# The language bases of reading comprehension: insights for assessment and instruction

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# LARRC

Language and Reading Research Consortium

ASU • FSU • KU • LU • MGH IHP • OSU • UNL







# Acknowledgements

Institute of Education Sciences (**Grant# R305F100002**)

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Shelley Gray (Co-PI)
Hugh Catts (Co-PI)
Tiffany Hogan (Co-PI)
Kate Cain (Co-PI)
Mindy Bridges
Jim Bovaird
Richard Lomax
Diane Nielsen
Ann O'Connell
Jill Pentimonti
Stephen Petrill
Shayne Piasta
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# Language and Reading Research Consortium: project overview

Lancaster University

**Study 1 (2010-2015)**

Language Bases of Reading Comprehension

US study of over 800 PreK-G3 students

Longitudinal study of higher- and lower-level language skills and their relations to listening and reading comprehension

**Study 2 (2010-2013)**

Language-Based Comprehension Instruction

Iterative development of instructional practices to be used across five grades

Advisory Groups
Teaching Trials
Pilot Study

**Study 3 (2013-2015)**

National Field Trial

Test instructional practices from Study 2 across the nation in 295 PreK-3 classrooms

# Talk overview

## What is (reading) comprehension?

## Learning to read: should we keep things simple?

- How word reading and listening comprehension contribute to reading comprehension between 6 to 9 years

## The dimensionality of language

- The oral language skills that support text comprehension

## Pressure points in reading comprehension

- The contributions of different language skills and cognitive resources to reading comprehension outcomes

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Pressure points in reading comprehension

- The contributions of different language skills and cognitive resources to reading comprehension outcomes

# Reading comprehension: what's involved?

Molly was carrying the glass of juice. She tripped on the step. Her eyes filled with tears. *"Don't worry, darling"* said Mum, and went to fetch the mop.

# Retrieval of word meanings

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# Understanding sentences

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Molly was carrying the glass of juice. She tripped on the step. Her eyes filled with tears. *"Don't worry, darling"* said Mum, and went to fetch the mop.

# Summary: what is (reading) comprehension

Comprehension draws on different levels of language:

- word meanings are retrieved,
- sentence meanings are constructed,
- and beyond the word- and sentence-level, the discourse-level message is extracted to construct the mental model of the text.

Beyond decoding, the same language skills that support reading comprehension also support listening comprehension.

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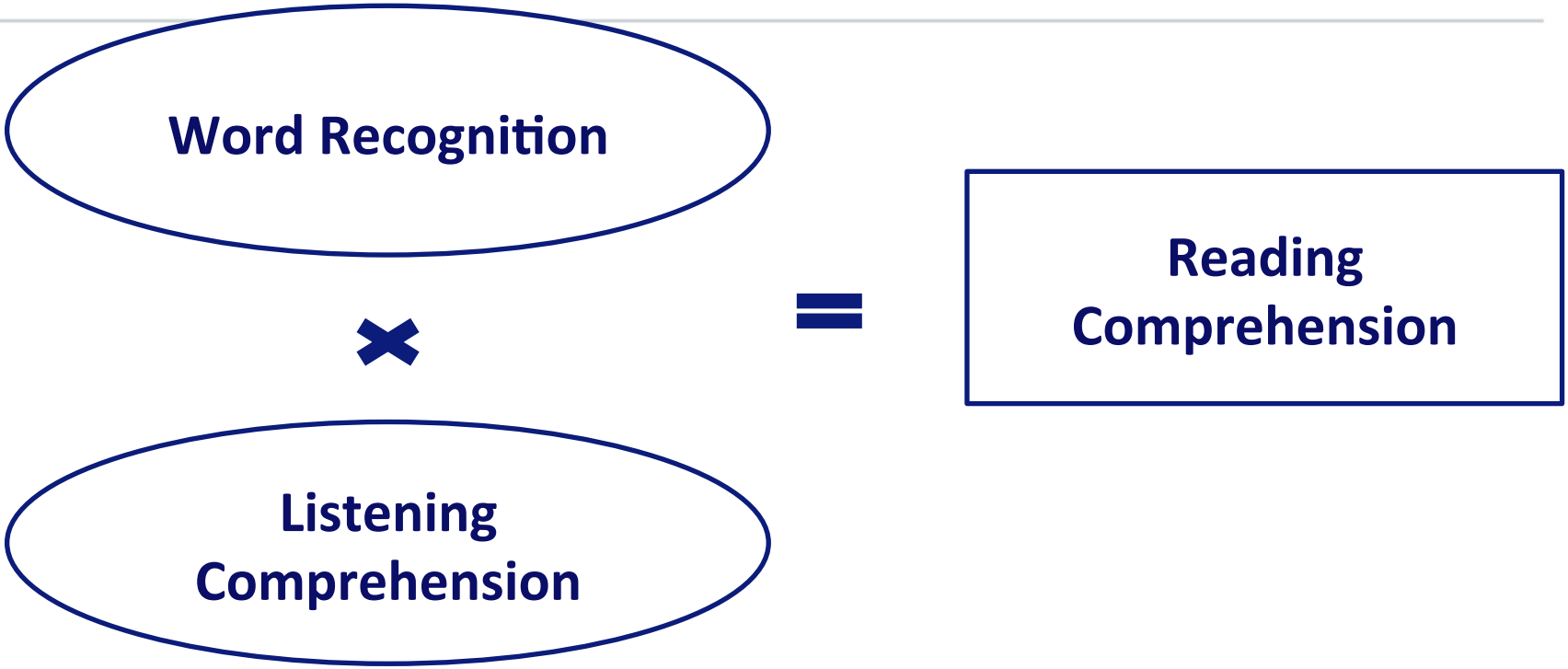
# Learning to read: should we keep things simple?




The Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990) describes reading comprehension as the product of word reading and listening comprehension and the relative contribution of each to reading comprehension across development.

# The Simple View: research questions

- **Change over time:** Does the simple view adequately capture change over time?

- **The role of reading fluency:** Is word recognition *fluency* separate from accuracy? What is its role in the prediction of reading comprehension?

- **The role of vocabulary:** Should independent assessments of vocabulary be included, beyond tests of listening comprehension?

# The Simple View: change over time

**The relative balance between word recognition skills and listening comprehension should change over time**

- Confirmation for broad developmental change:
  - longitudinal study sampling in grades 2, 4, and 8 (Catts et al, 2005)
  - meta-analysis (Garcia & Cain, 2014)
- No studies of consecutive grades to pinpoint this shift
- Contribution of word reading and listening comprehension to reading comprehension varies by measure (Keenan et al., 2008; Nation & Snowling, 1997)

# Participants

| Grade | Age *(years, months)* | % female | % English home lang. |
|---|---|---|---|
| **Grade 1** N=125 | 6,06 | 57 | 78 |
| **Grade 2** N=123 | 7,06 | 48 | 86 |
| **Grade 3** N=123 | 8,06 | 54 | 77 |

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# Methods and measures

- **Participants:** Children aged 6-7, 7-8, and 8-9 years

- **Multiple assessments of key skills:**
  - Word recognition
  - Listening comprehension
  - Reading comprehension
  - Vocabulary

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# Word recognition

Each child completed two measures of word/nonword reading accuracy (number correct), two measures of speeded isolated word/nonword reading, one measure of fluency for connected prose.

| **Age** | **WJ** word ID | **WJ** word attack | **TOWRE** sight word | **TOWRE** non-words | **FAIR** |
|---|---|---|---|---|---|
| **6 years** | ✔ | ✔ | ✔ | ✔ | ✔ |
| **7 years** | ✔ | ✔ | ✔ | ✔ | ✔ |
| **8 years** | ✔ | ✔ | ✔ | ✔ | ✔ |

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# Listening comprehension

Three measures: passages followed by open-ended questions

| **Age** | **CELF** *USP* | **LCM** open-ended | **TNL** open-ended |
|---|---|---|---|
| **6 years** | ✔ | ✔ | ✔ |
| **7 years** | ✔ | ✔ | ✔ |
| **8 years** | ✔ | ✔ | ✔ |

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# Reading comprehension

Three measures: passages followed by multiple-choice questions, open-ended questions, cloze procedure

| **Age** | **Gates** multiple-choice | **RCM** open-ended | **WJ** cloze |
|---|---|---|---|
| **6 years** | ✔ | ✔ | ✔ |
| **7 years** | ✔ | ✔ | ✔ |
| **8 years** | ✔ | ✔ | ✔ |

