

Order of Hierarchical Complexity Scores for the WAIS-IV Verbal Subtests

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What is WAIS Test?

- An adult intelligence is a score most often measured by the Wechsler Adult Intelligence Scale (WAIS)
- The Current fourth edition (WAIS-IV) Includes (Wechsler, 2008) :
 - Verbal Comprehension
 - Similarities
 - Vocabulary
 - Information
 - Comprehension
 - Perceptual Reasoning
 - Working Memory
 - Processing Speed
- The verbal test score has been shown to strongly predict the WAIS full scale score (Wildman & Wildman, 1977)

Limitations of IQ Tests

- IQ tests are developed using norms and *psychometric analysis*
 - Only responses are analyzed in psychometrics using factor analysis
 - It is not known why some items are more difficult than others a priori
- To a large extent, intelligence tests only test surface information (McClelland, 1973)
- These tests have been shown to have cultural and education level biases
- Intelligence tests may mainly predict testing-taking and symbol-manipulation competencies (McClelland, 1973)

Theoretical and Empirical Relationships between Psychometric and Piagetian Conceptions of Intelligence

- Piaget's definition about IQ is an individual's place in a universal sequence of development toward formal operational reasoning (McClelland, 1973)
- Piagetian's cognitive stage measures provide a rational standard for educational intervention (Kohlberg & Mayer, 1973)
- Piaget's definition of intelligence is not limited to school-type success (Devries, 1974)
 - It takes the long-range perspective of the evolution of knowledge and intelligence in the individual
 - It describes changes with age in the structure of knowledge
 - It describes changes in reasoning about reality

Correlation Between IQ Tests and Piaget-Type Tasks

Paper	Test Used	Correlation	N	Age
Devries, 1974	Fifteen Piaget-type Tasks and Stanford-Binet IQ Test	$r = 0.34$	143	Age 5-7
Humphreys and Parsons, 1979	Twenty Seven Heterogeneous Piagetian Tasks and 11 Wechsler Subtests	$r = 0.837$	150	Age Range: Age 6-10, 10-14 and 14-18
Dudek, Lester, Goldberg and Dyer, 1969	Nine Piaget test and Wechsler intelligence scale for children	$r(\text{kindergarten}) = 0.48$ $r(\text{Grade 1}) = 0.52$ $r(\text{Grade 2}) = 0.56$	100	Age 5-8

- $r_{\text{Average}} = 0.578$

The Model of Hierarchical Complexity

- **The Model of Hierarchical Complexity (MHC)** (Bernholt, Parchmann, & Commons, 2009; Commons, Goodheart, Pekker, Dawson, Draney, & Adams, 2008; Commons, Goodheart, Pekker, A., Dawson-Tunik, Cyr, E., Rodriguez, et al., 2005; Dawson, 2002; Skoe, (in press))
- Is a non-mentalistic, neo-Piagetian and quantitative behavioral development theory
- It offers a **standard method** of examining the universal pattern of development
- A fundamental assumption is that development proceeds across a large number of general **sequences** of behavior
- These sequences exist in every domain including
 - Mathematical, logical, scientific, moral, social, and interpersonal domains
- The stages of the MHC have been shown to predict human's “smartness” in the colloquial sense using the Laundry and the Balance Beam instruments (Commons, Goodheart, Pekker, Dawson, Draney, & Adams, 2008)

