Sign and Spoken Language Interface: 
Applied Brain Language Research

Deanna Gagne, Ph.D. & 
Jessica Contreras, M.S.

Research Questions:
• How do children influence the language they learn?
• What aspects of the human experience require having a language? What aspects do not?

Deanna L. Gagne
B.S., ASL-English Interpreting / Psychology & Linguistics: Northeastern University
M.A. & PhD., Developmental Psychology / Cognitive Sciences & the Neurobiology of Language: University of Connecticut

Research Questions:
• Does early language experience shape cognitive development?
  o Sign Language 
  o Spoken and Sign Language (Bilingualism)
  o 2 Signed Languages (Bilingualism)
  o 2 Spoken Languages (Bilingualism)

Jessica Contreras
B.S., & M.S. Experimental Psychology: Rochester Institute of Technology
2nd year PhD., Developmental Psychology / Cognitive Sciences & Neurobiology of Language: University of Connecticut
What do we mean by **Language**?

I. Emerge spontaneously and organically by a community of people

II. Cohesive grammar at all levels
   - Words/signs -> sentences -> dialogue

III. Acquired easily by children

---

Language Areas of the Brain:

All languages (spoken or signed) are processed in the same places
Brain development

In all children:
- Pruning begins at about 2 years of age
- Related to the Critical Period Hypothesis

Deaf individuals with little to no language exposure show less physical brain growth (smaller brain volume) as compared to those who had language exposure.

Bilingual Advantage

Evidence suggests that bilingual individuals may have an advantage in cognitive abilities, as shown in the diagram.
Executive Function

Complex set of integral processes that are developed throughout one's life and are shaped by experience.

EF is important for learning and behavioral regulation.

1. Inhibition
2. Working Memory
3. Cognitive Flexibility

---

EF Processes

- Inhibition
- Working Memory
- Cognitive Flexibility

---

EF Model

Higher-Level Executive Functions

- Reasoning
- Problem Solving
- Planning

- Inhibition
- Working Memory
- Cognitive Flexibility

Adapted from Diamond, 2013
Research Question

Is there a bilingualism advantage for deaf individuals who are fluent in American Sign Language and English?

Language Assessments

- Peabody Individual Achievement Test-Revised
- American Sign Language-Sentence Reproduction Test
Groups

- **ASL-English** Group
  - ASL: Top 50%
  - English: Top 50%

- **ASL** Group
  - ASL: Top 50%
  - English: Bottom 50%

- **English** Group
  - ASL: Bottom 50%
  - English: Top 50%

Participants

<table>
<thead>
<tr>
<th>Groups</th>
<th>ASL</th>
<th>English</th>
<th>Deaf Children n=78</th>
<th>Deaf Adults n=36</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASL-English</td>
<td>✔</td>
<td>✔</td>
<td>33</td>
<td>13</td>
</tr>
<tr>
<td>ASL</td>
<td>✔</td>
<td>×</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>English</td>
<td>×</td>
<td>✔</td>
<td>29</td>
<td>7</td>
</tr>
</tbody>
</table>
Executive Function Task

Trail 1

Trail 2

---

4.

Cognitive Abilities

Bilingual advantage for deaf children and adults fluent in ASL & English.

---

4.

Cognitive Abilities

Hauser, P.C. & Contreras, J. In Progress

---

Impact of Executive Function Development

Diamond, 2013

---
Social Abilities

Socio-Cognitive Abilities
Understanding that someone can have a False Belief

The Trajectory of Social Cognition

WHAT do others see?

HOW do others see it?

The world CHANGES

People can have a FALSE BELIEF
The Trajectory of Social Cognition

WHAT do others see?

HOW do others see it?

The world CHANGES

Others' FALSE BELIEFS

<table>
<thead>
<tr>
<th>WHAT</th>
<th>HOW</th>
<th>CHANGES</th>
<th>False Belief</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanish Speakers</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Deaf - NSL</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Deaf Homesigners</td>
<td>✔</td>
<td>✔</td>
<td>✗</td>
</tr>
</tbody>
</table>

Gagne & Coppola, 2017

Numerical Cognition

What do babies know about numbers?

Few

Many

Xu & Spelke, 2000

Counting

Can babies count?

Not when differences are small

Xu & Spelke, 2000
Research Questions

1. Can deaf adult homesigners not exposed to any formal language count?

2. Can deaf adult homesigners use their fingers as a count system?

Tactile Matching Task

<table>
<thead>
<tr>
<th>Target</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

http://youtu.be/Pw4RCP_h5SM
Spaapen et al. 2011
What’s On this Card?

![Image of a person and a card]

Target: 14 2
Response: 12 2

http://youtu.be/r_caetYf5kE
Spaepen et al. 2011

Research Questions

1. Can Adult homesigners not exposed to any formal language count? **NO**
   Language provides a system for counting.

2. Can Adult homesigners use their fingers to count? **NO**
   Fingers are not representation of numbers, you need language.

Spaepen et al. 2011

Early exposure to natural, organic language provides:

- Stimulation for proper brain growth and development
- The groundwork for behavior regulation
- A foundation for successful social interactions
- The infrastructure for understanding and using number and quantity

UCONN
This material is based upon work supported by the National Science Foundation under Grant Numbers NSF #1553589 and DGE-1247393. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Thank you!