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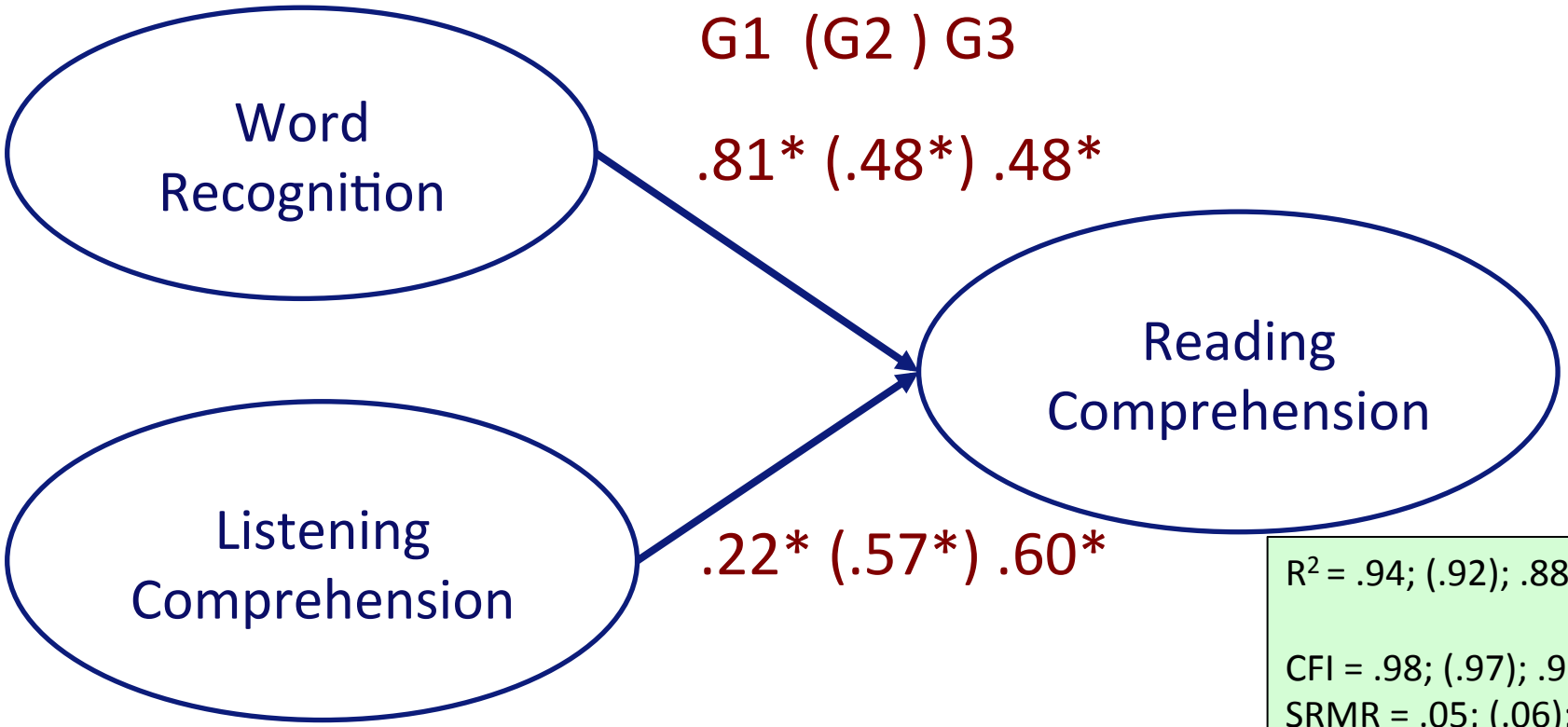
# Change over time

A shift around grade 2 (7 - 8 years) in the relative contributions of word recognition and listening comprehension




$R^2$ = .94; (.92); .88

CFI = .98; (.97); .97
SRMR = .05; (.06); .06
NFI = .96; (.95); .94
NNFI = .97; (.95); .95

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# The Simple View: research questions

- **Change over time:** Does the simple view adequately capture change over time?

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- **The role of vocabulary:** Should independent assessments of vocabulary be included, beyond tests of listening comprehension?

# The Simple View: the role of fluency

- **Fluent word recognition enables rapid access to meaning-based representations of written words** such that greater cognitive resources are available for comprehension processes

- **Accuracy may be a sufficient indicator in the early years,** when word recognition is slow and more error prone, but fluency may be more important later on (Kershaw & Schatschneider, 2012 vs Høien-Tengesdal & Høien, 2012)

- **Do accuracy and fluency make separable contributions?** (Silverman et al., 2013 vs Adlof et al., 2006)

# Word recognition: accuracy vs fluency

Each child completed two measures of word/nonword reading accuracy (number correct), two measures of speeded isolated word/nonword reading, one measure of fluency for connected prose.

| **Age** | **WJ** word attack | **WJ** word ID | **TOWRE** sight word | **TOWRE** non-words | **FAIR** |
|---|---|---|---|---|---|
| **6 years** | ✔ | ✔ | ✔ | ✔ | ✔ |
| **7 years** | ✔ | ✔ | ✔ | ✔ | ✔ |
| **8 years** | ✔ | ✔ | ✔ | ✔ | ✔ |

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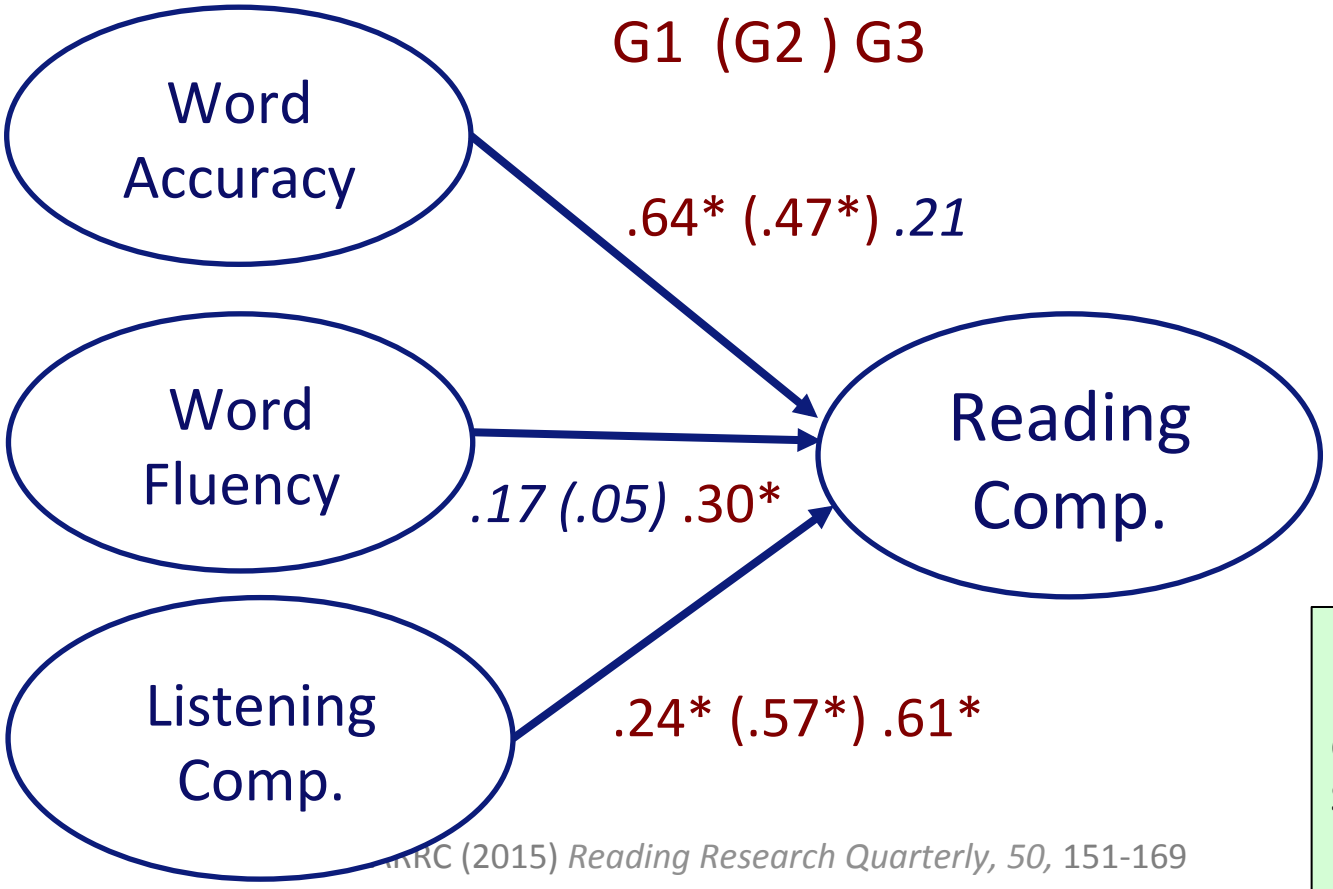
# The role of fluency

- The influence of accuracy decreased over time and the influence of fluency increased

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# The Simple View: the role of vocabulary

- **High-quality meaning-based representations support discourse-level text processing and comprehension** (Perfetti, 2007)

- **How does vocabulary influence reading comprehension?**
  - **Directly** in addition to listening comprehension (Braze et al., 2007) or **indirectly** through word recognition and/or listening comprehension (Nation & Snowling, 2004)?

