Semantic processing in skilled and less-skilled comprehenders: A preliminary ERP study

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- Ms Caroline Henning

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- Tessa Feinberg
- Merryn Horsfall
- Michaela Noble
The Simple View of Reading

Gough & Tunmer, 1986; Scarborough, 2001

- Word recognition & Language comprehension

Catts et al. (2006)

- Year 8: typical readers, poor comprehenders, poor decoders
- Kindy, Year 2, & Year 4
- Poor decoders: problems at all years with PA
- Poor comprehenders: subtle deficits at all years with vocabulary & discourse comprehension; problems with PA in Kindy only
- No difference between the 2 groups on Year 2 & 4 reading comprehension
The simple view: Elaborated
(Catts et al., 2006)

Word Recognition

<table>
<thead>
<tr>
<th>Poor</th>
<th>Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyslexia</td>
<td>No impairment</td>
</tr>
<tr>
<td>Mixed deficit</td>
<td>Specific comprehension impairment</td>
</tr>
</tbody>
</table>

Language Comprehension

<table>
<thead>
<tr>
<th>Poor</th>
<th>Good</th>
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<tbody>
<tr>
<td>Poor</td>
<td>Good</td>
</tr>
</tbody>
</table>
In search of a sensitive measure...

Lexical decision paradigms

- Poor comprehenders 6-11 years (Nation & Snowling, 1999)
- Abnormal priming for categorically related but not associatively & functionally related words.
- Good for older children but not suitable for preschoolers.

EEG & Event-related potentials (ERPs)

- N400 in infants at "risk" (Torkildsen et al., 2007);
- Adult skilled & less skilled comprehenders (Landi & Perfetti (2007);
- Little in school-aged children
  - Listening comprehension but not vocabulary correlated with N400 in 8-10 year olds (Henderson et al., 2011).
Aims & Hypotheses

Overarching Research Question
Can the N400 be used as a marker of specific comprehension impairment in preliterate children?

Aim
To determine whether the N400 waveform can differentiate between children classified as skilled & less skilled comprehenders by behavioural assessments.

Hypotheses
Less-skilled comprehenders would exhibit abnormal N400 waveforms in comparison to skilled comprehenders.
Less-skilled decoders would perform in similar manner to skilled comprehenders.
Reading skills assessment

• Word Recognition
    • Word identification & word attack subtests.

• Reading Comprehension
  – Neale Analysis of Reading Ability – 3rd Ed. (NARA, Neale, 1999);
    • Open-ended questions; reading aloud.
  – WRMT-R Passage comprehension;
    • Cloze procedure; silent reading.
Participants: 3 profiles

1. Typical readers (TR)
   - skilled comprehenders & skilled decoders
   - No history of speech, language, or learning problems
   - Word recognition & reading comprehension performance > 40th percentile
   - 12 children; 6 males, 6 females
   - 12 – 13 years
   - Mean age 12.77 years (4.95 months)
   - ERP data reported for a subgroup of 4; 3 males, 1 female.
2. **Less-skilled comprehender (LSC)**
   - Skilled decoder
   - Word recognition performance > 40\textsuperscript{th} percentile
   - Reading comprehension performance < 25\textsuperscript{th} percentile
   - One participant
   - 13;8 years

3. **Less-skilled decoder - (LSD)**
   - Skilled comprehender
   - Word recognition performance <25\textsuperscript{th} percentile
   - Reading comprehension performance > 40\textsuperscript{th} percentile
   - One participant
   - 12;8 years
# Reading profiles

<table>
<thead>
<tr>
<th></th>
<th>TR</th>
<th>LSC</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Word recognition</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Basic Skills</td>
<td>110.67 (8.34)</td>
<td>94</td>
<td>77</td>
</tr>
<tr>
<td>• Word Identification</td>
<td>108.33 (6.91)</td>
<td>91</td>
<td>83</td>
</tr>
<tr>
<td>• Word Attack</td>
<td>112.33 (10.31)</td>
<td>95</td>
<td>72</td>
</tr>
<tr>
<td><strong>Reading comprehension</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• NARA (AE in years)</td>
<td>13.00 (0.00)</td>
<td>11;4</td>
<td>13;0+</td>
</tr>
<tr>
<td>• WRMT-R SS</td>
<td>109.67 (6.17)</td>
<td>93</td>
<td>98</td>
</tr>
</tbody>
</table>
Testing: 2 components

