Diagnosing learning disorders

Tim Hannan

28 May 2010
The workshop

This workshop explores the formulation and diagnosis of learning disorders and other developmental cognitive disorders.

The benefits of the neuropsychological approach to the identification of learning disorders will be discussed. The cognitive characteristics of common learning disabilities will be reviewed, with particular consideration of language disorders and reading disorders.

The role of psychological assessment in diagnosis and classification will be explored, with discussion of the utility of the Wechsler scales and popular tests of academic achievement.

The presenter

Tim Hannan is a clinical psychologist and neuropsychologist, with twenty years experience in psychological practice with children and adolescents. He is a Senior Lecturer in the School of Psychology at the University of Western Sydney, where he teaches in the areas of clinical psychology, clinical and forensic neuropsychology, psychological assessment, and sport psychology.

Tim has completed postgraduate degrees in clinical psychology, clinical neuropsychology, cognitive science, and sport psychology. A member of the APS Colleges of Clinical Psychologists, Clinical Neuropsychologists, Forensic Psychologists, Educational & Developmental Psychologists and Sport Psychologists, he has served on national or state committees of each of these colleges, including terms as National Chair of the APS College of Clinical Neuropsychologists (1999-2001), the APS College of Educational and Developmental Psychologists (2003-2005), and the APS College of Sport Psychologists (2008-2010). Tim was elected to Fellowship of the APS in 2008.

Tim has lectured extensively on child clinical psychology and neuropsychology, and has presented over 150 lectures and workshops on these topics around the country and overseas. He has presented at each of the last eleven annual conferences of the APS on various topics in child psychology, and has been an invited presenter at numerous Educational Psychology conferences.
Diagnosing learning disorders

Overview
1. a taxonomy of developmental cognitive disorders
2. major methods of collecting information relevant to formulation and diagnosis
3. diagnoses
4. reporting scores

Taxonomy

Orton (1937)
• developmental alexia
• developmental agraphia
• developmental word deafness
• developmental motor aphasia
• abnormal clumsiness
• stuttering

DSM-IV
• Expressive Language Disorder
• Mixed Receptive-Expressive Language Disorder
• Phonological Disorder
• Reading Disorder
• Disorder of Written Expression
• Mathematics Disorder

Developmental cognitive disorders
• intellectual disability
• sensory impairments
  – visual impairment
  – auditory impairment
• motor disorders
• learning disorders
  – language disorders
  – dyslexias (reading disorders)
  – dysgraphias (spelling - writing disorders)
  – dyscalculias (arithmetic disorders)
• attention-deficit hyperactivity disorder
• autistic spectrum disorders
• other disorders
DSM-5 - proposed

• Learning Disabilities (new category)
  – Dyslexia
  – Dyscalculia
• Communication Disorders (no change)
  – Expressive Language Disorder
  – Mixed Receptive-Expressive Language Disorder
  – Phonological Disorder
  – Stuttering
  – Communication Disorder NOS

DSM-5 - proposed

• Autistic Spectrum Disorder (revised)
• Attention-Deficit and Disruptive Disorders
  – ADHD (nature of changes uncertain)
  – ADHD NOS
• Developmental Coordination Disorder (minor changes)

Methods

Aims of assessment

• description of cognitive, behavioural, emotional, social functioning
• identification of cognitive deficits
  – nature
  – severity
• explanation of behaviour, emotional and social functioning
• planning management

Complotencies

1. theory of cognition

1. Competencies

Observation  Questionnaires

Interview    Testing

Formulation

Diagnosis

Reporting
Cognitive systems
• perceptual systems
• motor functions
• language
• memory
• spatial processing
• attention & executive functions
• quantitative
• social cognition

Competencies
1. theory of cognition
2. psychological assessment
   – test administration and interpretation
   – psychometrics

Tests
• intelligence
• language
• reading, spelling and writing
• arithmetic
• memory
• spatial abilities
• executive functions

