The Role of Gesture and Other Cues in Word Learning & Retrieval

Nina Capone-Singleton, Ph.D., CCC-SLP
Presented to the University of Florida
G. Paul Moore Symposium
February 2020

Learning Objectives Participants will...
- ...identify at least 3 milestones in typical gesture development.
- ...state how gestures predict word learning in children with and without language impairments.
- ...describe 2 ways gestures enrich word learning and retrieval for children with and without language impairments.
- ...identify how multisensory cues enrich storage and retrieval of words.

What are gestures?
- Hand and other body or facial movements
- Majority of gestures convey information
- Information context can be external or inherent to the gesture (e.g., Acredolo & Goodwyn, 1993; Goldin-Meadow, 2003)

Financial & NonFinancial Disclosures
- Financial: Full-time faculty member in the Department of Speech-Language Pathology at Seton Hall University. Faculty appointment in the Hackensack-Meridian School of Medicine at SHU.
- Financial: Honorarium by the University of Florida National Students Speech Language and Hearing Association (UF NSSLHA).
- Nonfinancial: Member of the American Speech-Language-Hearing Association, SIG 1, SIG 2, and the Hanen Center.

Representational
- Iconic
- Conventional / Social
- Emblem
Iconic Co-Speech Shape Gestures

helicopter  bunny  bowl

Deictic
- Show / Give
- Pointing
- Other Indicators (e.g., extended hand, touching)

...in isolation
- To compensate for words unspoken
  - Word retrieval failure
  - Words not yet known
  - Still evolving articulation abilities

(Acredolo & Goodwyn, 1988)

...in combination
- Co-speech gestures
  - Occurs in temporal synchrony
  - Indicates learning readiness
  - Predicts cognitive change

...in combination
- Gesture - Speech combinations
  - Children read gesture as well as speech/ language
  - Will ignore gesture if they do not need it

Understanding gesture
...in the context of spoken language and development
How do children’s gesture develop?

<table>
<thead>
<tr>
<th>Gesture Only</th>
<th>Gesture or Speech</th>
<th>Gesture and Speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Deictic</td>
<td>· Deictic</td>
<td>· Complements</td>
</tr>
<tr>
<td>· Iconic</td>
<td>· Iconic</td>
<td>· Supplements</td>
</tr>
<tr>
<td>· Social</td>
<td>· Social</td>
<td></td>
</tr>
<tr>
<td>· Conventional</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Predictable sequence

Stages of Communication:

Perlocution……………………..Illocution …………..Location

1st WORD

OBJECT

PLAY

Vocalizing Coo-Goo Babbling Jargoning

Joint Attention

Birth…….. 6-months 8-to 10-months 12 months

Predictive Relationships

Show → Give → Point

Point → First Word

Point + Word → Word + Word combinations

Gesture - Speech Mismatch indicates readiness to learn

Iconic 16 months Point + Word

Social Conventional

Discourse - Narrative

Semantics / Vocabulary Phonology

Morphology / Syntax

18-18 months

Word Generalization & Vocabulary Spurt

Word Combinations

12 months → 18-24 months → 24 + months → 30+ mo.

Joint Attention

Ritual request gestures

Stages of Communication:

Birth…….. 6-months 8-to 10-months 12 months

Cognitive

Social Neurological

Underpinnings

Written Language / Reading…Writing

Pragmatics

Pragmatics

Semantics / Vocabulary Phonology

Phonology

1st WORD

Discourse - Narrative

12 months

Word Generalization & Vocabulary Spurt

Word Combinations

12 months → 18-24 months → 24 + months → 30+ mo.

Social Conventional

Shape

Bia

(Inverson & Goldin Meadow, 2001)
Explaining solutions to mathematical equivalence problems:

“We add both sides so they are equal.”

Cognitive

- **Gesture-Speech Mismatch**
  - Grouping strategy conveyed by a horn gesture.

- **Gesture-Speech Match**
  - Equalizer strategy conveyed by a sweeping point gesture.