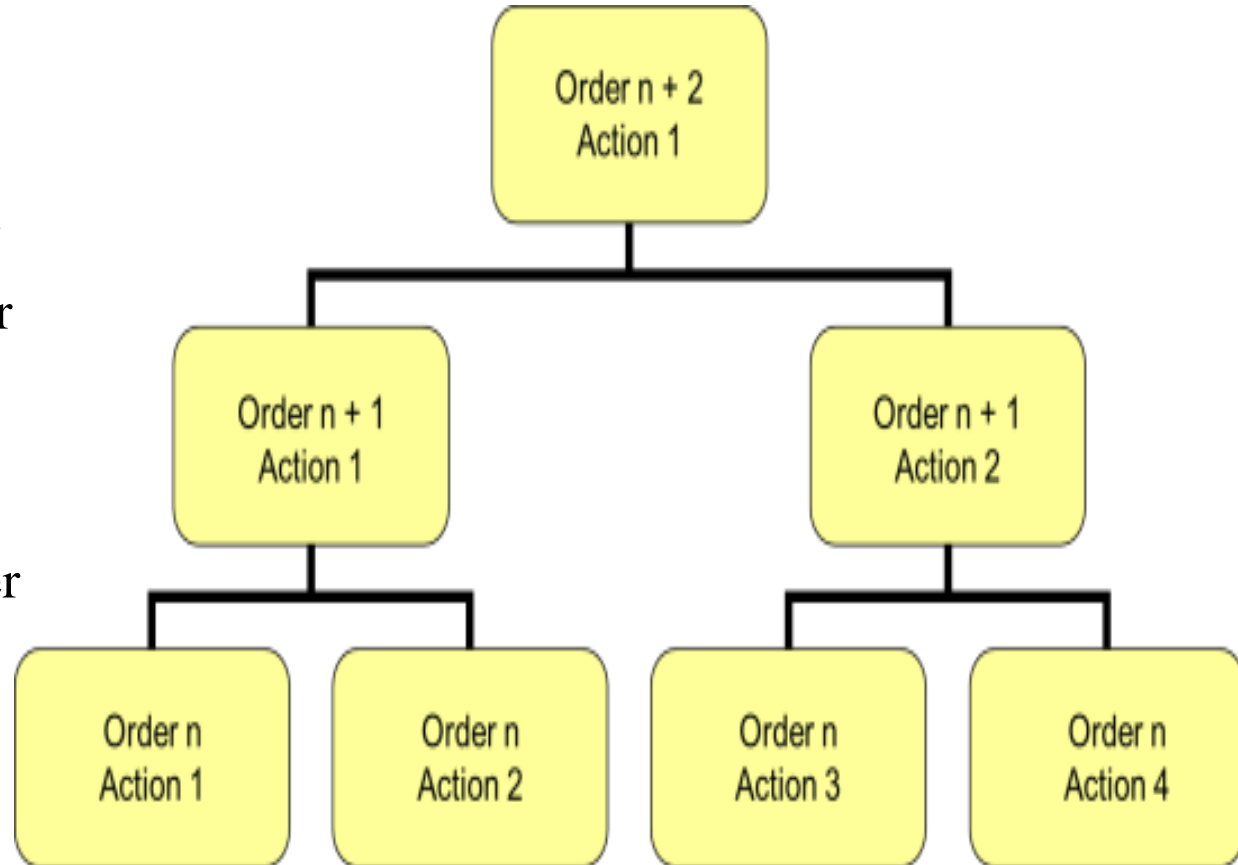
The Model of Hierarchical Complexity: What Does It Consist Of ?

- ***Orders***
 - The different layers in a hierarchical sequence of task complexity are referred to as “orders”
- ***Stages***
 - The **successful completion** of a task of a given order is referred to as “stage”
- ***Orders of Hierarchical Complexity*** (OHC)
 - Assess the predicted difficulty of behavior tasks (Commons & Miller, 1998; Commons & Pekker, 2008; Commons & Richards, 1984a, 1984b; Commons, Trudeau, Stein, Richards, & Krause, 1998, Commons, Gane-Mcalla, Barker, Li, in press)
 - The OHC is a equally-spaced unidimensional ordinal scale
 - The OHC measures difficulty independent of domain and content
- The higher the order of hierarchical complexity, the more the difficulty of the task

Three Axioms of The Model of Hierarchical Complexity

Higher Order Action Is:

- a) Defined in terms of tasks actions from the **next lower** order of hierarchical complexity
- b) Defined as the higher order task action that **organizes** two or more less complex actions
- c) The ordering of lower task actions have to be carried out **non – arbitrarily** way



The Model of Hierarchical Complexity Generates 16 Known Orders

- MHC Generates 16 Orders or Hierarchical Complexity

Order Number	Order Name	Order Number	Order Name
0	Computational	8	Concrete
1	Sensory Or Motor	9	Abstract
2	Circular Sensory Motor	10	Formal
3	Sensory-Motor	11	Systematic
4	Nominal	12	Metasystematic
5	Sentential	13	Paradigmatic
6	Preoperational	14	Crossparadigmatic
7	Primary	15	Meta- Crossparadigmatic

Why We Use the Model of Hierarchical Complexity to Score IQ Test?

