Atypical Language Representation in Childhood Epilepsy: Re-examining the Crowding Hypothesis

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Patterns of language dominance

Typical language dominance

Atypical language dominance
The Crowding Hypothesis (Lansdell, 1969; Teuber, 1974)
Atypical language dominance may lead to “crowding” of visual-spatial functions primarily subserved by right hemisphere.

- Supported by large (n=561) adult temporal lobe epilepsy study (Loring et al., 1999)
What we don’t yet know...

- Crowding effects in children?
  - Evidence is mixed

- Can language laterality uniquely explain group differences?
  - What about the impact of associated factors such as:
    - Early vs late seizure onset
    - Handedness
    - Seizure localization
Research Questions

• Do children with epilepsy and atypical language perform worse on visual vs verbal cognitive measures than those with typical language?  
  -> Univariate analyses

• What are the relative contributions of the following factors on verbal vs visual cognitive functions?  -> Multivariate analyses
  • Seizure onset (before age 5 vs after age 5)
  • Handedness (right vs left)
  • Seizure localization (temporal vs extratemporal)
  • Language dominance (typical vs atypical)
Verbal Measures

- Boston Naming Test (confrontation naming)
- Vocabulary subtest (vocabulary knowledge)
- Similarities subtest (verbal abstract reasoning)

Visual Measures

- Beery VMI (visual-motor construction)
- Block Design (visual-motor construction & problem solving)
- Matrix Reasoning (visual abstract reasoning)
Participants

110 consecutive patients with left-sided, medically refractory focal epilepsy who completed neuropsychological assessment and assessment of language dominance between October 1981 and March 2017 at SickKids.

16 patients excluded - overall intellectual functioning lower than 2SD below population mean.

3 patients excluded – language laterality investigations unreliable/inconclusive.

Final sample = 91 (mean age = 12 years, range 3-17 years)
34 typical (left) language dominance, 57 with atypical (right or bilateral) language dominance
fMRI=63, Wada/eSAM=24, MEG=4
Demographic and epilepsy-related characteristics of our sample.

<table>
<thead>
<tr>
<th></th>
<th>Typical language (n = 57)</th>
<th>Atypical language (n = 34)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (# males)</td>
<td>24</td>
<td>23</td>
<td>.029</td>
</tr>
<tr>
<td>Handedness (# right-handed)</td>
<td>54</td>
<td>24</td>
<td>.004</td>
</tr>
<tr>
<td>Age of seizure onset (mean, standard deviation)</td>
<td>7.14 (4.69)</td>
<td>7.14 (4.50)</td>
<td>.999</td>
</tr>
<tr>
<td># onset of seizures prior to age 5 years</td>
<td>22</td>
<td>15</td>
<td>.662</td>
</tr>
<tr>
<td>Age at assessment (mean, standard deviation)</td>
<td>12.03 (3.52)</td>
<td>12.87 (3.55)</td>
<td>.277</td>
</tr>
<tr>
<td>Duration of epilepsy at time of assessment (mean in years, standard deviation)</td>
<td>4.90 (3.68)</td>
<td>5.73 (4.08)</td>
<td>.317</td>
</tr>
<tr>
<td>Site of seizure focus (#)</td>
<td></td>
<td></td>
<td>.91</td>
</tr>
<tr>
<td>Temporal</td>
<td>37</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Extratemporal</td>
<td>20</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Number of AEDs (mean, standard deviation)</td>
<td>1.58 (.71)</td>
<td>1.76 (.70)</td>
<td>.239</td>
</tr>
<tr>
<td>Full scale IQ</td>
<td>93.65 (12.15)</td>
<td>87.34 (13.00)</td>
<td>.03</td>
</tr>
</tbody>
</table>
Regression Analyses

- Dependents Variable
  - Seizure onset (before or after age 5 years)
  - Seizure localization (temporal vs extratemporal)
  - Handedness (right vs left)
  - Language dominance (typical vs atypical)
Regression Analyses: Visual Measures

**Background**

**Study Objective**

**Measures**

**Participants**

**Results**

**Discussion**

**Beery VMI**

\[ R^2 = 0.25, p = 0.015 \]

- Seizure onset (B = -0.59)
- Seizure localization (B = 0.41)
- Handedness (B = -0.48)
- Language dominance (B = 0.80)

**Block Design**

\[ R^2 = 0.14, p = 0.02 \]

- Seizure onset (B = -0.20)
- Seizure localization (B = -0.19)
- Handedness (B = 0.49)
- Language dominance (B = 0.57)

**Matrix Reasoning**

\[ R^2 = 0.30, p < 0.007 \]

- Seizure onset (B = -0.35)
- Seizure localization (B = 0.03)
- Handedness (B = 0.89)
- Language dominance (B = 0.45)
Regression Analyses: Verbal Measures

- **Boston Naming**
  - $R^2 = .31$, $p < .001$
  - Seizure onset ($B = 0.23$)
  - Seizure localization ($B = -1.36$)
  - Handedness ($B = 0.10$)
  - Language dominance ($B = 1.72$)

- **Vocabulary**
  - $R^2 = .11$, $p = .06$
  - Seizure onset ($B = -0.15$)
  - Seizure localization ($B = -0.58$)
  - Handedness ($B = 0.06$)
  - Language dominance ($B = 0.49$)

- **Similarities**
  - $R^2 = .08$, $p = .16$
  - Seizure onset ($B = -0.28$)
  - Seizure localization ($B = -0.48$)
  - Handedness ($B = -0.13$)
  - Language dominance ($B = -0.41$)
Summary

• Univariate analyses largely support crowding hypothesis
  • But language functions may not be completely spared in children (naming poorer in atypical language group)

• Multivariate analyses provide some support for right-hemisphere functional crowding
  • Language dominance the strongest predictor of performance on 2 of 3 visual tasks (visual-motor construction and problem solving)
  • Vocabulary knowledge and verbal abstract reasoning similar between typical and atypical language groups
Take home message

- Consideration of language dominance is important in pre-surgical neuropsychological evaluations

- In children with atypical language dominance and left-sided seizure focus
  - Some (but not all) language functions may be within age expectations
  - Visual-spatial deficits may be expected
  - Overall intelligence may be mildly impacted
Future Directions

• Consideration of language dominance on a continuum
  • We did not have fine-grained metrics of language dominance

• Replication with other visual and verbal cognitive tasks
Acknowledgements

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Thank you!