Test knowledge
• normative data
• psychometrics
   – reliability
   – validity
• administration & scoring
• interpretation

Competencies
1. theory of cognition
2. psychological assessment
   – test administration and interpretation
   – psychometrics
3. knowledge of common disorders
   – cognitive profile
   – epidemiology

Language
**Key questions**

- what is a language disorder?
- are there different types?
- do symptoms change over time?
- why do some children have a language disorder?
- how common is it?
- what is the nature of the impairment?
- how do we identify it?
- how do we distinguish this from other diagnoses?
- how do we treat it?

**Components of language**

- phonology
- grammar
- semantics
- pragmatics

**Language change**

- changes over time
  - pronunciation
  - vocabulary
  - grammar
  - use
- language development through history

**Language universals**

- principles which govern the structure of all languages

**Germanic languages**

- Proto-Germanic
  - West Germanic
    - English
    - German
    - Frisian
    - Dutch
  - North Germanic
    - Swedish
    - Danish
    - Icelandic
    - Norwegian

**Indo-European languages**

- Proto-Indo-European
  - Armenian
  - Proto-Germanic
  - Proto-Italic
  - Slavonic
  - Old Celtic
  - Greek
  - Indo-Iranian
  - Albanian
Some other families

- Chinese
- Japanese
- Korean
- Dravidian
- Mon-Khmer
- Vietnamese
- Tai
- Austronesian

- Polynesian
- Afroasiatic
- Sub-Saharan
- Caucasian
- Turkic
- Uralic
- Basque

Speech comprehension

1. auditory processing
2. discriminating speech sounds
3. identifying phonemes in speech

Auditory processing

- acoustic waveform processed by the peripheral auditory system

- (note: diagnoses of language disorders exclude individuals with difficulties processing sounds)

Discrimination of speech sounds

- distinguishing and classifying speech sounds, from other sounds
- this process evident in babies

Identifying phonemes

- speech does not contain discrete phonological elements (co-articulation)
- no simple correlation between a phoneme and acoustic form
- theory that phonological development reflects move from larger to smaller elements
Phonemes

- development
  - words
  - syllables
  - sub-syllabic elements (onset and rime)
  - phonemes

Grammar

- syntax
  - the principles that govern the combination of words in a language
- morphology
  - derivational morphology
  - inflectional morphology

Semantics

- the manner in which individual words and more complex forms express meaning

Colourless green ideas sleep furiously.

Pragmatics

- speech acts
- presuppositions
- conversational postulates

Language disorders

- deficits in all areas of language
- late emergence of language
- protracted development
- uneven pattern across areas
  - common pattern of grammar < phonology < semantics & pragmatics
### Key questions
- what is language disorder?
- how severe does a language deficit have to be?
- which aspects of language must be measured?
- how do we distinguish SLI from other cognitive disorders?
- do we exclude potential causes such as hearing loss etc?

### Definitions

**Zangwill (1978)**  
“slow, limited or otherwise faulty development of language in children who do not otherwise give evidence of gross neurological or psychiatric disability, and where the language difficulty is not secondary to deafness”

**Bishop (1997)**  
“language development … below age level, for no apparent cause”

### Consensus definition
- language test score below criterion (eg ~81 on standardised test, ie 1.25 standard deviations)
- evidence of normal or near-normal abilities in other areas (eg >85 of ‘nonverbal IQ’)
- normal hearing (can detect pure tones at 20 decibels in each ear at frequencies 500, 1000, 2000, 4000 Hz)
- no evidence of neurological damage (ABI, epilepsy etc)
- no abnormality of oral structure or function
- no evidence of ASD

### Problems with criteria
- severity criterion
  - statistical
  - impairment
- selection of language domains
- use of nonverbal IQ
- exclusion criteria

### Heterogeneity and subtypes
- characteristic weaknesses, but variation in profiles
- early classification
  - expressive
  - receptive-expressive
**Other classifications**

