The Roots of Intellectual Assessment

- Chinese Civil Service Exams
  - Circa 2200 BC

- 19th and early 20th Century
  - Early concepts of intelligence focused on sensorimotor activity
    - *Brass Instrument* psychology

The Father of the testing movement:
- Sir Francis Galton
  - Two important statistical concepts:
    - Regression to the mean
    - Correlation
  - Conceptualization of intelligence:
    - Our knowledge of the environment reaches us through the senses
      - From John Locke
    - Therefore, those with more acute sensory processes should be more intelligent
    - Created tests of sensory discrimination and motor coordination to assess mental function
The Roots of Intellectual Assessment

- Mental inheritance
  - Galton sought to demonstrate that a person’s natural abilities are derived by inheritance, just as physical features are.
  - Did I tell you his cousin was Charles Darwin?
  - Human abilities are genetically determined and the human species can be improved through controlled breeding practices
  - Eugenics
  - To prove the inheritance of intelligence, Galton examined eminent people
  - Showed that the probability of fame was correlated with having a famous relative

- Mental Tests
  - Even though we usually attribute this term to Cattell (see later), it was Galton who influenced Cattell in that direction

- Anthropometric Lab
  - Measured visual and auditory acuity, a judgment of visual distance, breathing power, reaction times, color discrimination, the strength of a blow, and olfactory discrimination
  - International Health Exhibition (1884)
    - Charged people to measure them
    - In 6 years, measured over 9000 people
    - Wanted to define the range of abilities in the British Empire

- The Roots of Intellectual Assessment
  - Idea was off-target, but methods were on target
    - In fact, still in use today
  - Also provided info on developmental trends in the population

- Karl Pearson
  - Others were working on stats in England at this time, too
  - Pearson product-moment correlation
    - Correlation formula for linear correlation, multiple correlation coefficient, phi coefficient, and the chi-square test
The Roots of Intellectual Assessment

- Others in England
  - Cyril Burt
    - Intelligence is strictly inherited
      - No influence of teaching, training, or environment
      - Thus, income levels are determined by intelligence, not environment
    - Unfortunately, it appears as though old Cyril manufactured much of his data.

The Roots of Intellectual Assessment

- Developments in Germany
  - Emil Kraepelin (1855-1926)
    - Psychopathology
    - Developed tests to measure mental functioning
      - Included tests of perception, memory, motor functions, and attention
    - Need to examine individual enough times to reduce chance variation

The Roots of Intellectual Assessment

- Others involved in assessment of motor/perceptual skills:
  - Munsterburg
  - Ebbinghaus
  - Wernicke
The Roots of Intellectual Assessment

Developments in the United States
- The term mental test appeared for the first time in a paper by James McKeen Cattell (1890)
  - Called for standardized tests of intelligence and proposed measurements of intelligence:
    - Dynamometer pressure
    - Rate of movement
    - Two-point skin sensitivity threshold
    - Amount of pressure to the forehead needed to cause pain
  - Just noticeable differences in judging weights
  - Reaction time for sound
  - Time for naming colors
  - Bisection of a 50 cm line
  - Judgment of a 10-second time period
  - Number of letters remembered after a single presentation
  - Others in the U.S.:
    - G. Stanley Hall
    - Franz Boas
    - Henry H. Goddard

Developments in France
- 1903
  - Blin & Damaye developed a set of standardized questions ordered by apparent difficulty that they claimed could identify the mentally retarded
  - Alfred Binet
    - At the same time Binet, Victor Henri, & Theodore Simon were developing methods for the study of mental functions
    - Key was to focus on higher mental processes
The Roots of Intellectual Assessment

- In the late 1800s/early 1900s, three trends were converging:
  - Individual Differences Testing Movement
  - Education Reforms
  - Mental Illness
- Which leads us to the 1905 Binet-Simon Scale of Intelligence
  - In just one moment, first…

Alfred Binet, The Early Years

- Alfred Binet (1857-1911)
  - Student of Wundt’s
  - 1899: founding of Societe Libre pour l’Etude Psychologique de l’Enfant
    - School people who were interested in the scientific study of education
  - Binet asked to be a member and then elected President

Alfred Binet and the Binet Scales of Intelligence

- 1903:
  - La Societe proposed that the French gov’t needed to create tests to differentiate those who could not benefit from normal education from those who would not (stupid vs. malicious)
    - “...[some] children, if considered educably retarded, should be grouped in special classes annexed to the regular school, or in a special establishment, and...that a special class for the educable be opened for the present in one of the Paris schools, as a demonstration.”
  - Results of the recommendation:
    - Commission formed to study the matter; Binet was one of the Commissioners
Alfred Binet and the Binet Scales of Intelligence