Social

- **Gestural motherese**
  - Simple form
  - Mostly pointing
  - Object oriented
  - Immediate context
  - Reinforces what mothers are saying
  - Helps infants link action to language

United States

- Britain

- Italy

  (e.g., Iverson, Capirci, Longobardi, Caselli, 1999; O’Neil, Bard, Linsell, & Fluck, 2000)

Social

- **Zammit & Schafer (2010)**
  - Spontaneous communication mothers use **iconic gestures** and pointing to objects
  - +/- relation to receptive object vocabulary

- **infancy**

- **Toddlerhood**

- **Gesture is all around us...**

Cultural differences

- **American babies**
  - Parents trained ➔ babies add iconic gestures to their conceptual vocabulary
  - (e.g., Acredolo & Goodwyn, 1993; Goodwyn, Acredolo & Brown, 2000; McGregor & Capone, 2004)

- **Wu & Coulson (2005; 2007)**
  - Iconic gestures & Speech/Language
  - Recruit the same neural areas
  - Processed along the same time course (N300, N400)
  - Iconic gestures are semantic cues ➔ integrated with speech
  - Enhance the understanding

Neurological

- **Evoked-Related Potentials by the “listener”**

19

20

21

22

23

24
Gestures within Functional Contexts

- In school (Goldin-Meadow, Kim & Singer, 1999; Fleuret & Perry, 2001)
- With caregivers

Grimminger, Rohlfing & Stenneken (2010)

GESTURE: Frees working memory resources...

Typical Word Learning Toddlers $n = 37$

$M = 20$ words

LLE Toddlers 22 to 25 months $n = 9$

$M = 3$ words

Mothers used point & iconic gestures

"...under" vs. "...there"

Baddley, 2000

VisuoSpatial Sketchpad
Episodic Buffer
Phonological Loop

Central Executive

Long Term Memory
The case of OBJECTS
LATE LANGUAGE EMERGENCE

Late Language Emergence (LLE; Mable Rice, 2012)

Rescorla, Mirak, & Singh (2000)
Semantic growth

100+ words
More rapid vocabulary growth
Word Spurt

< 100 words
Slow vocabulary growth
No Word Spurt

Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002
Object Name Learning Provides on-the-job Training for Attention

The SHAPE BIAS emerges

Step 1.

Step 2.

Step 3.

Step 4.
The SHAPE BIAS emerges

Object Word Learning – toddlers with LLE

- Toddlers with LLE are stuck at step 1
- Too few words, difficulty mapping words and retaining them

- Do not infer the shape bias

This is implicit for typical learners

This is a zup. (x3) Can you get the zup?

- Late talkers are actively choosing
- Generalize names by shape less often
- The more shape-based nouns in the lexicon → more likely to generalize new words by shape (use an efficient strategy)

Colunga & Sims (2017)

- Children with LLE extend words to objects that share texture – use an inefficient strategy
  - Would we call a bench and a floor the same thing because they were both made of wood?

- Other toddlers with LLE – used no bias at all

Children with LLE

- (Jones, 2003; Jones & Smith, 2005; Perry & Kucker, 2019)

Children with Developmental Language Disorder

- (Collisson, Grela, Spaulding, Rueckl, & Magnuson, 2014)

Children with Autism

- Abdelaziz, Kover, Wahner, Naigles, 2018; Tek, Jaffrey, Fein & Naigles, 2008

“DAX”

Intervention Approaches

- Current – Quantity or Quality of word models (Cable & Domasch (2011)
- MacRoy-Higgins, Schwartz, Shaffer, & Marton (2013
- No words said after treatment

- Alt, Meyers, Oplivo, Nicholas, & Arizmendi (2014)
  - Extreme volume of word modeling needed to say words

- Semantic approach to what we considered to be a semantic problem
Capone Singleton & Saks (2015)