# Vocabulary

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

| Age | PPVT-R | EVT-E | CELF-R | CELF-E |
|---|---|---|---|---|
| 6 years | ✔ | ✔ | ✔ | ✔ |
| 7 years | ✔ | ✔ | ✔ | ✔ |
| 8 years | ✔ | ✔ | ✔ | ✔ |

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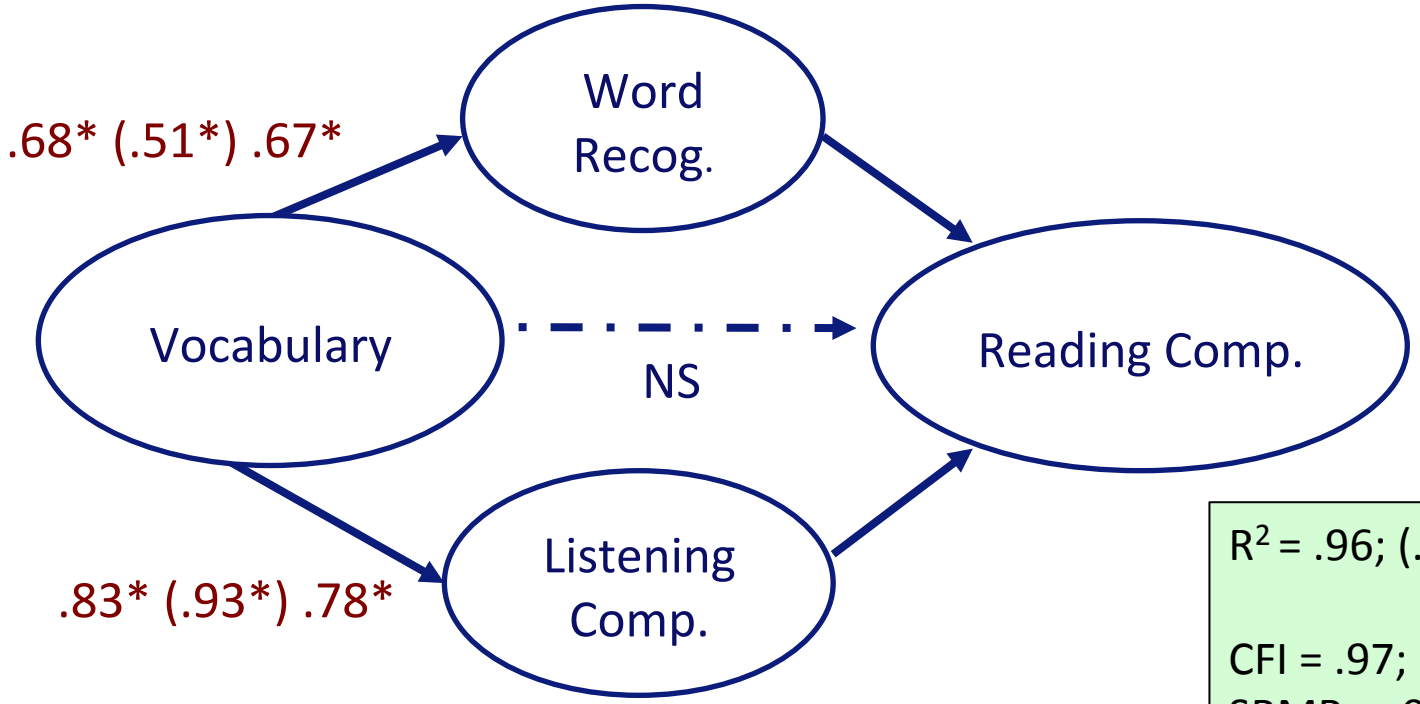
# Vocabulary and the simple view

There was no direct effect of vocabulary on reading comprehension. Indirect effects were apparent through word reading *and* listening comprehension at each grade.




$R^2$ = .96; (.91); .88

CFI = .97; (.96); .97
SRMR = .06; (.08); .05
NFI = .95; (.93); .95
NNFI = .96; (.94); .97

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# The Simple View: summary and conclusions

## Change over time

- word recognition was critical to early reading comprehension, but listening comprehension had a significant influence from the earliest stages of reading development
- demonstrates the need to include language in our models of literacy of development

## Word recognition

- best indicator was dependent on age: accuracy was sufficient in the early years, but fluency was more sensitive by 8 years

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# The Simple View: summary and conclusions

**Vocabulary**

- influenced reading comprehension *indirectly* through both word recognition and listening comprehension in each age group
- may provide a reason for why vocabulary is so strongly predictive of reading comprehension – influences *both* components of the SVR

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The dimensionality of language

- The oral language skills that support text comprehension

Pressure points in reading comprehension

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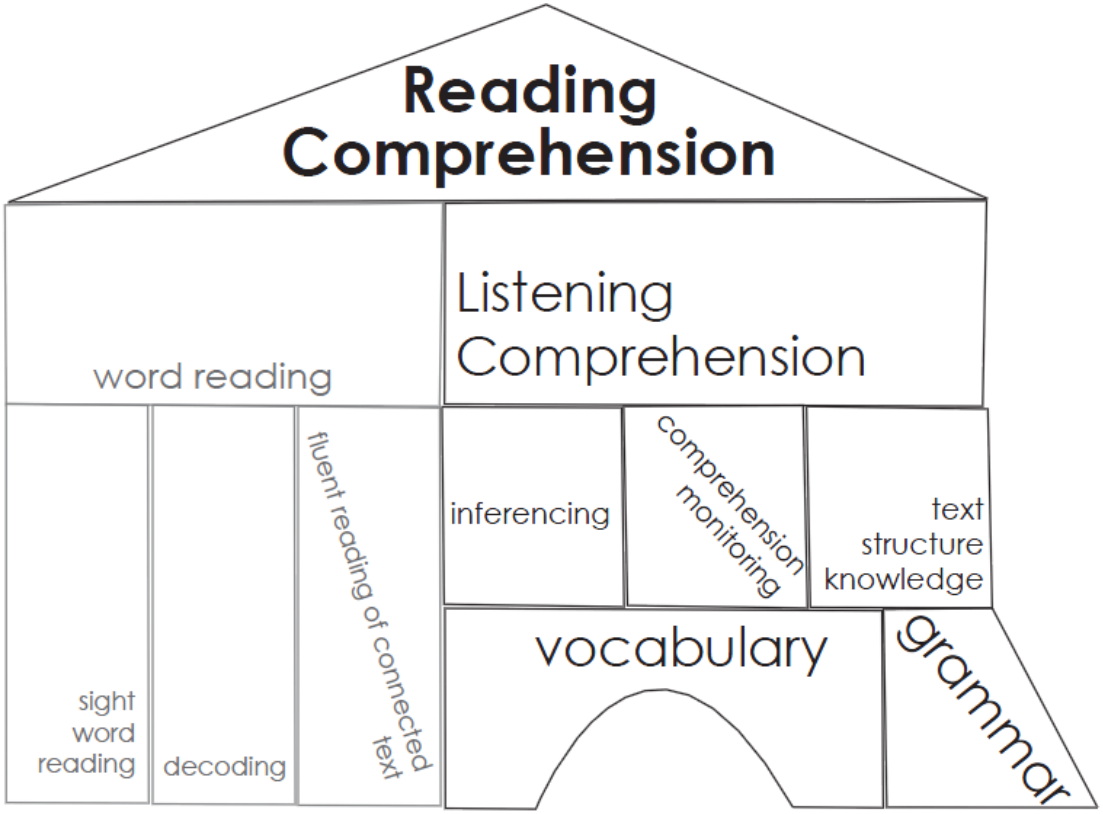
# The dimensionality of language

Language is typically viewed as a complex system consisting of several components:

- phonology, semantics, syntax/morphology, and pragmatics
- expressive vs receptive
- lower-level (or foundational) vs higher-level skills

# The dimensionality of language



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Language is typically viewed as a complex system consisting of several components:

- phonology, semantics, syntax/morphology, and pragmatics
- expressive vs receptive
- lower-level (or foundational) vs higher-level skills

Distinctions are reflected in standardised assessments.