- Aram & Nelson (1975): six groups
- Wolfus et al (1980): two groups
  - poor phonology and syntax
  - global language deficits
- Korkman (1994): two groups
  - deficits in all areas
  - comprehension of complex sentences
  - phonological-syntactic
  - lexical-semantic
  - verbal-auditory agnosia

**Summary model**

1. poor syntax and phonology, especially in production
2. broader profile of deficits in all areas, both comprehension and production
   - further subdivision possible within each category

**Prevalence**

- estimates of 5 – 7%
- boy: girl ratio estimated at 2.8 : 1

**Course**

- studies indicate substantial continuity of language disorders
- improved long-term prognosis if language problems substantially resolved by 5 years of age, but deficits in phonology and reading evident
- poor outcome if little progress by 5 years

**Theories**

- diverse theories on nature and aetiologies of language disorders
- linguistic
- cognitive
- mixed

**Linguistic theories**

- propose deficits in acquisition or use of grammatical rules
- Gopnik (1980): failure to recognise certain syntactic features, such as number, tense
- theories do not clearly account for diversity of performance, or cross-linguistic differences
Cognitive theories
- propose deficits in broader aspects of cognition, such as speed/capacity
- Gathercole: phonology
- Tallal: auditory perception

Mixed theories
- propose interrelationship of cognitive and linguistic factors
- Leonard (1988): speed/capacity affects language, depending on surface features of the individual language

Common referral questions
- concern over language development
- academic problems

Types of assessment
- screening
- diagnostic assessment
- assessment of comorbid cognitive, behavioural and emotional disorders, family functioning

Issues in assessment
- developmental factors
- differential diagnosis
- psychometric issues

Elements
- language abilities
- intellectual abilities
- academic achievement
Case 4

- 11 year old boy
- history of difficulties with acquisition of reading skills
- differential diagnosis reading disorder or language disorder

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Reading disorders

Reading

- the ability to comprehend written text
- a set of skills usually acquired in early childhood
  - phonological decoding
  - word recognition
  - text comprehension
Early Identification
• importance of identifying those children who skills are weaker than peers
  – ≈ 8% children are slow to develop these skills
  – ≈ 2% significant and lifelong difficulties
• intervention before Year 2 maximises outcome

Overview
• reading and development
  • dyslexia
    – definition
    – learning disabilities
    – neurobiology
    – cognitive aspects
    – course, comorbidity
• theories and models
• assessment
• interventions

Writing systems
• semantic
• phonological – semantic
• phonological
  – alphabets
  – syllabic alphabets

Learning to read
• integrating a system for processing written language with a system that already exists for processing spoken language
  LaBerge & Samuels (1974)
Dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading, comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge.

International Dyslexia Association (2003)

Specificity

• the child with a LD has a deficit in cognitive functioning which is specific to one domain, such that deficits do not extend to other areas of cognitive functioning
• e.g., the child with dyslexia has deficits specific to reading, which do not extend to other cognitive functions

Familial patterns

• son of dyslexic father has 40% risk of being dyslexic
• son of dyslexic mother has 36% risk
• daughter of dyslexic mother has 20% risk
• daughter of dyslexic father has 20% risk

Heritability

• decoding: .59 genetic, .29 environmental
• orthography: .56 genetic, .27 environmental
  Olsen et al (1994)

Genetic studies

• chromosome 15, long arm
  Smith et al (1983)
• chromosome 6, short arm
  Cardon et al 1994; Fisher et al, 1999
  Gayan et al 1995; Grigorenko et al 1997
• translocation on chromosome 1
  Rabin et al (1993)

Neuropathology

• symmetry of planum temporale
• ectopias and dysplasias
  Galaburda (1994)

Neuroimaging

• symmetry of planum temporale
• differential activation in dyslexics in
  – parieto-temporal
  – occipito-temporal
  – frontal (Broca’s)

