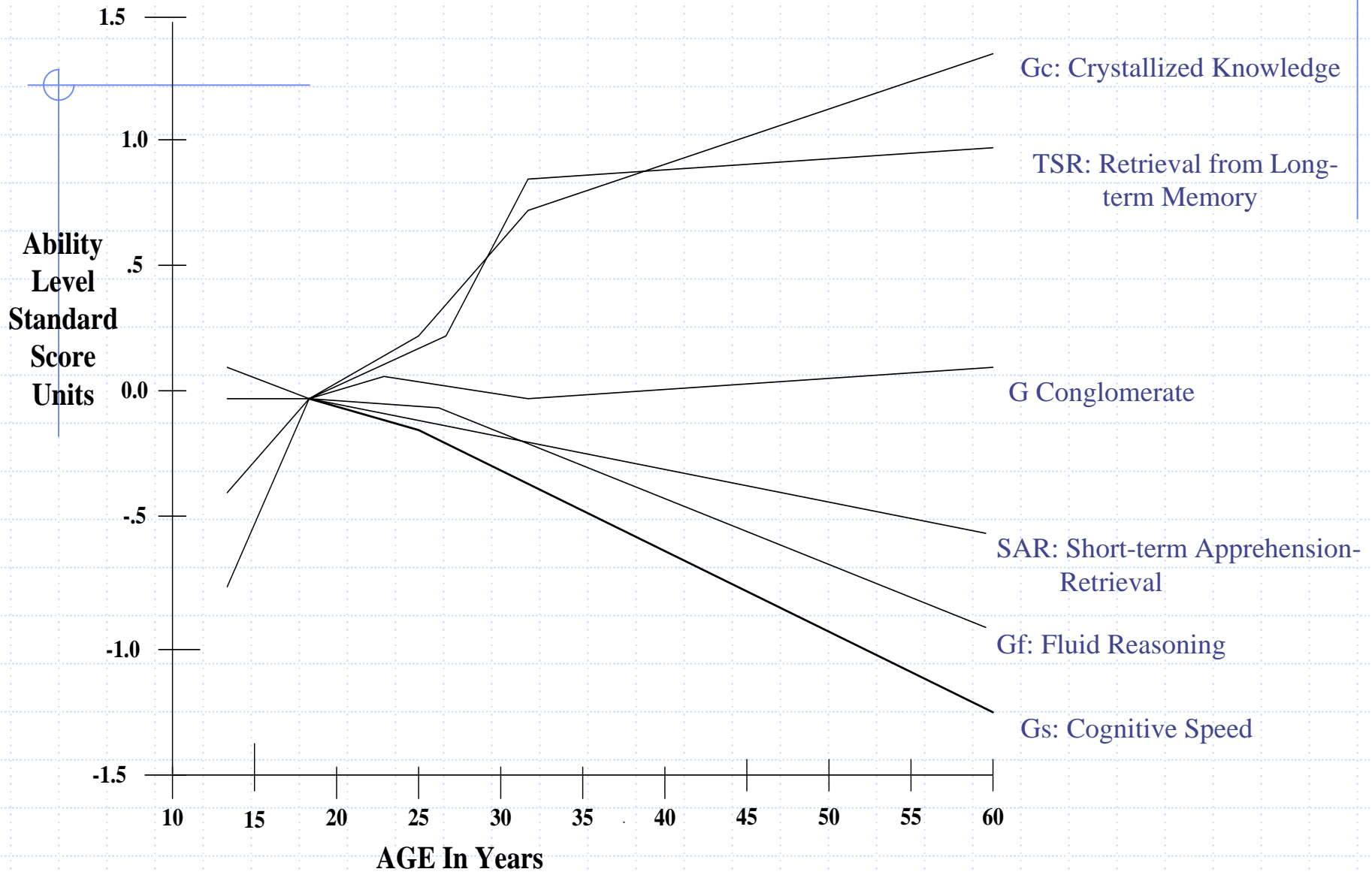
◆ Declining Capacities

Gf: Reasoning

SAR: Short-term Apprehension

Gs: Cognitive Speed

Adulthood Age Differences in Cognitive Capabilities



Conclusions on g

- ◆ Positive correlations among cognitive ability measures is necessary but not sufficient evidence in support of an hypothesis stipulating a g construct –a superordinate general principle of process uniting all cognitive abilities.
- ◆ It is reasonable to suppose that there should be such a principle, but the sufficient evidence to support the g hypothesis has yet to be found.