Language disorders typically diagnosed in two ways:

- below threshold on one subtest or overall composite

# Dimensions of language: vocabulary and grammar

Evidence for uni-dimensional construct in early language development (Tomblin & Zhang, 2006):

- the factors representing vocabulary and grammar are highly correlated (*r*s > .90) for children in K, G2, & G4, but lower for children in G8 (*r* = .78).
- CFA supported a two-factor model for older children.
- little support for a two-factor modality model.

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.

# Dimensions of language and reading comprehension

**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)

**Young readers:**

- evidence for separability; lower- and higher-level skills predict unique variance in reading comprehension outcomes (Oakhill & Cain, 2012; Silva & Cain, 2015)

# Dimensionality: developmental study

- **Structure of language:** What is the dimensional structure of language ability in young children between 4 to 8 years?

- **Change over time:** Does the dimensional structure change over time?

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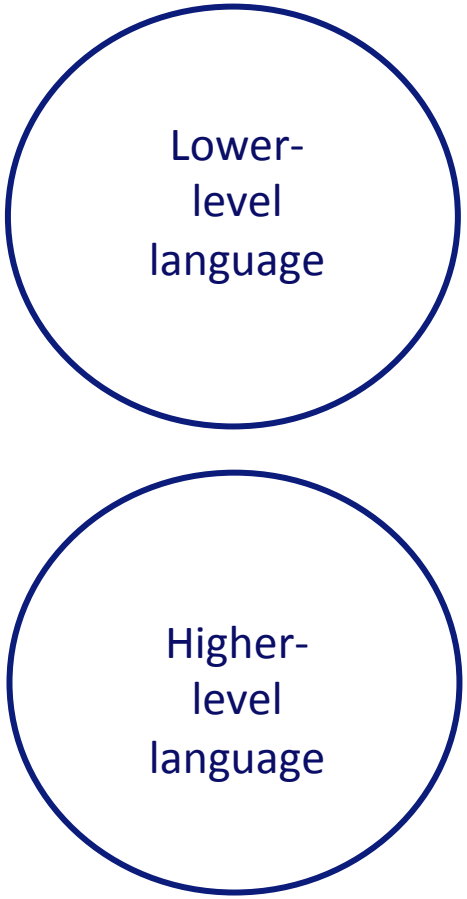
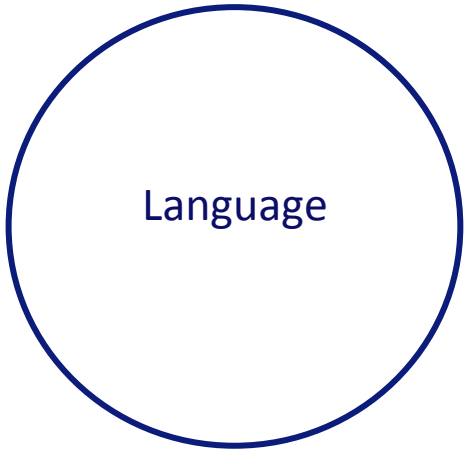
# Dimensionality: models

**Three factors**


**Two factors**




**Uni-dimensional**

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# Participants

| Grade | Age *(years, months)* | NV IQ *(standardised score)* |
|---|---|---|
| **Pre-K** | 4,06 | 102 |
| **Kindergarten** | 5,06 | 101 |
| **Grade 1** | 6,06 | 106 |
| **Grade 2** | 7,06 | 109 |
| **Grade 3** | 8,06 | 109 |

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# Language measures: vocabulary

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

| Age | PPVT-R | EVT-E | CELF-R | CELF-E |
|---|---|---|---|---|
| 4 years | ✔ | ✔ | ✔ | ✔ |
| 5 years | ✔ | ✔ | ✔ | ✔ |
| 6 years | ✔ | ✔ | ✔ | ✔ |
| 7 years | ✔ | ✔ | ✔ | ✔ |
| 8 years | ✔ | ✔ | ✔ | ✔ |

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# Language measures: grammar

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

| Age | Morph Der | TROG | CELF *word* | CELF *recall* | TEGI *past* | TEGI *3rd* |
|---|---|---|---|---|---|---|
| 4 years | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 5 years | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 6 years | ✔ | ✔ | ✔ | ✔ | | |
| 7 years | ✔ | ✔ | ✔ | ✔ | | |
| 8 years | ✔ | ✔ | ✔ | ✔ | | |

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# Language measures: higher-level

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

| **Age** | **CompM** *KVT* | **CompM** *DI* | **Inf** *BK* | **Inf** *Int* | **Narr** *PAT* | **Narr** *SAT* |
|---|---|---|---|---|---|---|
| **4 years** | ✔ | | ✔ | ✔ | ✔ | |
| **5 years** | ✔ | | ✔ | ✔ | ✔ | |
| **6 years** | | ✔ | ✔ | ✔ | ✔ | |
| **7 years** | | ✔ | ✔ | ✔ | | ✔ |
| **8 years** | | ✔ | ✔ | ✔ | | ✔ |

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# Higher-level language: 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.

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# Higher-order language: 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'.

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# Higher-order language: inference

Billy, Susie, and their Mum had gone out for the day. Billy spent the morning building a sandcastle near the water. Mum sat on their large beach towel and read a book. Susie wanted to go for a swim. She put her feet in the sea but the water felt too cold. Susie went and sat down next to Mum, instead.

Background knowledge (link with BK to establish theme)
Q: Where were Billy and his family?

Integrative (connecting propositions)
Q: Why did Susie not swim in the sea?

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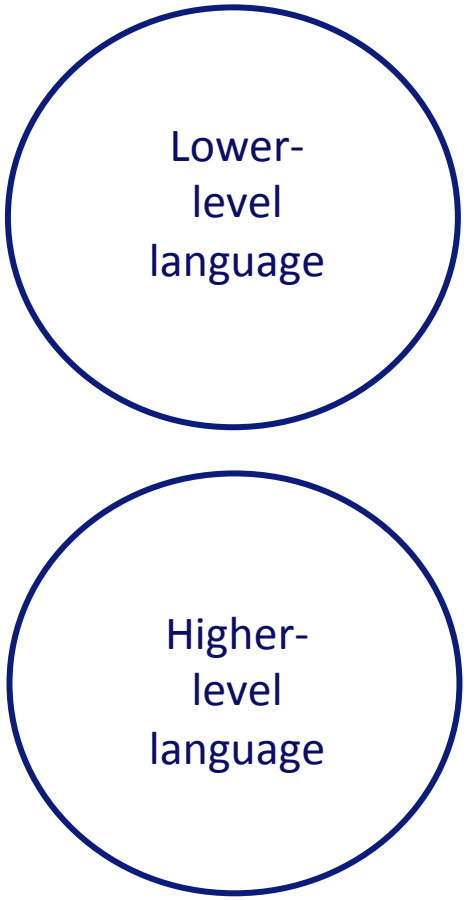
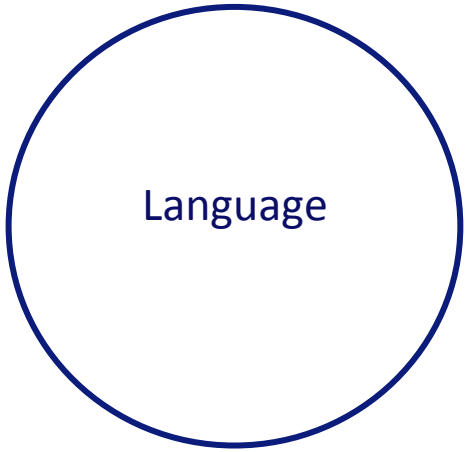
# Dimensionality: models

**Three factors**


**Two factors**




**Uni-dimensional**

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# Dimensionality: results 4 to 6 years

**A unidimensional structure for language was apparent for 4 to 5 and 5 to 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.