Theories

• intelligence
• visual perception
  – Orton (1925)
• auditory perception
• phonological processes
  – Vellutino (1979)
• cerebellar deficit

Phonological impairment

• children with dyslexia have deficits in phonological aspects of language
• these deficits underlie poor development of reading, and deficits in certain other aspects of cognitive functioning
Phonology and working memory
• dyslexics perform poorly on tests of verbal working memory
  – digit span
  – letter span
  – word span
  – sentence repetition

Phonology and naming
• dyslexics have deficits in naming
  – confrontation
  – rapid automatised naming
  Wolf (1997)
• also observed in adult dyslexics
  Pennington et al (1990)
• suggests deficit in access to or retrieval of phonological code

Phonology and vocabulary
• receptive vocabulary thought to be superior to naming
• theory of “double deficit” in some dyslexics
  – phonology
  – naming
  Wolf & Bowers (1999)

Phonological awareness
• verbal tasks assessing metacognitive aspects of phonology
  – tapping out or counting syllables
  – segmentation of word
  – addition or deletion of units of word
  – substitution of units
  – transposition (Spoonerisms)
  – blending

Phonological awareness
• numerous studies indicate that phonological awareness is associated with reading ability, and with the development of reading skills

Summary
• core phonological deficit
• development affected by
  – additional cognitive deficits
  – compensatory techniques employed by child
  – educational strategies
• outcome varies according to severity of deficit and effect of moderating variables
Summary

- Phonological deficits are related to dyslexia
- Theory: phonological deficits at the time of learning to read hamper acquisition of reading skills
- Bidirectional effect

“Dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading, comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge.”

International Dyslexia Association (2003)

Dyslexia and SLI

- Poor decoding
  - Phonology
  - “Specific reading disorder”
- Poor comprehension
  - Grammar
  - “Reading disorder - poor comprehender”
- Broad deficits
  - Phonology, grammar, semantics
  - “SLI” or developmental language disorder

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Individual variation

- Children with dyslexia may display variations in reading profile, or in profile of other cognitive test results
- Raises question of whether subtypes of dyslexia can be identified

The rationale for subtyping

- Cognitive test profile
- Aetiological factors
- Comorbidity and risk
- Prognosis and outcome
- Response to intervention
### Approaches to subtyping
- cognitive battery profile (e.g., WISC)
  - Kinsbourne & Warrington (1963)
- neuropsychological profile
  - Mattis, French & Rapin (1975)
- multivariate statistical techniques
  - Doehring & Hashko (1977)
- reading and spelling patterns
  - Boder (1971, 1973)

### Case studies
- analysis of a series of individual profiles
- found deficits in phonological and morphological components
- argued that variation attributable to varied development following early core deficit
- concluded that variation not attributable to discrete subtypes
  - Seymour (1986)

### Dyslexia
- primary deficits
  - phonological disorder
- secondary deficits
  - reading
  - spelling
  - writing
  - verbal fluency
  - acquired verbal knowledge
  - verbal working memory

### Assessment
- reading
  - decoding
  - word recognition
  - comprehension
- language
  - phonology
  - grammar
  - semantics
- cognition

### Reading
- Neale Analysis of Reading Ability -3
- Wechsler Individual Achievement Test - II
- Wide Range Achievement Test - 4

### Phonological skills
- CELF-4 phonological battery
- PAL
- PAT
- Sutherland
- NEPSY
Case 7

- 9 year old boy
- history of reading difficulties

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Case 8

- 7 year old girl
- severe reading disorder

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Treatment

- training in phonological skills improves phonological skills and reading in non-dyslexic children
- however more limited improvements in children with dyslexia
- severity of phonological deficit predicts progress

Questions

- How precise are test scores?
- Should scores be reported? If so, how?
- Should ranges be reported?
Numbers
• a client’s performance produces a raw score, which is converted to a standard score
• the standard score enables the psychologist to compare the performance to those of peers