- The *Model of Hierarchical Complexity* is cultural, content and education free
 - It is just mathematical
- Assessments based on the Model Of Hierarchical Complexity may be a better measurement of intelligence than contemporary IQ tests
- The MHC does a better job measuring intelligence because
 - It does not rely on psychometrical analyzed norms
 - It based on a simple, clear mathematical model
 - They are based on what order of hierarchical complexity of test items that are correctly done

The Hierarchical Complexity Scoring System

- The Hierarchical Complexity Scoring System (HCSS) was used to score (Commons, Miller, Goodheart, & Danaher-Gilpin, 2005) the tasks in the Verbal Comprehension Section of WAIS-IV
- The HCSS is an application to score difficulty of tasks based on the Order of Hierarchical Complexity
 - It entails several steps for assessing performance on a task

Definitions of the Orders 1

Order	Characteristic of the Order	Examples of Words
4 Norminal	<ul style="list-style-type: none"> • Single words: verbs, nouns, number names, letter names 	<ul style="list-style-type: none"> • water
5 sentential	<ul style="list-style-type: none"> • Generalize Match-dependent Task Actions • Incomplete Sentences or Complete Sentences • Crude Dichotomies 	<ul style="list-style-type: none"> • Pronouns: my, mine, I; yours, you; we, ours; they, them • simple sentences
6 preoperational	<ul style="list-style-type: none"> • Make simple deductions Follows lists of sequential acts • Tell stories • products of simple operations 	<ul style="list-style-type: none"> • Connectives: as, when, then, why, before; • The categorization of fruit is a sequential act
7 primary	<ul style="list-style-type: none"> • Stories with logically order sequenced events connected solidly to reality with some specified times, places, acts, actors • Either perspective of self or other • Addition and subtraction 	<ul style="list-style-type: none"> • Right • Wrong

Definitions of the Orders 2

Order	Characteristic of the Order	Examples of Words
8 concrete	<ul style="list-style-type: none">• Stories about things, incidents, events, actors, actions, places in the context of the interaction between self and other• Multiplication and division	<ul style="list-style-type: none">• Things• Incidents Events• Actors• Actions• Places
9 abstract	<ul style="list-style-type: none">• Form variables out of finite classes• A label given a group of concrete things	<ul style="list-style-type: none">• Classification words• Variables such as Stereotypes, Logical Quantification
10 formal	<ul style="list-style-type: none">• Argue using empirical or logical evidence• Single variables on input side Empirical, or logical evidence and argument	<ul style="list-style-type: none">• Linear, logical, one dimensional• If...then, thus, therefore, because

Definitions of the Orders 3

Order	Characteristic of the Order	Examples of Words
11 Systematic	<ul style="list-style-type: none">• Coordinates more than one variable as input• Systems of relations• Relations among relationship among variables	<ul style="list-style-type: none">• System, Legal, Societal, Corporate, Economic, National, Functional, Structural
12 Metasystematic	<ul style="list-style-type: none">• Constructs multisystems out of disparate systems and perspectives	<ul style="list-style-type: none">• Autonomy, Parallelism, Heteronomy, Completeness, Incompleteness

A Score Summary with Verbal Comprehension Section

Verbal Comprehension	Lowest Order in Questions		Highest Order in Questions	
Similarities	Nominal	(Order 4)	Systematic	(Order 11)
Vocabulary	Sentential	(Order 5)	Systematic	(Order 11)
Information	Primary	(Order 7)	Primary	(Order 7)
Comprehension	Abstract	(Order 9)	Systematic	(Order 11)

- The results of this study are shown by the scoring of the WAIS-IV items

Scoring for **Similarities** Section 1

- **Question: In what way are a FORK and a SPOON alike?**
- Sample Answers for 2 points