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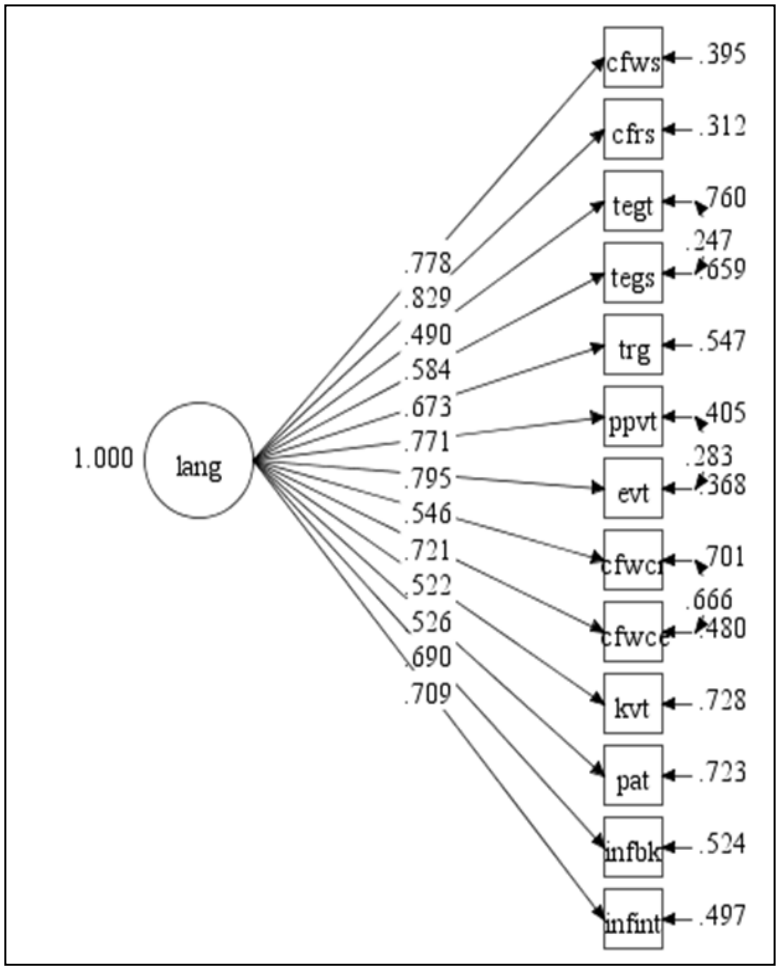
# Dimensionality: results 4 to 6 years




## Fit indices

$X^2 = 160.37$, $p < .001$

RMSEA = .06

CFI = .96

SRMR = .04

AIC = 25663.17 (lowest of all 3 models)

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# Dimensionality: results 4 to 6 years

**Three factors**

Vocabulary

Grammar

Discourse

**Two factors**

Lower-level language

Higher-level language

**Uni-dimensional**

Language

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# Dimensionality: results

**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.

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# Dimensionality: results 6 to 8 years

**Three factors**

Vocabulary

Grammar

Discourse

**Two factors**

Lower-level language

Higher-level language

**Uni-dimensional**

Language

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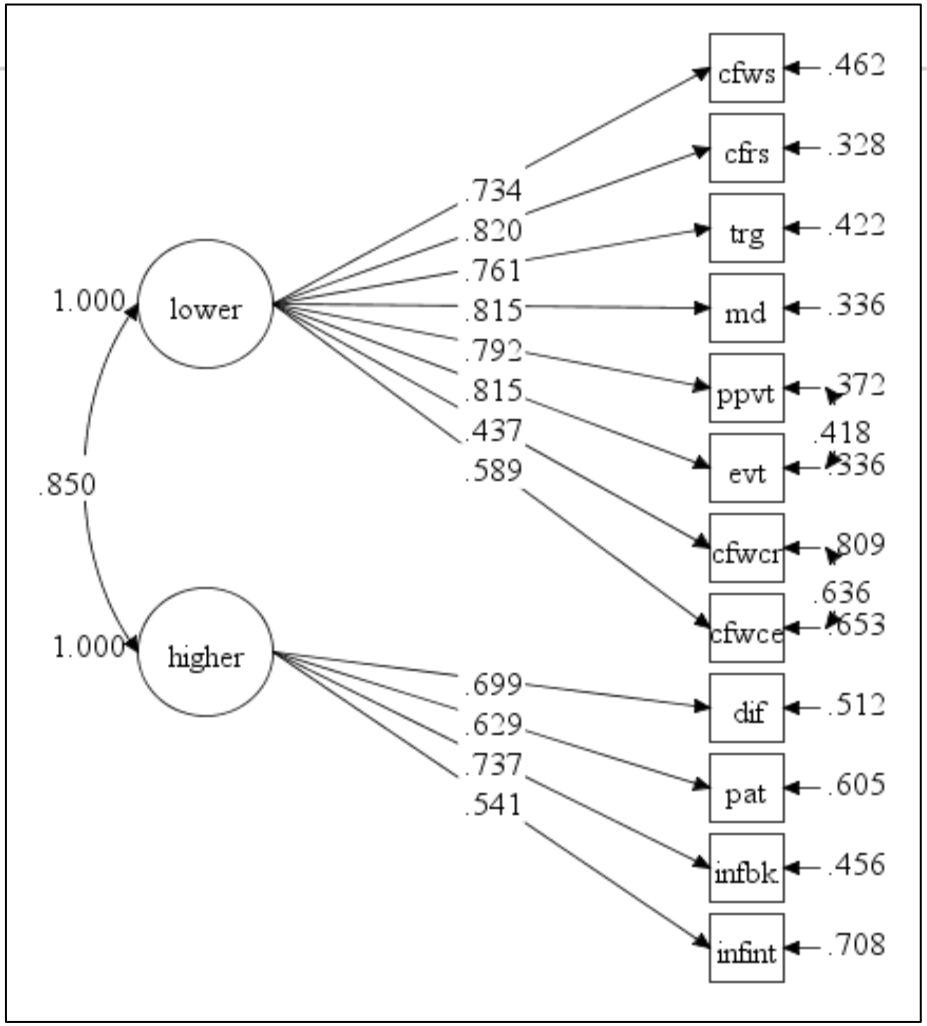
# Dimensionality: Grade 1 (7 years)




## Fit indices

$X^2 = 64.61$, $p = .10$

RMSEA = .05, $p > .05$

CFI = .98

SRMR = .05

AIC = 6855.41 (lowest of all 3 models)

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# Dimensionality: results

**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.

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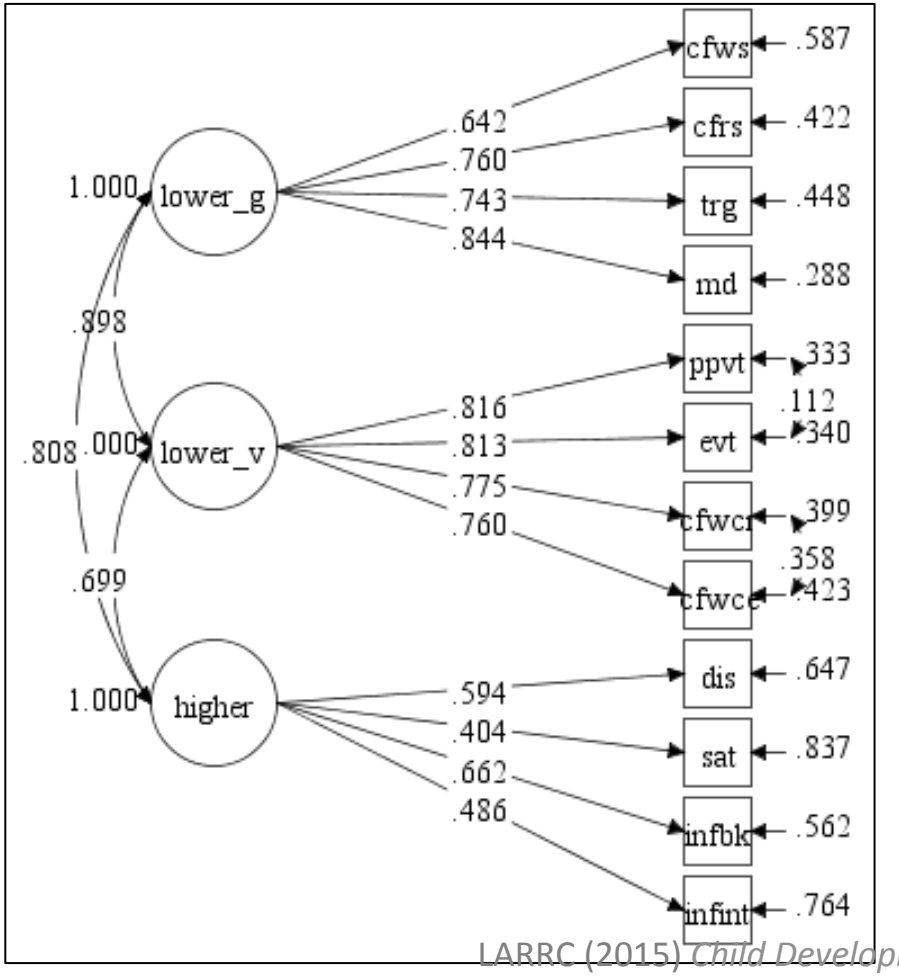
# Dimensionality: Grade 3 (9 years)