“On the WAIS-IV, Mr Smith obtained a score of 94”
“John’s performance on the WISC-IV produced a score of 110”
“Ms Johnson’s Full Scale Intelligence Quotient was 85”

Numbers
• standard scores do not provide a direct comparison of performance with that of peers
• standard scores are not well understood by non-psychologists, and may be misinterpreted

Percentiles
• enable a client’s test performance to be directly compared with peer performance, both by psychologists and non-psychologists

“On the WAIS-IV, Mr Smith obtained a percentile of 34”
“John’s performance on the WISC-IV was at the 75th percentile”
“Ms Johnson’s Full Scale Intelligence Quotient was at the 16th percentile”

Percentiles
• not easily employed in statistical analyses
  – cannot be averaged across areas
  – consideration of difference between two tests more difficult when using percentiles, as meaning of difference varies with overall level
Ranges

- A statement of the range in which the test performance may be placed
  - eg Average, Low Average, Borderline, Superior, Above Average
- The use of ranges may be quite informative for readers, as allows direct comparison with peers in a descriptive way

IQ ranges

<table>
<thead>
<tr>
<th>IQ</th>
<th>%ile</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;130</td>
<td>&lt;97</td>
<td>Very Superior</td>
</tr>
<tr>
<td>120 – 129</td>
<td>91 – 96</td>
<td>Superior</td>
</tr>
<tr>
<td>111 – 119</td>
<td>76 – 90</td>
<td>Above Average</td>
</tr>
<tr>
<td>90 – 110</td>
<td>25 – 75</td>
<td>Average</td>
</tr>
<tr>
<td>81 – 89</td>
<td>10 – 24</td>
<td>Low Average</td>
</tr>
<tr>
<td>71 – 80</td>
<td>3 – 9</td>
<td>Borderline</td>
</tr>
<tr>
<td>&lt; 70</td>
<td>&lt; 2</td>
<td>Int. Disability</td>
</tr>
</tbody>
</table>

“On the WAIS-IV, Mr Smith’s performance was in the Average range”

“John’s performance on the WISC-IV was in the Above Average range”

“Ms Johnson’s Full Scale Intelligence Quotient was in the Low Average range”

Summary

- Each of these methods provides a means of indicating test performance
- Methods vary in how informative they are for readers
- May vary in potential for misunderstanding and misuse

Ranges

- At junctures, ranges do not define markedly different levels of test performance, yet readers will interpret results in this way
- Within range, implies homogeneity of performance, yet performance may differ in clinically significant ways
  - Average: 25th to 75th percentile
  - Borderline: 2nd to 9th percentile

Points, intervals and estimates
Precision vs approximation

- another major issue concerns the degree of precision implied in reports of test results, and clients' understanding of these reports
- test results are measures of performance, which provide estimates of competence, or level of ability

"On the WAIS-IV, Mr Smith obtained a score of 94"

Psychologists' understanding

"On the WAIS-IV, Mr Smith obtained a score of 94"

That means:
- Mr Smith's intellectual abilities are average for age
- this estimate may be of assistance in vocational guidance, or determining presence of specific cognitive disorders etc

Clients' understanding

"On the WAIS-IV, Mr Smith obtained a score of 94"

That means:
- my IQ is 94
- 66% of people are smarter than me
- my brother, whose IQ is 97, is smarter than me

The problem with points

- test reliability studies demonstrate the amount of error in measurement
- point scores (standard scores or percentiles) imply a degree of precision in measurement which does not exist
- one solution to this is to report scores as confidence intervals

Classical Test Theory

- for each "ability", each person has a particular level of skill
- we do not know the person's true level of ability (because we do not have a perfect test)
- an obtained score on a test is an estimate of a person's true level of ability
- an even better estimate of a person's true level of ability can be derived from the obtained score by taking into account regression to the mean
Estimated true scores