Sample Answer	HCSS Scoring	Explanation
Deliver food to your mouth	Sentential Order 5	The incomplete but logical sentence makes the answer Sentential Order 5
Eating (utensils, tools)	Preoperational Order 6	The modifier makes the answer Preoperational Order 6
Utensils	Preoperational Order 6	The modifier makes the answer preoperational Order 6
Silverware	Preoperational Order 6	The modifier makes the answer preoperational Order 6

Scoring for **Similarities Section 2**

- **Question: In what way are a FORK and a SPOON alike?**
- Sample Answers for 1 point:

Sample Answer	HCSS Scoring	Explanation
Eating	Nominal Order 4	Single word expression (verb) makes the answer Nominal Order 4
On the table	Sentential Order 5	The incomplete but logical sentence makes the answer Sentential Order 5
Have handles	Sentential Order 5	The incomplete but logical sentence makes the answer Sentential Order 5
Eat Put in (your, the) mouth	Sentential Order 5	The incomplete but logical sentence makes the answer Sentential Order 5
Are handheld	Preoperational Order 6	The modifier makes the answer preoperational Order 6

Scoring for **Similarities** Section 3

- **Question: In what way are a FORK and a SPOON alike?**
- Sample Answers for 0 points

Sample Answer	HCSS Scoring	Explanation
Both long	Sentential Order 5	Two words phrases are sentential
Made of (plastic, metal, silver)	Sentential Order 5	Two words phrases are sentential

- IQ gives these answers 0 points, because they believe these answers do not differentiate any further than not answering the question
- However, HCSS gives these answers scores because they are storable based on HCSS

Sample Scoring for Vocabulary Section 1

- **Question: Palliate**
- Sample Answers for 2 points

Sample Answer	HCSS Scoring	Explanation
Soothe	Abstract Order 9	A description of feeling makes the answer Abstract Order 9
Whitewash (Reduce, Decrease, Ease, Moderate, Relieve, Diminish) the (pain, symptoms, soreness)	Formal Order 10	The description of empirical logic between variables makes the answer Formal Order 10
(Reduce, Decrease, Ease, Moderate, Relieve, Diminish) the intensity	Systematic Order 11	The words represent analytic concepts of degrees which require systematic performance
Alleviate	Systematic Order 11	It represents analytic concepts of degrees which requires systematic performance

Sample Scoring for **Vocabulary Section 2**

- **Question: Palliate**
- Sample Answers for 1 point:

Sample Answer	HCSS Scoring	Explanation
Make better	Sentential Order 5	The incomplete but logical sentence makes the answer Sentential Order 5
Diminish	Abstract Order 9	A description of abstract variable makes the answer Abstract Order 9
To (cloak, conceal, shelter, hide)	Abstract Order 9	A description of abstract variable makes the answer Abstract Order 9
Reduce	Formal Order 10	The description of empirical logic between variables makes the answer Formal Order 10
Moderate	Formal Order 10	The description of empirical logic between variables makes the answer Formal Order 10

Sample Scoring for **Vocabulary Section 3**

- **Question: Palliate**
- Sample Answers for 0 points

Sample Answer	HCSS Scoring	Explanation
Care for older people	Sentential Order 5	The incomplete but logical sentence makes the answer Sentential Order 5
Show emotion	Sentential Order 5	The incomplete but logical sentence makes the answer Sentential Order 5

Sample Scoring for Information Section 1

- **Question: What is the circumference of the Earth at the equator?**
- Sample Answers for 1 point

Sample Answer	HCSS Scoring	Explanation
24,901 miles	Concrete Order 8	The task of reciting memorized knowledge about the world is at the Concrete Order 8
Any response ranging from 19,921 to 29,881 miles	Concrete Order 8	It is hard to score any of these knowledge higher than Concrete Order 8

Sample Scoring for Information Section 2

- **Question: What is the circumference of the Earth at the equator?**
- Sample Answers for 0 points

Sample Answer	HCSS Scoring	Explanation
Any response ranging from 19,921 to 29881	Concrete Order 8	The wrong answers do not lower their stage
Any response less than 19,921 miles or greater than 9,881 miles	Concrete Order 8	The wrong answers do not lower their stage
Any response from 32,060 to 48,090	Concrete Order 8	The wrong answers do not lower their stage
Any response less than 32,060 kilometers or greater than 48,090 kilometers	Concrete Order 8	The wrong answers do not lower their stage