<table>
<thead>
<tr>
<th>CHILD</th>
<th>Age</th>
<th>Race</th>
<th>Gender</th>
<th>Inclusion:</th>
<th>Enrolled in TX</th>
<th>Gesture Conditions</th>
<th>Iconic Indicator</th>
<th>No G</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELD 1</td>
<td>28 m</td>
<td>W</td>
<td>F</td>
<td>MCVI &lt; 5*</td>
<td>Yes</td>
<td>SHP, FNC</td>
<td>No G</td>
<td></td>
</tr>
<tr>
<td>ELD 2</td>
<td>33 m</td>
<td>AA</td>
<td>M</td>
<td>PLR &lt; 10*</td>
<td>Yes</td>
<td>SHP, FNC</td>
<td>No G</td>
<td></td>
</tr>
<tr>
<td>ELD 3</td>
<td>33 m</td>
<td>W</td>
<td>M</td>
<td>CVT-1*</td>
<td>Yes</td>
<td>SHP, FNC</td>
<td>Point</td>
<td></td>
</tr>
<tr>
<td>ELD 4</td>
<td>27 m</td>
<td>W</td>
<td>F</td>
<td>MCVI &lt; 5*</td>
<td>Yes</td>
<td>SHP, FNC</td>
<td>Point</td>
<td></td>
</tr>
<tr>
<td>ELD 5</td>
<td>27 m</td>
<td>W</td>
<td>F</td>
<td>CVT-2*</td>
<td>Yes</td>
<td>SHP, FNC</td>
<td>Point</td>
<td></td>
</tr>
<tr>
<td>ELD 6</td>
<td>30 m</td>
<td>AA</td>
<td>F</td>
<td>MCVI &lt; 5*</td>
<td>Yes</td>
<td>SHP, FNC</td>
<td>Point</td>
<td></td>
</tr>
<tr>
<td>ELD 7</td>
<td>32 m</td>
<td>W</td>
<td>F</td>
<td>CVT-18*</td>
<td>Yes</td>
<td>SHP</td>
<td>Palm up</td>
<td></td>
</tr>
</tbody>
</table>

AA = African American, As = Asian, W = White, M = male, MCVI = MacArthur Bates Communicative Development Index; PLR = Preschool Language Scale, CVT = Expressive Vocabulary Test.

Table: Tabulated data with columns for each participant including Age, Race, Gender, Inclusion status, Enrollment status, Gesture Conditions, Iconic Indicators, and No G response.

What will I see in the results?

- Treatment Fidelity
- Dependent Measure Reliability

Capone Singleton & Anderson (in press)

- 4 toddlers with Late Language Emergence (LLE)
- Common objects on the MCDI
  - Children did not previously say them
  - Generalization session
  - Play-based without teaching
  - Experiment did not label them
  - Objects not seen with taught objects
- CV criteria = Naming
- 91% agreement

Figures:

- Figure 3: Number of taught objects named by each participant. Black bars represent SHP condition. White bars represent CMP condition.
- Figure 4: Number of taught words extended to untaught exemplars by each participant in generalization sessions. Black bars represent SHP condition. White bars represent CMP condition.

Generalization of types and tokens (in parentheses): Black bars represent SHP condition. White bars represent CMP condition.
<table>
<thead>
<tr>
<th>Participant</th>
<th>Caused Objects Extended</th>
<th>Object Types Named</th>
<th>Object Tokens Named</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>SHAPE IND</td>
<td>SHAPE IND</td>
<td>SHAPE IND</td>
</tr>
<tr>
<td>P2</td>
<td>SHAPE IND</td>
<td>SHAPE IND</td>
<td>SHAPE IND</td>
</tr>
<tr>
<td>P3</td>
<td>SHAPE IND</td>
<td>SHAPE IND</td>
<td>SHAPE IND</td>
</tr>
<tr>
<td>P4</td>
<td>SHAPE IND</td>
<td>SHAPE IND</td>
<td>SHAPE IND</td>
</tr>
</tbody>
</table>

Generalization (last session only)

Phonemes mapped

- Collapsed across sessions 7 & 8
- Indicating gesture: 1.08 phonemes / attempt
- Shape gesture: 2.62 phonemes / attempt $p = .018$

Capone Singleton & Anderson (in press)

Semantic Benefit
- Semantic Enrichment
- Co-Speech
- Link between word & Referent
- Explicit cue to shape
- Generalization Test

Phono-Lexical Benefit
- Semantic Binding
- Frees cognitive resources
- Gesture externalizes a representation

How did we know what gestures to use?

How do we know semantic learning occurred?

Experimental Controls

How did we know what gestures to use?

How do we know semantic learning occurred?