- **1905 Scale**
  - First practical test of intelligence
  - Developed by Binet and Theodore Simon
  - Developed a test that differentiated between normal children and those who required additional instructional resources
  - Had 30 tests
  - Items ordered in level of difficulty
    - The more tasks completed, the greater the assumed intelligence of the subject

- **Used the following types of tests:**
  - Association tests in which the child was given 25-30 words and asked to describe the idea each word aroused
  - Sentence completion
  - Picture drawings
  - Object drawing and description
  - Digit repetition and other memory and attention tests
  - Accompanied by relatively careful instructions for administration
  - Some concern with age-based cognitive development
  - Objectively diagnosed degrees of mental retardation

Criticisms of the Binet Scale

- Tests were too easy for the subjects
- Several flaws in the instrument
- Led to the 1908 revision
1908 Revised Binet-Simon Test of Intelligence

- Test items are now grouped by ages at which children usually passed them
  - Rather than by level of difficulty
  - If a majority of children at a given age (75-90%) passed an item, it was assigned to that age level
- 54 tests
  - 14 of the original 30
  - Created different tests for children of different ages

1908 Revised Binet-Simon Test of Intelligence

- Included mental level
  - Emphasized change and fluctuation in intelligence
  - Dramatically increased the attention paid to the test from outside of France
  - When a child was tested, his or her mental level was said to be equivalent to that of the highest age group wherein he or she could pass all of the tests for that group

1911 Binet-Simon Test of Intelligence

- Final revision to the test
  - Even in the early days, tests were revised continually
- Contained only minor revisions
  - Tests were relocated
  - Number of tests per age was set at 5
- Binet died October 18, 1911
Binet’s Assumptions About Intelligence

- Whatever intelligence is, it is something that shows a normal and fairly consistent course of average intelligence.
- Intelligence is needed for success in school.
- These two points formed the basis for the Binet-Simon scales.

Binet’s Views on Heritability

- Scientific atmosphere dominated by Darwinism and the theory of evolution.
- Binet, however, felt that intelligence was modifiable.
  - He proposed mental orthopedics.
  - Reaction to the idea that intelligence is fixed and inherited:
    - “…we must protest and react against this brutal pessimism…”

Binet in Context

- Just one of many working on a test of intelligence.
  - How intelligence was defined differed among these theoreticians.
    - And continues today.
- Binet worked methodically.
  - Desired to improve classification of students rather than define intelligence as a concept.
Binet in Context
- As early as 1890, Cattell had pointed out the need for a normative data base.
- However, early work in intelligence focused on reaction times and sensory processing.
- Binet’s contribution was to move beyond sensory processes and into higher cognitive functions.

1916 Stanford-Binet and “IQ”
- Henry Goddard
  - Director at Vineland Hospital
  - Encountered and tried out the 1908 Binet scale:
    - Liked it a lot
    - Developed translation of the scale
    - Worked to popularize the scale
    - Wanted to use adaptations of the Binet scale to differentiate classes of mental retardation and facilitate treatment.

1916 Stanford-Binet and “IQ”
- Lewis Terman
  - Stanford University
  - 1911:
    - Observed that the 1908 Binet had great practical and theoretical value
    - Also recognized the need for standardization since there was now a proliferation of Binet scales
  - 1916:
    - Revised the Binet-Simon scale
    - Later called the Stanford-Binet
    - Replaced all other tests of intelligence.
1916 Stanford-Binet and “IQ”

- Terman added additional tests to supplement those in the Binet-Simon test
- Standardized the test on 2600 California children
- Adopted the concept of mental quotient
  - Idea originated with Wilhelm Stern of Germany (1914)
  - Terman provided the formal expression
  - MA/CA = MQ
  - Also known as a Ratio IQ Score
  - Terman renamed this ratio Intelligence Quotient
  - Later in the 1920’s, the formula would be amended so that
    the quotient was multiplied by 100
    - MA/CA \times 100 = IQ
  - Binet would not have liked this

Criticisms of the IQ

- Ratio IQ is highly age dependant
  - Certain tasks should be completed by certain ages
  - If people complete the tasks early, they are intelligent
  - Wildly inaccurate as people age
  - Robert Yerkes
    - IQ should be derived from the mean score for people of the same age as the examinee
      - coefficient of intelligence

