The Dimensionality of Language Ability in Young Children


Acknowledgements

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Aims and specific research questions

• Aim of LARRC Study 1: to characterize the explicit contributions of different levels of language skills during early and middle childhood to individual differences in listening and reading comprehension.

• Research question addressed in this presentation: What is the nature of language ability among young children?

LARRC: project overview

Study 1 (2010-2015)
Language Bases of Reading Comprehension

Study 2 (2010-2013)
Language-Based Comprehension Instruction

Study 3 (2010-2013)
National Field Trial

Overview

• The dimensionality of language
  – theoretical ways to conceptualise language
  – practical implications

• Design and methods
  – our measures and analysis plans

• Results
  – comparison of models

• Summary and implications
The dimensionality of language

Language is typically viewed as a complex system consisting of several components:
• phonology, syntax, morphology, semantics, and pragmatics
• expressive vs receptive
• lower vs higher-order skills

Distinctions are reflected in standardised assessments.
Language disorders typically diagnosed in two ways:
• below threshold on one subtest or the overall composite

Vocabulary and grammar

Different ways to conceptualise the relation between vocabulary and grammar:
• domain-specific systems for the lexicon and grammar (Pinker, 1997, 1998)
• interdependence of vocabulary and grammar (Bates & Goodman, 1991)

Lower- and higher-level skills

Distinction more commonly used in reading research:
• lower-level: basic lexical & grammatical abilities
• higher-level: global integrative processes necessary for understanding discourse and narrative
  (Cain et al., 2004; Perfetti, 2007)
• foundational vs text-level
  (Lepola et al., 2012)

Evidence: vocabulary & grammar

Evidence for uni-dimensional construct in early language development (Tomblin & Zhang, 2006):
• the factors representing vocabulary and grammar are highly correlated ($r > .90$) for children in K, G2, & G4, but lower for children in G8 ($r = .78$).
• CFA supported a two-factor linguistic domain model for older children.
• little support for a two-factor modality model.

Tomblin and Zhang (2006) did not include higher-level skills, so we do not know if these are also part of a uni-dimensional construct in early development or separable from ‘lower-level’ skills.

Evidence: lower- and higher-level skills

Young language learners:
• vocabulary, sentence memory (proxy for grammar), and inference making (higher-level) each explain unique variance in concurrent listening comprehension in 6-year-olds.
  (Lepola et al., 2012)

Early readers:
• evidence for separability; lower- & higher-level skills predict unique variance in reading outcomes.
  (Oakhill & Cain, 2012)

Research question

What is the nature of language ability among young children?
Different possible models

<table>
<thead>
<tr>
<th>Three factors</th>
<th>Two factors</th>
<th>Uni-dimensional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>Lower-level language</td>
<td>Language</td>
</tr>
<tr>
<td>Grammar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discourse</td>
<td>Higher-level language</td>
<td></td>
</tr>
</tbody>
</table>

Longitudinal study design

[For English sample; separate ELL sample]

<table>
<thead>
<tr>
<th>Yr</th>
<th>PK</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PK</td>
<td>400</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Yr 2</td>
<td>400</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Yr 3</td>
<td>400</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Yr 4</td>
<td>400</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Yr 5</td>
<td>400</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
<td>420</td>
<td>760</td>
<td>880</td>
</tr>
</tbody>
</table>

Language measures: vocabulary

Each child completed two measures of receptive vocabulary and two of expressive vocabulary.

<table>
<thead>
<tr>
<th>Grade</th>
<th>PPVT-R</th>
<th>EVT-E</th>
<th>CELF-R</th>
<th>CELF-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-K</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Kindergarten</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Grade 1</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Grade 2</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Grade 3</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Language measures: grammar

Each child completed 4 - 5 measures of receptive and expressive grammar, assessing a range of knowledge.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Morph</th>
<th>TROG</th>
<th>CELF word</th>
<th>CELF recall</th>
<th>TEGI past</th>
<th>TEGI 3rd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-K</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Kindergarten</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Grade 1</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Grade 2</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Grade 3</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Language measures: discourse

Each child completed measures to assess 3 discourse-level skills: comprehension monitoring, inference, & knowledge of narrative structure.

<table>
<thead>
<tr>
<th>Grade</th>
<th>CompM KVT</th>
<th>CompM DI</th>
<th>Inf BK</th>
<th>Inf int</th>
<th>Narr PAT</th>
<th>Narr SAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-K</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kindergarten</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 1</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 2</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 3</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comprehension monitoring

Knowledge violations test: A man had three sons. The youngest was Jack. Every morning Jack chopped wood for his family. He always used a knife to chop the wood. Jack had to do it quickly on school days so he wouldn’t be late for school.