## Fit indices

$X^2 = 67.03$, $p = .05$

RMSEA = .05, $p > .05$

CFI = .97

SRMR = .06

AIC = 6262.03 (lowest of all 3 models)

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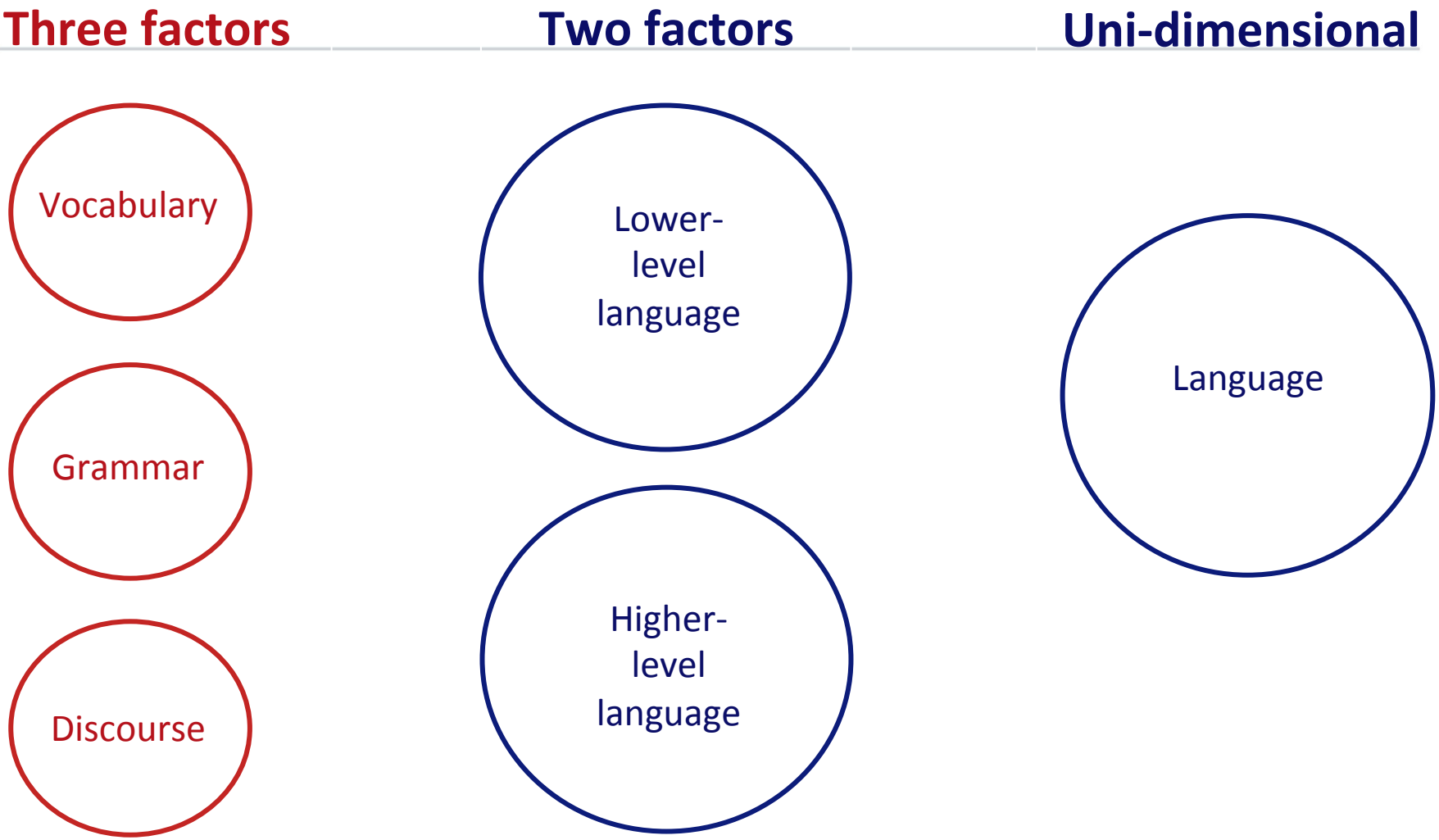
# Dimensionality: results 8 to 9 years

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# Dimensionality: summary and conclusions

## Structure of language

- The dimensional structure of language appears to change across development

## Dimensionality emerges with age

- Higher-level language skills, when included, form part of a unidimensional construct at 5 and 6 years
- A multi-dimensional structure emerges after 6 years, with two factors at 7 to 8 years and three factors by 8 to 9 years

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# Dimensionality: summary and conclusions

## Why does dimensionality emerge?

- Measurement issues?
  - As 'lower-level' skills of vocabulary and grammar are consolidated and automatized, cognitive resources freed up for higher-level processing..... but, higher-level skills are evident < 2 years of age.
  - Vocabulary and grammar measures not as demanding on cognitive resources such as memory.

- Experiences of literacy and interactions with increasingly complex texts may enhance structure of language.

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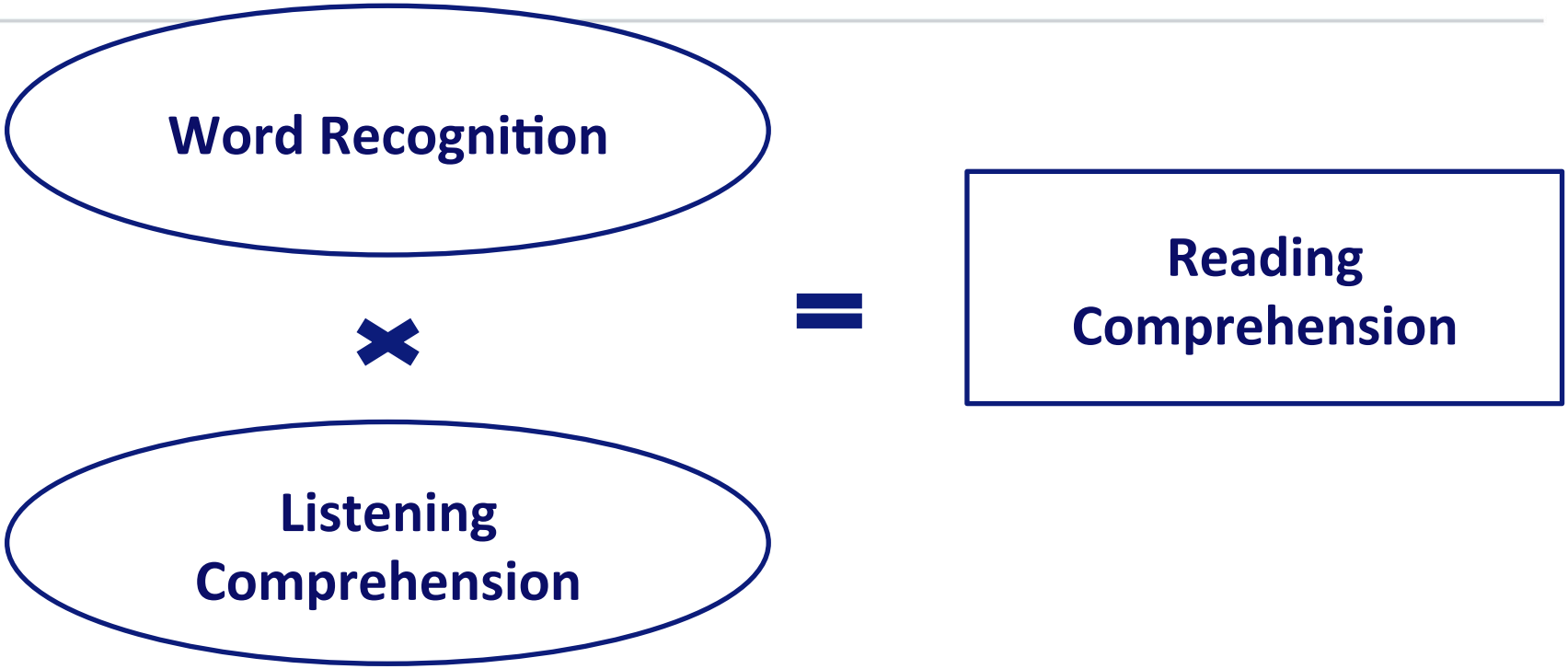
# Pressure points in the reading system