Criticisms of the IQ

- Terman, obviously, did not agree and kept the Ratio IQ score in the Stanford-Binet
- Terman’s prestige won out all the way to the 1956 version of the Stanford-Binet, which incorporated a Deviation IQ score
Further Revisions of the Stanford-Binet

- Stanford-Binet remains popular
  - In 5th revision
  - Not the Big Dog any more, though

The Influence of WWI

- Testing of military recruits provided the first massive use of psychological tests
  - Robert Yerkes (Psychological Testing Corps) and Lewis Terman (Stanford University) created the Army Alpha and Army Beta tests
    - Tests intended to help the Army, primarily through the elimination of feeble-minded recruits
    - Designed to measure native ability rather than the results of school testing (Samelson, 1977, p. 276)

The Influence of WWI

- Hundreds of psychologists and psychology grad students were recruited to help
  - Among them, one David Wechsler
  - Realized early on that individual testing would be too time consuming
    - Designed Alpha and Beta to be group administered
  - Eventually, over 2,000,000 intelligence tests were administered
    - 8,000 men recommended for immediate discharge
    - 19,000 men were assigned to labor or development battalions
The Influence of WWI

- This experience engrained the psychological test in American psychology
  - Because of Alpha and Beta, the General Education Fund initiated a grant for the development of an intelligence test for children
  - National Test of Intelligence—given to approximately 7 million children during the 1920's
- Testing provided unity for the field of psychology
  - Before the war, there were big rifts in the field

Testing allowed Terman to bring psychology down from the clouds and [make] it useful to men (Samelson, 1977, p. 275)

Criticisms/Problems After the War

- Mostly centered around the scientific findings from the data
- Average mental age for soldiers was 13 years
  - 12 years is considered the upper limit for feeblemindedness
  - Fed into discussion about about eugenics, race deterioration, democracy and public education
Criticisms/Problems After the War

- Results pertaining to race and nationality
  - Southern and Eastern Europeans inferior in scores to Northern Europeans
  - African Americans inferior to Caucasians
  - Findings were eventually abandoned, except maybe as prejudices
  - We’ll talk more about this when we get to correlates of intelligence

Criticisms/Problems After the War

- Question as to whether Alpha and Beta actually assessed native ability rather than school learning
  - Assessment of school learning could (and probably does) account for racial differences
    - Alpha and Beta were highly correlated with school learning
      - Yerkes et al. took this to mean that native intelligence kept people in school longer rather than the other way around

Criticisms/Problems After the War

- Problems with Beta
  - Nonverbal test where examinees had to perform ballet moves
    - Some evidence that African American recruits fell asleep while examiners pantomimed instructions
  - Everybody and his brother created an intelligence test
    - 1921: Thomas Edison intelligence test
      - Few people could answer his questions
      - Led to some loss of faith in psychological testing
The Influence of James McKeen Cattell

- Huge promoter of psychological tests and testing
- Founded the Psychological Corporation in 1921 as a nonprofit publisher of psychological tests
  - Psychological Corporation remains a major publisher today, but is in the private sector

Defining Intelligence

- Difficulty in defining intelligence
  - Before discussing theories of intelligence, need to know what intelligence is
  - Definitions of intelligence has occupied much time amongst theoreticians in the field
  - Binet defined intelligence functionally
    - In terms of school success and level at which students performed
    - No Intelligence Quotient

Defining Intelligence

- Boring (1923)
  - Intelligence is nothing more than a measurable capacity... to do well in an intelligence test. Intelligence is what the test tests.

- Hebb (1949)
  - Felt that intelligence was an equivocal term that each writer can define... to suit himself, and there is no sense in arguing over terminology
Defining Intelligence

Intelligence as a global capacity
- Wechsler (1939) defined intelligence as the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment.
- Evidence for global nature
  - Individuals who are skilled in certain areas do not possess what would commonly be called high levels of general intelligence.
  - Similarly, individuals may do poorly on one test but are adept at other areas, such as solving problems and adapting to complex life situations.
- Spearman would take up this argument.

Intelligence as a set of abilities
- Others (Thorndike) argued that intelligence is composed of several different abilities.
  - Evidence for this is similar to that used to support the general intelligence position.
  - People do not function at the same level in all areas.
    - cf. school grades.