Detecting inconsistencies: Last night Jill walked home through the park. There was no moonlight, so Jill could hardly see her way. Jill often takes this route home. She walked along a narrow path. The moon was so bright that it lit the way. Jill lives on the other side of the park.

Text structure

Picture arrangement test: arrange sequence of 3 to 5 pictures into a ‘good story’.

Sentence arrangement test: arrange sequence of 6 to 12 sentences into a ‘good story’.
### Sample characteristics

<table>
<thead>
<tr>
<th>Grade</th>
<th>Age (years, months)</th>
<th>PPVT (standardized score)</th>
<th>NV IQ (standardized score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-K</td>
<td>5,01</td>
<td>108</td>
<td>102</td>
</tr>
<tr>
<td>N=416</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kindergarten</td>
<td>6,00</td>
<td>110</td>
<td>101</td>
</tr>
<tr>
<td>N=228</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 1</td>
<td>6,11</td>
<td>111</td>
<td>106</td>
</tr>
<tr>
<td>N=125</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 2</td>
<td>8,00</td>
<td>108</td>
<td>109</td>
</tr>
<tr>
<td>N=123</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 3</td>
<td>9,01</td>
<td>108</td>
<td>109</td>
</tr>
<tr>
<td>N=122</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Analysis plan

- The three (one, two, and three factor) models were run for each grade, separately.
- A range of fit indices were considered to identify the best fitting model for our data:
  - Chi-Square (pref. ns)
  - Comparison of adjusted (scaled) differences in $\chi^2$ test
  - RMSEA ($<.05$, also $p$ (close fit) $>.05$)
  - CFI ($>.95$)
  - SRMR ($<.08$)
  - AIC (lower is better)

### Models overview: younger children

A unidimensional structure for language was apparent for 5- and 6-year-olds (PK & K):

- The 1-, 2-, and 3-factor models were all good fits to the data.....
- ...but, taken together, the fit indices identified the uni-dimensional model as the best fitting model for both age groups.

### Best fitting model: Pre-Kindergarten

**Fit indices**
- $\chi^2 = 160.37, p < .001$
- RMSEA = .06
- CFI = .96
- SRMR = .04
- AIC = 25663.17 (lowest of all 3 models)

### Models: Pre-kindergarten (5 years)

All models had acceptable fit. Correlations between latent factors all $>.85$: poor discrimination. Most appropriate model for language is uni-dimensional.

### Models: Kindergarten (6 years)

None of the (scaled) difference tests between models were statistically significant. Favours least restrictive uni-dimensional model.
Best fitting model: Kindergarten

Fit indices
- $X^2 = 69.12, p = .25$
- RMSEA = .03
- CFI = .99
- SRMR = .04
- AIC = 7727.15 (lowest of all 3 models)

Models overview: for Grades 1 - 3

With increasing age, a multidimensional structure emerged:
- For Grades 1 & 2, the 2-factor model was a better fit than the 1-factor model and there was no difference between the 2- and 3-factor models.
- By Grade 3, the 3-factor model was the better fit.

Best fitting model: Grade 1 (7 years)

Fit indices
- $X^2 = 64.61, p = .10$
- RMSEA = .05, $p > .05$
- CFI = .98
- SRMR = .05
- AIC = 6855.41 (lowest of all 3 models)

Best fitting model: Grade 2 (8 years)

Fit indices
- $X^2 = 75.32, p = .02$
- RMSEA = .06, $p > .05$
- CFI = .97
- SRMR = .05
- AIC = 6379.63 (lowest of all 3 models)

Summary

Our data support Tomblin & Zhang’s (2006) identification of a uni-dimensional structure for language in 5- and 6-year-olds.

Our data fundamentally extend that work by showing:
- that higher-level language skills, when included, form part of a uni-dimensional construct at 5 & 6 years
- clear evidence of a multi-dimensional structure of language emerging after 6 years:
  - two factors emerge at 7 years; three factors by 9 years
Final thoughts & implications

Why are separate factors apparent in older children?

- Older children are more likely to have adequate specific vocabulary to perform syntactic and higher-order tasks?
- Syntax and morphology are emergent dimensions?
  (Bates & Goodman, 1991; Tomblin & Zhang, 2006)

If language is uni-dimensional (at least for younger children) why do we find subtypes? (e.g., Conti-Ramsden & Botting, 1999)

If language is uni-dimensional (at least for younger children) why do we find subtypes? (e.g., Conti-Ramsden & Botting, 1999)

... but can the decrease in association between dimensions explain instability of subtypes over time? (e.g., Tomblin & Zhang, 2006)

Final thoughts & implications

Does uni-dimensionality mean that we should just measure one aspect of language, not many?

- Not necessarily....
  - The measures of different ‘domains’ all contributed to the latent factor.
  - And best prediction of reading comprehension evident when vocabulary, grammar, and discourse-level skills included (National Early Literacy Panel, 2008).

Thank you

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