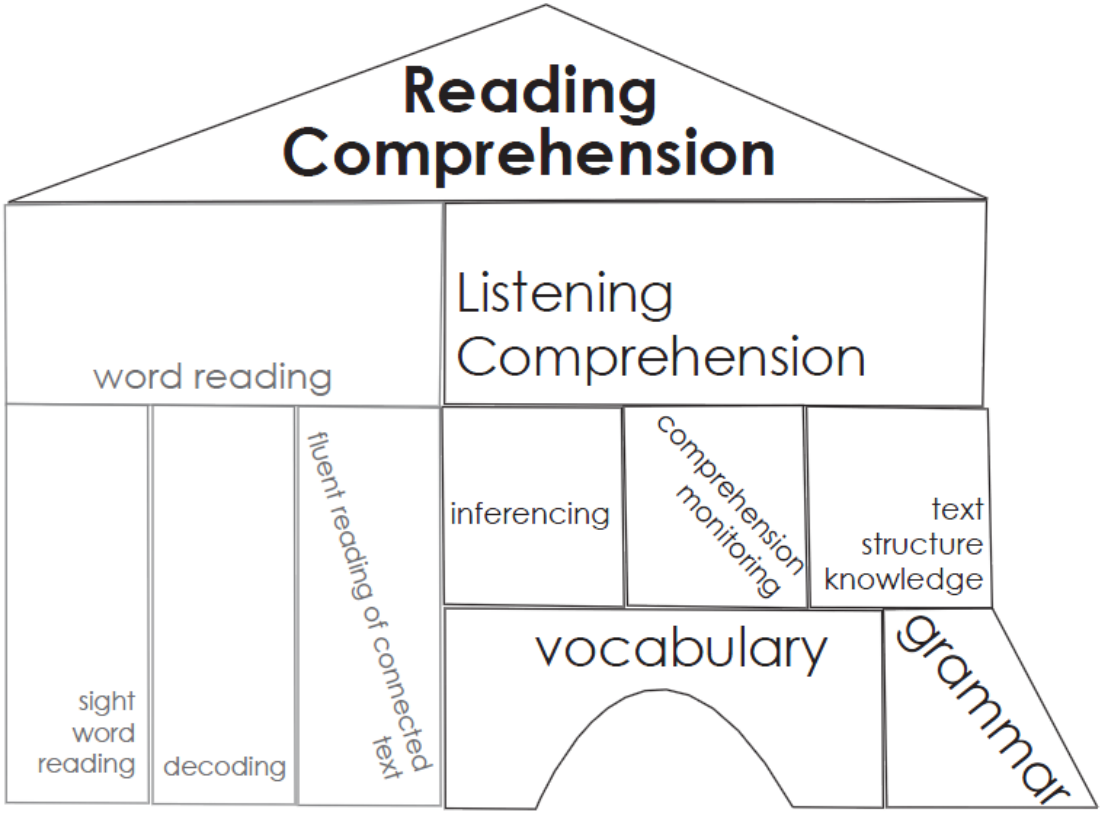

According to the Simple View of Reading, poor reading comprehension can arise from difficulties with word recognition, listening comprehension, or both.

# Pressure points in the reading system

Perfetti, Stafura, and Adlof (2013) proposed three possible "pressure points" in the reading system:

- Word-level processes, e.g., word recognition and meaning retrieval
- Higher-level comprehension processes, e.g., inference making, comprehension monitoring
- General cognitive abilities, e.g., poor working memory

# The dimensionality of language



# Pressure points in the reading system

Poor comprehenders have difficulties with many potential pressure points;

| | Yes | No |
|---|---|---|
| **word recognition** | ✔ | |
| **vocab/semantic** | ✔ | |
| **grammar** | ✔ | |
| **discourse** | ✔ | |
| **working memory** | ✔ | |

# Pressure points in the reading system

Poor comprehenders have difficulties with many potential pressure points; but not always

| | Yes | No |
|---|---|---|
| **word recognition** | ✔ | ✔ |
| **vocab/semantic** | ✔ | ✔ |
| **grammar** | ✔ | ✔ |
| **discourse** | ✔ | (✔) |
| **working memory** | ✔ | (✔) |

Cain & Oakhill (2006); Nation et al (2004); Catts et al (2006)

# Pressure points in the reading system

Perfetti, Stafura, and Adlof (2013) proposed three possible "pressure points" in the reading system:

- Word-level processes, e.g., word recognition and meaning retrieval
- Higher-level comprehension processes, e.g., inference making, comprehension monitoring
- General cognitive abilities, e.g., poor working memory

When considered *together,* several language skills predict reading comprehension outcomes (Catts et al., 1999; Oakhill & Cain, 2012)

# Pressure points: analysis approach

## Quantile regression

- weighting procedure to estimate relationship between a predictor and an outcome at several specified quantiles (percentiles) of the outcome (different levels of reading comprehension ability)

- previous applications have identified sensitivity of this approach for uncovering non-linear relationships (Catts et al., 2009; Logan et al., 2012)

# Pressure points: study

- **Participants:** Children (N=245) aged 7 to 9 years (US grades 2 and 3)

- **Multiple assessments of key skills:**
  - Word recognition: accuracy and fluency
  - Vocabulary: receptive and expressive
  - Grammar: receptive and expressive, word – (morphology) and sentence-level
  - Higher-level skills: comprehension monitoring, inference
  - Memory: storage and processing

# Memory measures

All 'verbal' memory measures that require some executive control

| **Age** | **WJ** *Numbers reversed* | **WJ** *Auditory memory* | **Updating** *Belacchi et al.* |
|---|---|---|---|
| **7 years** | ✔ | ✔ | ✔ |
| **8 years** | ✔ | ✔ | ✔ |

LARRC (under review)

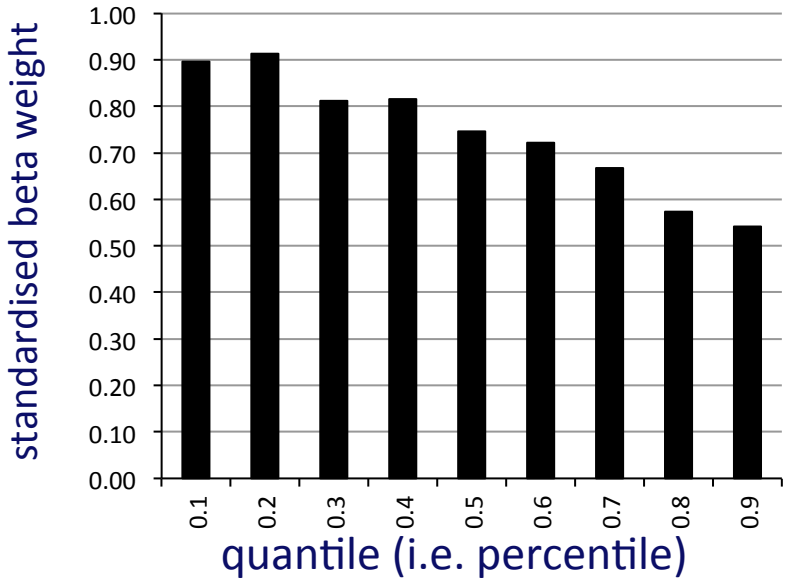
# Pressure points: developmental study

**Individual pressure points:** Do selected pressure points predict unique variance in children's reading comprehension level?

**The relation with reading comprehension level:** Does the importance of pressure points vary as a function of the level of children's reading comprehension skill?