Stoddard (1943)
- The Meaning of Intelligence
  - Intelligence is the ability to undertake activities that are characterized by:
    - Difficulty
    - Complexity
    - Abstractness
    - Economy
    - Adaptiveness to a goal
    - Social value
    - Emergence of originals
  - These can be done under conditions that demand concentration of energy and a resistance to emotional forces (Stoddard, p. 23, in Reitan & Wolfson, 1992, p. 522).
Defining Intelligence

- Halstead (1947)
  - The definition of intelligence is diverse and poorly operationalized
- Gardner (1985)
  - Theory of multiple intelligences
    - Thorndike revisited
    - Based on Gardner’s introspections on what intelligence is or should be

...it is important to remain open to the possibility that many—if not most—of these competencies do not lend themselves to measurement by standard verbal methods, which rely heavily on a blend of logical and linguistic abilities. (Gardner, p. x, in Reitan & Wolfson, 1992, p. 523)

- Sternberg (1997)
  - Theory of Successful Intelligence
    - Successful intelligence is the ability to succeed in life according to your own definition of success within your sociocultural context by capitalizing on your strengths and correcting or compensating for your weaknesses—and doing this through a combination of analytical, creative, and practical skills in order to adapt to, shape, and select environments (Sternberg, 2003, p. 5)

Defining Intelligence

- Analytical Intelligence
- Creative Intelligence
- Practical Intelligence
- Metacomponents
- Cultural Relevance
  - Emotional intelligence
    - the ability to monitor one’s own and others’ feelings and emotions, to discriminate among them and to use this information to guide one’s thinking and actions (Salovey & Mayer, 1990, p. 189)
Defining Intelligence

- The capacity to process emotional information accurately and efficiently, including that information relevant to the recognition, construction and regulation of emotion in oneself and others (Mayer & Salovey, 1995, p. 197)
- Capacity to reason with emotions in four areas:
  - To perceive emotion
  - To integrate emotion into thought
  - To understand emotion
  - To manage emotion

Definition and Implementation Problems

- We have a number of problems when trying to define and measure intelligence
  - And few of them have been addressed—that’s why we still have problems
  - What is an adequate criterion for the measurement of intelligence?
  - If someone scores highly on an intelligence test, what should that predict?

Definition and Implementation Problems

- What other behaviors should correlate well with high scores?
  - Traditionally, intelligence scores have been correlated with scores from other intelligence tests
  - If intelligence is diverse, what are the diverse expressions of intelligence and how should they be represented fairly on an intelligence test?
Definition and Implementation Problems

- How do we distinguish between what is achievement and what is aptitude?
  - Or, do we have to distinguish between the two (cf., Gardner)
- Do different cultures value the same “type” of intelligence?

Conceptual Framework of Theories of Intelligence

- Theories of intelligence can be broken down into three classes:
  - Factor analytic theories
  - Information-processing theories
  - Developmental theories

Factor Analytic Theories of Intelligence

- What is a factor?
  - Term used to describe the results of a statistical technique called factor analysis
  - In examining factors of intelligence, scores on subtests of IQ tests are correlated with one another
  - If a set of subtest scores correlate well with one another, then a factor name is created to describe what the subtests have in common
Factor Analytic Theories of Intelligence

Looking for $g$ in all the wrong places
- Outline of the debate
  - Thorndike’s grandson recently wrote:
    - ...the contest over the nature of intelligence was fought out across the Atlantic between Charles Spearman and his students in England and E. L. Thorndike and his students in the United States...
  - Nature of the debate focused on whether intelligence can be defined as a single unitary entity or whether intelligence is multi-faceted

Factor Analytic Theories of Intelligence

- Charles Spearman (the $g$-man)
  - Performance on any given test could be attributed to a combination of $g$ and a factor specific to the test
  - Two-factor theory
  - Attempted to demonstrate the existence of $g$ by showing an order in the intercorrelations of subtests on intelligence tests
In general, for most subjects the subtests are highly correlated. Mental horsepower: In 1923, Spearman defined $g$ as a fund of mental energy that a person could bring to a task. Reflects differences in people’s abilities to apprehend experiences, deduce relations among these experiences, and deduce correlates. Thus, $g$ was taken into the realm of encoding and memory of information, inferential reasoning, and... 

Edwin Thorndike (Mr. Multiple Factors): In general, there is evidence of a complex set of bonds between the psychological equivalents of both what we call the formal side of thought and what we call its content, so that one is almost tempted to replace Spearman’s statement by the equally extravagant one that there is nothing whatever common to all mental functions, or to any half of them. (Thorndike, 1990, p. 227) The primary fact is that intelligence is not one thing but many. The abilities measured by a speed test with language and mathematics are not identical with, or even very similar to, those measured by a test with pictures and less exacting in speed. (Thorndike, 1990, p. 228) 