Tasks
**Novel Objects, Labels, and Gesture**

<table>
<thead>
<tr>
<th>Kitchen objects</th>
<th>Nonsense</th>
<th>Shape</th>
<th>Function</th>
<th>Gesture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Label</td>
<td>/paam/</td>
<td>/kas/</td>
<td>/torb/</td>
<td>/gef/</td>
</tr>
<tr>
<td>Gesture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Procedures**

- **Day 1**: teach fast mapping probe
- **Day 2 & 3**: teach
- **Day 4**: slow mapping probe

**Experimental Design**
- Show Teaching Object
- Demonstrate Function
- Child enacts Function

**Experimenters Label object 3x – Co-Speech Gestures**

**Representational Richness Reflected in Word Retrieval**

<table>
<thead>
<tr>
<th>Level of Scaffolding</th>
<th>Semantic Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncued picture naming</td>
<td>Rich</td>
</tr>
<tr>
<td>Cued picture naming (on the cup)</td>
<td>Moderately rich</td>
</tr>
<tr>
<td>Picture recognition</td>
<td>Weak</td>
</tr>
</tbody>
</table>

**Slow mapping – Word retrieval Results**

- **Shape**: Uncued, Cued, Recognition
- **Function**: Uncued, Cued, Recognition
- **Control**: Uncued, Cued, Recognition

- *p < 0.01
- *p < 0.02
Day 1 - Fast mapping Results

Percent Accuracy in Object Recognition from a 4-Object Array

<table>
<thead>
<tr>
<th>Condition</th>
<th>Shape</th>
<th>Function</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncued</td>
<td>50%</td>
<td>50%</td>
<td>20%</td>
</tr>
<tr>
<td>Cued</td>
<td>80%</td>
<td>70%</td>
<td>40%</td>
</tr>
</tbody>
</table>

p = .01

Slow mapping - Function naming Results

Percent accuracy in stating functions of objects that were never heard or taught

<table>
<thead>
<tr>
<th>Condition</th>
<th>Shape</th>
<th>Function</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncued</td>
<td>20%</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Cued</td>
<td>50%</td>
<td>40%</td>
<td>30%</td>
</tr>
</tbody>
</table>

p = .02

Gesture Helped Us Understand Word Learning

- We treated word learning as graded
- Words learned with iconic gestures were retrieved with less task support
- We found evidence of semantic knowledge in those conditions at fast and slow mapping intervals

The Next Step...

The Ne[WSWeS«

Capone Singleton (2012)

- Tap a broader learning space
  - How far can the semantic representation reach that I am enriching?
  - Word extension (Hollich et al., 2000; Markman, 1991)
    - Generalization
    - unnamed exemplar objects of the taught word
    - teaching categories

Comparison of Shape & Function gesture to Pointing

Stimuli

<table>
<thead>
<tr>
<th>Stimuli</th>
<th>/pin/</th>
<th>/koll/</th>
<th>/wav/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trained Objects</td>
<td><img src="image" alt="Trained Object" /></td>
<td><img src="image" alt="Trained Object" /></td>
<td><img src="image" alt="Trained Object" /></td>
</tr>
<tr>
<td>Shape-similar</td>
<td><img src="image" alt="Shape-similar" /></td>
<td><img src="image" alt="Shape-similar" /></td>
<td><img src="image" alt="Shape-similar" /></td>
</tr>
<tr>
<td>Shape-dissimilar</td>
<td><img src="image" alt="Shape-dissimilar" /></td>
<td><img src="image" alt="Shape-dissimilar" /></td>
<td><img src="image" alt="Shape-dissimilar" /></td>
</tr>
<tr>
<td>Shape gesture</td>
<td><img src="image" alt="Shape Gesture" /></td>
<td><img src="image" alt="Shape Gesture" /></td>
<td><img src="image" alt="Shape Gesture" /></td>
</tr>
<tr>
<td>Function gesture</td>
<td><img src="image" alt="Function Gesture" /></td>
<td><img src="image" alt="Function Gesture" /></td>
<td><img src="image" alt="Function Gesture" /></td>
</tr>
</tbody>
</table>
- **AIM:** Place a window onto the evolution of the representation with eye on the effect of shape cues
  - Error analysis
  - Challenging naming context
  - Primed naming task
  - Increase difficulty and control of Stimuli
  - Word extension/Generalization task