# Pressure points: individual quantile regression

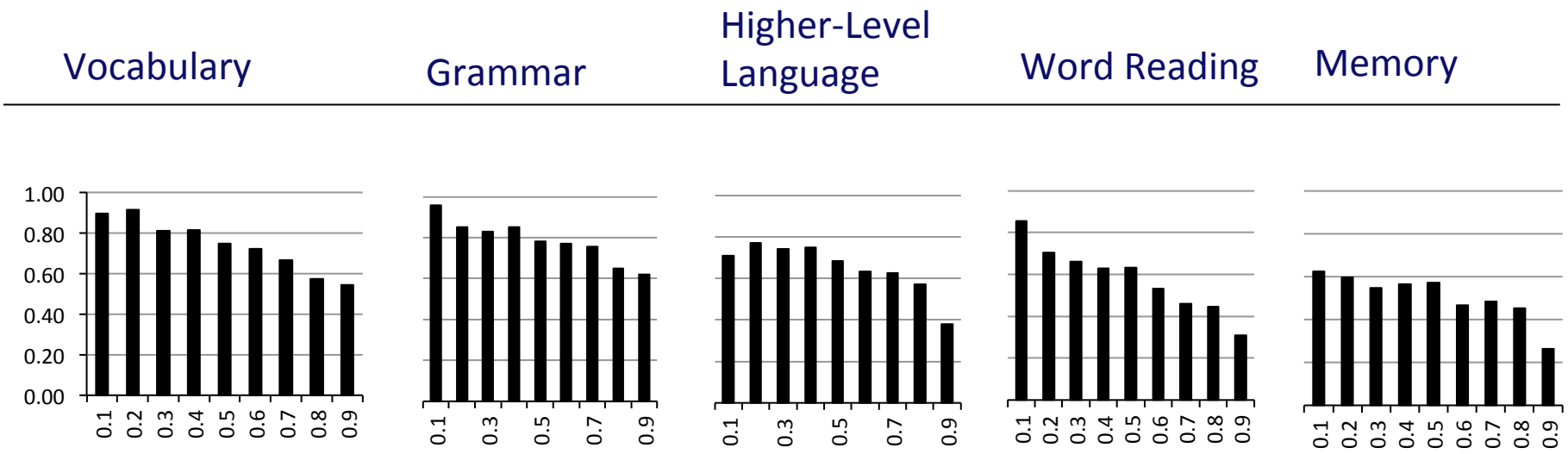
## Vocabulary and its relationship with reading comprehension




At the lower end of the comprehension distribution there is a stronger relationship between vocabulary and comprehension scores than at higher end

LARRC (under review)

# Pressure points: individual multiple regression




Similar pattern for each construct: more predictive of reading comprehension at the lower end of the reading comprehension distribution

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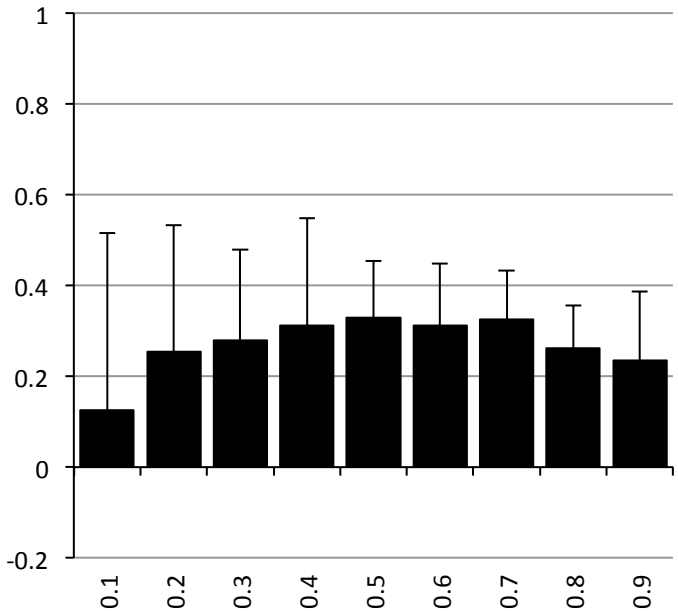
# Pressure points: quantile multiple regression

Vocabulary and its unique relationship with reading comprehension




When controlling for other constructs, vocabulary predicted variance in reading comprehension across the distribution

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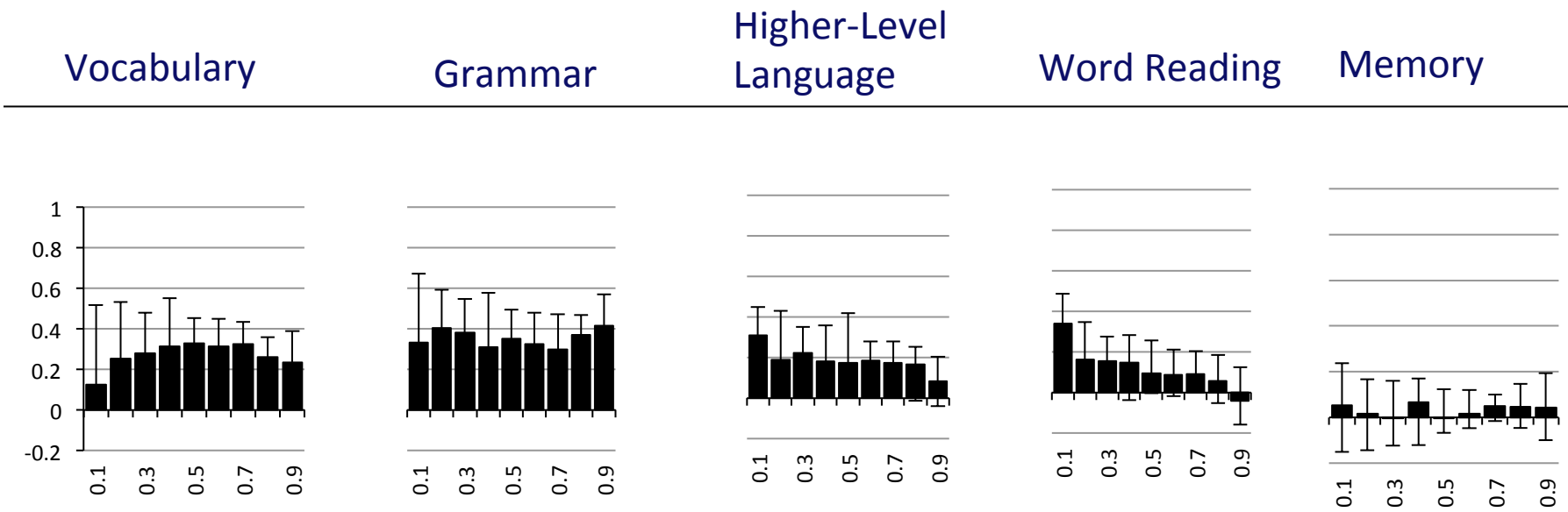
# Pressure points: quantile multiple regression




When controlling for other constructs, vocabulary, grammar, and higher-level language each predicted variance in reading comprehension across the distribution

LARRC (under review)

# Pressure points: summary and conclusions

## Individual pressure points

- Vocabulary, grammar, and higher-level language each uniquely accounted for variance in reading comprehension
  - Constructs are consistent with dimensionality findings
- Memory was not a strong predictor

## The relation with reading comprehension level

- Word reading was only a unique predictor for poor readers
- Greater proportion of variance in reading comprehension accounted for in poor comprehenders (84%) than better comprehenders (53%)

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# Pressure points: summary and conclusions

**Why was grammar such a strong predictor?**

- Integrative function that many aspects of grammar serve: pronouns, connectives.
- Morphology included, which will feed into word reading, vocabulary, and reading comprehension.
- Comprehensive assessment of the construct.

**Why was word reading a predictor only at lower end of range?**

- More important in early stages of reading development.

# Pressure points: summary and conclusions

**Does memory matter?**

- Probably!
- Shares variance with the language skills, so unlikely to predict unique variance.
- Other measures that tap language comprehension skills, e.g., listening span, may be stronger predictors.

# General conclusions

## Learning to read: should we keep things simple?

- good reading comprehension is not simply the result of good word reading; good word reading skills and good listening comprehension skills are both necessary for reading comprehension success.

- listening comprehension has a critical influence on reading comprehension early in development.

- together, these findings suggest that, whilst early instruction should include tuition in decoding skills, it should also foster language comprehension skills.

# General conclusions

## The dimensionality of language

- oral language skills are separable and measurable early
- instructional perspective: language-rich interactions are important to develop the foundations for literacy
- assessment perspective: we should not to rely on a single language measure, because all dimensions are important (if not separable)
  - *National Early Literacy Panel* (2008) - best prediction of reading comprehension evident when vocabulary, grammar, and discourse-level skills included in assessment

# General conclusions

## Pressure points in reading comprehension

- reading comprehension determined by skills beyond the word- and sentence-level: higher-level language skills, such as inference and monitoring, are also important.

# General conclusions

Together, these findings suggest that instruction and intervention need to include multiple skills to support the construction of the meaning-based representation of the text; a focus on a single skill runs the risk of overlooking the contributions made by other aspects of language *and will not result in effective curricula and robust interventions for young or struggling readers.* (Dickinson et al., 2010)

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# Thank you


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