- we can derive an estimated “true score” for an individual from the obtained score, by taking into account the reliability of the test
- estimated true scores will always be closer to the mean than obtained scores (except where $r = 1$)

True score

$$X_T = r_{xx} (X_O - \bar{X}) + \bar{X}$$

Example

- an individual obtains a score of 84 on an intelligence test (mean = 100, sd = 15) with $r = .8$

  $$X_T = .8 (84 - 100) + 100$$
  $$X_T = 87.2$$

Confidence intervals

- CI indicates range in which individual’s true score probably lies
- CI established around true scores, using the standard error of estimate ($SE_e$)
  - $CI = X_T +/- z SE_e$

Example

- $X = 84$
- $X_T = 87.2$

  $$CI (%) = X_T +/- z SE_e$$
  $$CI (.90) = 87.2 +/- (1.65) 6$$
  $$= 77.3 - 97.1$$

Note

- there are several ways of deriving confidence intervals:
  - obtained score +/- SEM
  - true score +/- SEM
  - true score +/- SEE
- psychometricians debate the merits of each; we not explore this issue here
Confidence intervals

- a statement of the range in which a person’s true level of ability probably lies, given the score obtained from their test performance, and taking into account the reliability of the test

“On the WAIS-IV, Mr Smith obtained a score in the range of 90 to 98”

“John’s performance on the WISC-IV produced a score between 105 and 115”

“Ms Johnson’s Full Scale Intelligence Quotient was somewhere between 83 and 93”

Confidence intervals: numbers

- “There is a 90% chance that Mr Smith’s true abilities lie somewhere in the range between 90 and 98 (and a 10% chance his true abilities are either below 90 or above 98)”

Confidence intervals: percentiles

- as percentiles are generally more informative than scores, Crawford proposed creating intervals with percentiles

“On the WAIS-IV, Mr Smith obtained a score in the range of the 30th to 47th percentiles”

“John’s performance on the WISC-IV produced a score between the 63rd and 84th percentile”

“Ms Johnson’s Full Scale Intelligence Quotient was somewhere between the 19th and 34th percentiles”
• “There is a 90% chance that Mr Smith’s true abilities lie somewhere in the range between the 30th and 47th percentile (and a 10% chance his true abilities are either below the 30th percentile or above the 47th percentile)”

Summary
• confidence intervals are better than point scores in acknowledging that obtained score is an estimate
• percentiles are better than numbers at conveying information
• however, reports using CIs are likely to be confusing for many readers
• to date, psychologists have not used CIs with percentiles

Test scores
• test scores are measures of performance, that provide estimates of a client’s abilities
• test scores do not directly measure abilities

Test scores, cognitive systems, and diagnoses

Scores and cognitive systems
“On the WAIS-IV, Ms Jones obtained a Verbal Comprehension score of 84. That means that she has problems with verbal comprehension.”
• Sentences like this indicate a confusion between test scores and cognitive systems

Scores and diagnoses
“On the WMS-IV, Mr Jackson obtained a Memory Index of 75. That means that he has a memory disorder.”
• sentences like this indicate a faulty interpretation of a test score as indicating a diagnosis
Scores, systems and diagnoses

Principles
• test scores are estimates of a construct, based on performance
• reports should not imply that test scores are precise measurements of abilities
  – reporting obtained score
  – reporting exact percentile
• psychologists should not encourage misuse or misinterpretation of test scores

Issues
• several issues influence psychologists’ decisions when reporting scores
  – purpose of the report
  – test score vs level of ability
  – implying precision vs approximation
  – provision of detail vs risk of misinterpretation

Guidelines
• do not report exact numbers or percentiles
• approximate percentiles are usually informative and at lower risk for misuse
• indicate approximate level of performance in descriptive manner
  – do not reify ranges
• ensure the summary section is clear, informative, and addresses all referral questions