Intelligence is the summation of multiple distinct abilities. Thorndike’s position is much like Binet’s: Intelligence can only be understood in the context of the entire person. Intelligence tests measure only a limited aspect of behavior: Abstract intelligence. Intelligence includes: Social intelligence: The ability to understand and work successfully with people...
Factor Analytic Theories of Intelligence

- Mechanical intelligence
  - The ability to understand and deal with concrete things
- There is not a perfect relationship among different mental tests
- Simpson (Thorndike’s student) conceded there may be something called general mental ability
  - However, there were also certain capacities that were relatively specialized and did not necessarily imply other abilities except to a very limited extent

Resolution to the Debate

- No firm resolution
- In 1920, Spearman claimed victory between himself and Thorndike
  - ...as regards the fundamental theory [of two factors], I venture that this has now been demonstrated with finality...it becomes a bed of Procrustes into which all our doctrines must somehow or other be made to fit. (Thorndike, 1990, p. 228)
- Claim was premature
  - Spearman and Thorndike were never able to agree on the methodology to be used to resolve the issue

Resolution to the Debate

- Data presented by either side was rejected on methodological grounds
- In fact, neither side could have won using the rules as defined by the other
- People still are arguing over this today
Factor Analytic Theories of Intelligence

Raymond Cattell and John Horn
- Two types of intelligence:
  - Fluid intelligence
    - Essentially nonverbal, culture-free mental efficiency
    - At work when learning novel concepts or associations
    - Dependent upon sound neurological functioning
  - Crystallized intelligence
    - Acquired skills and knowledge that are strongly dependent upon exposure to culture
    - Reflects overlearned behaviors and the products of fluid intelligence

Each type are subfactors of a general intelligence
- Some intelligence tests tap into fluid intelligence
  - Block Design, Number and Letter Series, Paired Associations, Figural Analyses, Matrix Reasoning
- Some tap into crystallized intelligence
  - Vocabulary, General Information, Abstract Word Analogies
  - Created Kaufman Assessment Battery for Children (K-ABC) and Kaufman Adult Intelligence Test (K-AIT)

Both tests use sequential and simultaneous processing
- Sequential processing
  - Emphasizes serial, or temporal, order of stimuli when solving problems
- Simultaneous processing
  - Demands a gestalt-like, frequently spatial, integration of stimuli to solve problems

David Wechsler and the Wechsler scales
- Believed in g
  - And that intelligence was a part of the larger whole of personality
Factor Analytic Theories of Intelligence

- Intelligence as global capacity
  - 1939: intelligence is the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment
  - Global capacity is a primary factor in defining intelligent behavior
- The Wechsler-Bellevue Intelligence Scale
  - Created this scale in response to the criticisms of the Stanford-Binet
  - After studying current intelligence tests, Wechsler selected 11 different subtests

Factor Analytic Theories of Intelligence

- Sources included:
  - 1916 Stanford-Binet
    - Comprehension, Arithmetic, Digit Span, Similarities, and Vocabulary
  - Healy Picture Completion Tests
    - Picture Completion
  - Army Alpha
    - Picture Arrangement
  - Kohs Block Design Test
    - Block Design
  - Army Beta
    - Digit Symbol and Coding

Factor Analytic Theories of Intelligence

- Wechsler designed original material for all subtests
  - Though some items differed only slightly from their original forms
- Selected tasks that were easy to administer and score, were appropriate across a wide range of ages and ability levels, and had been proven to discriminate between high and low levels of intellectual ability
- Divided test between verbal and nonverbal subtests
- IQ obtained from the scale was designed to represent an index of general mental ability
Factor Analytic Theories of Intelligence

- Broad verbal and nonverbal domains
  - Underscored Wechsler's convictions that there are different ways in which intelligence can manifest itself
  - Distinction between Verbal and Performance subscales reflects the different ways in which intelligence could be measured, not different types of intelligence
- Multifaceted nature of intelligence
  - We do not measure intelligence directly
  - Subtests he selected were a means to an end

Factor Analytic Theories of Intelligence

- Empirical Support for Wechsler's model
- Current Wechsler tests:
  - WPPSI
  - WISC
  - WAIS

Multiple Intelligences

- Gardner
  - Theory of Multiple Intelligence
    - Intelligence is defined as the ability to solve problems in a given situation
    - Types
      - Linguistic
      - Musical
      - Logical/Mathematical
      - Spatial
      - Bodily/Kinesthetic
      - Interpersonal
      - Nature
      - Spiritual
      - Existential
Multiple Intelligences

- Sternberg's theory of successful intelligence
  - Components of intelligence:
    - Analytic
    - Creative
    - Practical
  - Note, there are no practical tests for these theories...yet.

References