1. Behavioural
   • Receptive language
   • Phonological processing

2. Electrophysiological (EEG)
   • Semantic priming
   • Phonological priming (not reported here)
Behavioural Testing

Standardised tests of oral language

- Language Comprehension
  - Clinical Evaluation of Language Fundamentals – Australian standardised 4th Ed (Semel, Wiig, & Secord, 2006)
    - Receptive language index.
  - Peabody Picture Vocabulary Test 4th Edition (Dunn & Dunn, 2007)
Behavioural Testing

• Phonological Processing
  – Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999)
    • 4 Cluster Scores
    • Phonological Awareness (PA)
    • Alternate PA (APA)
    • Phonological memory (PM)
    • Rapid Naming (RN)
EEG: Semantic Priming

- Spoken word prime/picture target
- 156 trials = 3 blocks of 52
- Animals, vehicles, clothing, furniture, fruit, body parts
- Mean (SD) AoA = 35.75 (16.84) months
- Pictures – Snodgrass & Vanderwart (1980)
- 3 conditions
  - Congruent
    - e.g. cat/cat
  - Incongruent related = same semantic category
    - e.g., horse/cow
  - Incongruent unrelated = different semantic category
    - e.g., giraffe/bike
Semantic Priming

1500ms + Fixation Cross
1500ms Prime
3000ms Target

same or different
2500ms Next trial

cat

Next trial
EEG Procedures

Data Recording
• 128 channel Electrical Geodesics sensor net
• Net AMPS EEG amplifier
• EEG activity continuously recorded with:
  • Sampling rate = 500Hz
• Online bandpass filtered from 0.1 to 100Hz

Data Analysis
• Filtered 0.1 to 30Hz
• Eye blink correction
• Baseline corrected to 100ms before prime (spoken word)
• Early & late N400
• Latency, mean & peak amplitude
## Results: language profiles

<table>
<thead>
<tr>
<th></th>
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<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Language comprehension</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• CELF-4 RLI SS</td>
<td>107.25 (8.06)</td>
<td>83</td>
<td>103</td>
</tr>
<tr>
<td>• PPVT-4 SS</td>
<td>114.42 (10.51)</td>
<td>98</td>
<td>102</td>
</tr>
<tr>
<td><strong>Phonological processing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• PA</td>
<td>108.75 (7.51)</td>
<td>91</td>
<td>82</td>
</tr>
<tr>
<td>• APA</td>
<td>110.00 (8.12)</td>
<td>103</td>
<td>106</td>
</tr>
<tr>
<td>• PM</td>
<td>104.25 (8.81)</td>
<td>103</td>
<td>112</td>
</tr>
<tr>
<td>• RN</td>
<td>104.50 (12.50)</td>
<td>85</td>
<td>67</td>
</tr>
<tr>
<td><strong>Working memory</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• CELF-4 WMI SS</td>
<td>108.73 (7.64)</td>
<td>85</td>
<td>94</td>
</tr>
</tbody>
</table>
Results: Reaction time

- **TR**
- **LSC**
- **LSD**

* $p = .001$
Results: TR

Early N400  Late N400

N100
Results: TR

• 2 time windows: 200 – 400 ms (early N400); 400 – 650 ms (late N400);
• Related vs unrelated.

Early N400
• Mean amplitude $p = .040$
• Peak amplitude non-significant

Late N400
• Mean amplitude $p = .048$
• Peak amplitude $p = .043$
Electrode 12

TR

LSC

LSD
Electrode 29

TR

LSC

LSD
Electrode 36

TR

LSC

LSD

-12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12

-12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12

-100 0 500 1000
Discussion

Behavioural measures

• 3 distinct profiles consistent with simple view
• Significant –ve priming (unrelated faster than related) for TR only;
• Both LSC & LSD slower overall;
• LSC & LSD exhibited same pattern as TR.
Discussion

All groups exhibited early sensory negativity (N100) of similar amplitude, although LSD later.

N400

• Task elicited both early & late negative components in 12-13 year old typical readers;
• More negative for unrelated than for related items;
• Most prominent in fronto-central regions;
• Both LSC & LSD showed attenuated N400s but different patterns;
  – LSC late N400 most affected; similar early N400 peak latency but smaller peak amplitudes; late N400 absent; semantic integration problems?
  – LSD both early and late N400 affected; lexical access problems.
Implications & Future Directions

Experimental:
• Increase sample size;
• Range of skills within LSC & LSD;
• Phonological processing.

Data analysis:
• Correlations with behavioural measures
• Closer inspection of data:
  – Principle components analysis, PCA, (Molfese et al., 2001) or intra-class correlation co-efficients, ICC, (McArthur et al., 2011);
  – Other components e.g., late positivity component (LPC) particularly sensitive to controlled processing (Wang et al., 2009).
Thank you!


References