Problems In Describing Adult Intelligence With Current Theory

- ◆ Adults that are intellectually able in life pursuits that demand high levels of reasoning, memory and cognitive speed score lower on tests of intelligence -- particularly those of Gf, SAR and Gs-- than younger persons not as able
- ◆ Suggests that extant tests are not measuring important aspects of the reasoning, memory and speed that is characteristic of adult intelligence.

Limitations in the Measures of the Gc Factor: Dilettante Measure

- ◆ **Breadth**: The breadth and depth of knowledge is too great to identify accurately within the confines of time available for measure. Current tests do not adequately sample the depth, particularly
- ◆ **Reasoning**: Test indicating the Gc factor do not well indicate reasoning, much less the high level of reasoning that characterizes the thinking of adults, at least those in some lines of work.

Expertise Development in Adulthood

Learning and Cognitive Development Do Not End With Entry Into Adulthood

- ◆ **Ericsson, Charness on Expertise**
- ◆ **Lubrinski, Benbow on Work Adjustment**
- ◆ **Ackerman on Adult Development**
- ◆ **Masunaga, Horn on GO Abilities**

- ◆ **All find that abilities continue to develop in adulthood**
- ◆ **More so for some than for others**
- ◆ **Example from Masunaga-Horn**

Invariant Factors Over Three Age Groups Among Comparable Expertise & Non-Expertise Measures

	EWM	EDR	Gf	Gs	STWM
1. REPGO5	.79	.00	.00	.00	.00
2. REPGO8	.87	.00	.00	.00	.00
3. RECGO7	.75	.00	.00	.00	.00
4. RECGO11	.77	.00	.00	.00	.00
5. SPDIDENTGO	.00	.76	.00	.57	.00
6. SPDCOMPGO	.42	.00	.00	.60	.00
7. REASONGO	.12	.66	.20	-.20	.00
8. REP	.00	.00	.00	.00	.88
9. REC	.11	-.14	.00	.00	.53
10. SPDIDENT	-.12	.00	.00	.71	.00
11. SPDCOMP	.00	.00	.27	.55	.00
12. MAZE	.00	.00	.46	.00	.00
13. BACKSPAN	.00	.00	.59	.00	.00
14. TOPOLOGY	.00	.13	.62	.00	.00

Fitting Intercorrelations Of Five First-order Factors Among Expertise and Non-expertise Measures: Non-expertise & Expertise

Eigenvalues: 2.73057 1.18058 0.43750 0.38850 0.26284

	Factor Loadings		Communalities
	Non-Ex	Expert	
EWM	0.463	0.687	0.686
EDR	0.027	0.928	0.862
Gf	0.777	-0.250	0.666
Gs	0.695	-0.288	0.566
STWM	0.710	0.021	0.505
Variance	1.806	1.479	3.285

Similar But Different Operational Definitions of Working Memory

- ◆ **Expertise Working Memory:** Reproduce a configuration involving up to 36 GO stones after the pattern has been exposed 8 seconds
- ◆ **Short-term Apprehension/Retrieval (SAR, or Short-term Working Memory):** Reproduce a configuration involving up to 36 shapes after the pattern has been exposed 8 seconds.
- ◆ **Tertiary Storage Retrieval (TSR)**
Retrieve shapes after 5 minutes

Working Memory at Different Levels of Expertise: N=263

Level of GO Expertise	Recall: % of possible		
	SAR	TSR	EWM
1. Amateur: 5 years	.24	.11	.34
2. Amateur: 5-10 Years	.26	.09	.52
3. Professional	.22	.08	.86
4.			