---

**Error Coding**

<table>
<thead>
<tr>
<th>Error Coding</th>
<th>Representation Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indeterminate</td>
<td>missing (“What’s that?”)</td>
</tr>
<tr>
<td>Overextension</td>
<td>mis-selection of semantic representation (“ball” for moon)</td>
</tr>
<tr>
<td>Taxonomic</td>
<td>weak semantic representation (“pig” for cow)</td>
</tr>
<tr>
<td>Circumlocution</td>
<td>access to semantic representation but less durable link to word form (“something you spend” for money)</td>
</tr>
<tr>
<td>Phonological</td>
<td>incomplete lexical representation (“chicken for children”)</td>
</tr>
<tr>
<td>Accurate naming</td>
<td>At least 2 of 3 CVC phonemes</td>
</tr>
</tbody>
</table>

---

**We Look To Other Cues and Scaffolds...is gesture special?**

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Vocabulary Learner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capone Singleton &amp; Saks (2015a)</td>
<td>3: 8 years – 4: 7</td>
<td>Typical range EVT</td>
</tr>
</tbody>
</table>
Multiple modalities
Color
Picture
Scent

What is Language Disorder?

- Previously Specific Language Impairment (SLI)
- DSM-V classification
  - Neurodevelopmental Disorders
    - Communication Disorder
    - Language Disorder
  - Sentence structure (morphology & syntax)
  - Discourse
  - Vocabulary

Also referred to as
Developmental
Language Disorder

Functional limitations

What will I see in the results?

Treatment Fidelity
100%
Dependent Measure
Reliability ≥ 80%

Alternating Treatments for Idiom Interpretation by Children with Language Disorder
(Raye & Capone Singleton, 2018)

- Idioms
  - large lexical units
  - Most frequently use form of figurative language (Brinton, Fujiki & Mackey, 1985)
  - in the classroom (Nippold, Moran, & Schwartz, 2001)
  - increase from 3rd to 8th grade
  - Figurative language are a component of Common Core State Standards (CCSS, 2016)

Story Condition
Has a Soft Spot

Jake and Josh found a puppy while they were walking home from school one afternoon. They both wanted to keep the puppy. Jake was afraid their mother would not let them keep it. But Josh disagreed and said, “Mother has a soft spot.” She would probably feel warm and caring towards the puppy.

Story with Picture Condition
Has a Soft Spot

Comprehension - P1

Explanation

12.8 year old male Enrolled in TX

Generalization - P1
Conclusions

Our Data

- Children with (D)LD benefit from explicit instruction (Archer & Hughes, 2013; Nippold, 2007)
- Explore stimuli: were pictures effective?

The Case of Under
- Gesture or Picture
- n = 20- to 24-months

[McGregor et al., 2008]

Gesture >> Picture
- Advantage observed after a delay
- Generalization materials
- 2 – 3 days after training

1 information unit 2 information units

Children with Developmental Language Disorder

- Shape gestures and Attention getting gestures
- Shape gestures helped children with Language Disorder learn names of rare animals over attention getting

Children with Language Impairments

- Children with Down syndrome
- Children with autism

DiMari & Ozaliskian & Adamson, 2016
Words We Use with 
& without Hints

...pilot data

Capone Singleton,
Hathaway,
Holguin, &
Nunez

Repeated Picture Description

- Once upon a time... or One day...
- No hints (Baseline)
- Smells (Scent)
- Smell+Word
  - Mother, Grass, Cookie, Flour, Dishes

Pilot ACQ male 6 years

Children's Gesture as a Function of 
Contextual Support

Typical Group
Age range 6.2 – 11; 9 years
5 girls 5 boys

Number of gestures

0 2 4 6 8 10 12 14 16 18

Indicators/Points I icons

Gesture & Word Learning/Use

From a connectionist perspective
An epigenetic mechanism

Acknowledgements

Karla McGregor
University of Iowa
Holly Storkel, Ph.D.
University of Kansas

The families who give their time and permission to share
their children with us!

Kaitlin Wagner
Jillian Johnson
Carolina Holguin
Natalie Nunez

Thank you.
nina.capone@shu.edu