Sample Scoring for **Comprehension Section 1**

- **Question: Why are there limits on trying someone twice for the same crime?**
- Sample Answers for 2 points

Sample Answer	HCSS Scoring	Explanation
Recognition that it provides protection from or acts as a safeguard against a corrupt legal system	Systematic Order 11	Coordinates more than one variable in a system makes the answer Systematic Order 11
To avoid malicious prosecution	Systematic Order 11	Coordinates more than one variable in a system makes the answer Systematic Order 11
To keep the (courts, legal system) from being (corrupt, unfair, unjust)	Systematic Order 11	Coordinates more than one variable in a system makes the answer Systematic Order 11

Sample Scoring for **Comprehension Section 2**

- **Question: Why are there limits on trying someone twice for the same crime?**
- Sample Answers for 1 point

Sample Answer	HCSS Scoring	Explanation
Recognition that it violates an individual's right to a fair trial or constitutes double jeopardy	Formal Order 10	The description of empirical logic between variables makes the answer Formal Order 10
Recognition that it would be detrimental to the court system in terms of public perception, time, or cost	Systematic Order 11	Coordinates more than one variable in a system makes the answer Systematic Order 11

Sample Scoring for **Comprehension Section 3**

- **Question: Why are there limits on trying someone twice for the same crime?**
- Sample Answers for 0 points

Sample Answer	HCSS Scoring	Explanation
General concept: Vague reference to law, constitutional rights, or protection of the accused	Random	Not Scorable
Indication that people only need to be found guilty or innocent one time	Random	Not Scorable

WAIS-IV Scoring System Limitations

- The WAIS-IV scoring is incomplete
 - The score 0 can be expanded into many lower order stages as shown by HCSS scoring
 - The 0 point also includes unscorable somewhat randomly appearing answer
 - These are not probed as would be done in a Piagetian type interview
- In some cases, the WAIS-IV Scoring System is also inconsistent based on HCSS scoring
 - Each question has more than one order within the same point answer
 - This restricts the range and therefore lowers the predictability and validity
- The information subsubsection of the verbal subsection to a large extent depends on culture, experience and knowledge
 - People in other culture may not understand the specific facts the WAIS-IV mentioned in the test, which may lower their scores

Why Is Stage A Better Measure of “Smartness”?

- It does not rely on norms and *psychometrics* for which
 - Only responses are analyzed in psychometrics
 - It is not known a priori why the items are more difficult
- The order of hierarchical complexity is based on 3 axioms
- There is no corresponding analytic a priori mathematical analysis of items on IQ tests
- No such measure is available with IQ because it is *psychometric* and not *psychophysically* tested
 - In psychophysics, stimulus characteristics are used to predict response characteristics
 - Task difficulty is scored using HCSS
 - *Order Of Hierarchical Complexity* predicts Rasch performance difficulty with r 's of over 0.9

Possible Future Study With Chinese Data

- Method
 - Participants
 - A wide range of participants is needed
 - They may be
 - “Normal”
 - Brain injured
 - Psychotic
 - Criminal
 - Retarded
 - Or otherwise
- Result
 - A Rasch Analysis will be preformed to obtain
 - Items scores
 - Person scores
 - Rasch Analysis is independent of types on participants
 - It is also indented of particular form of test

What a Future Study Will Consist of

- With actual data on individuals we will answer
 - What is the relationship between Rasch person scores and WAIS-IV verbal scores
- To answer this there are a number of steps
 - OHC of items is obtained as we did in this paper
 - Rasch Scores for Items & persons is obtained
 - Rasch items scores will be predicted from the OHC scores
 - Their WAIS-IV scores will be predicted from the Rasch Person Scores
- Therefore, we will know how well Rasch person predict IQ
- To find out how stage predicts WAIS-IV scores, we will see
 - How the Rasch person scores will line up with mean item Rasch scores to the right of them on the Rasch Map
- We will work on how do we figure out how to go from items to IQ

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