Self-Reported Hours Per Week Studying GO Among 263 Experts At Different Levels Of Expertise

Proportions In Each Category Of
Hours Spent In "Typical" Week

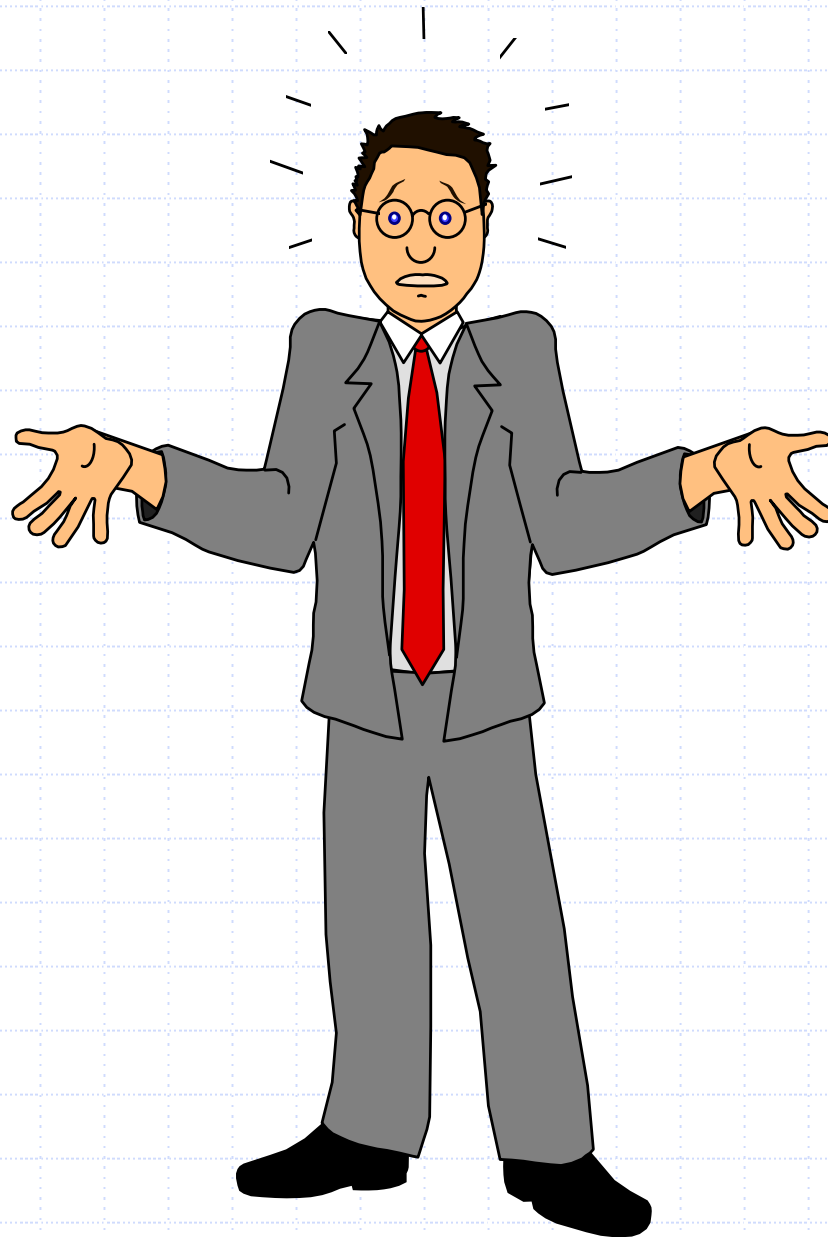
Level of Expertise

-10 11-20 21-30 31-50 50+

PROFESSIONALS	0	15	35	45	5
ADVANCED AMATEURS	1	3	43	46	7
INTERMEDIATE AMATEURS	4	11	50	43	3
BEGINNING AMATEURES	6	14	47	32	0

Extrapolations

- 1. The development of intellectual capacities into adulthood produces a form of Wide-Span Apprehension-Retention distinct from what has been identified as Working Memory and a form of Deductive Reasoning that builds upon Wide-Span Apprehension-Retention.**
- 2. Interventions aimed at raising the level of intelligence should be designed to enhance these dimensions of cognition.**





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your comments!



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