Processing and Learning in Multiple Modalities: Applications for AAC

Filip Loncke, University of Virginia, USA
Jane Hilton, University of Virginia, USA
Pei-Lin Weng, Purdue University, USA
Paul Corthals, University College Ghent, Belgium
Marwane El Fallah, Université Charles de Gaulle Lille3, France
Claire Leconte, Université Charles de Gaulle Lille3, France

What about speech-generating devices?

- Message formulation
- Lexical selection
- Syntactic selection
- Phonological preparation (inner speech)
- Operating device
- Generated speech

Study 2008

- 20 Pseudo-words
- Simple phonology/ complex phonology
- French speakers/ American speakers
- With or without auditory feedback

Results

- Learning curve French complete

Results/ interpretation data 2008

- No difference in learning effect of added auditory feedback for simple words
- Significant learning effect of added auditory feedback for complex words
- Consistent over the two groups – Americans and French

- Added (phonological: speech) feedback becomes more important as the task becomes more difficult (complex phonology)
- Auditory feedback may be a help to construct internal phonological representations
New study

• General multimodality study: can we consider modalities as resources available to the user? (not just auditory information, but also gestures)
• Will the resources be called up (and be more effective) depending on:
  (1) the difficulty of learning?
  (2) the stage in the learning process?

New study

• Modalities: gesture/manual sign; auditory feedback; visual modality
• Learning curve – four probes to identify the point of differential effect between modalities
• Differences between modalities/superior modality (the strongest resource)
• Independent variable: the modalities and combination of modalities presented
• Dependent variable: the orthographic accuracy
• [conducted in parallel in the US (English speakers), France (French speakers), Belgium (Dutch speakers)]

Background

 Multimodality:
   A combination of natural speech, written language, gestures and manual signs, device-generated speech output, graphic symbols, and nonverbal modes
   External multimodality (what is presented and what is produced)
   Internal multimodality (internal network of representations)

Background: Gesture

 Hand movements that convey communicative signals during message exchanges between senders and recipients
 Gestures serve internal and external functions that both have a significant impact on communication skills (Lozano & Tversky, 2005)
 A facilitator of language learning
   e.g., direction following, word retrieval, or development of an idea (Capone, 2004)

Research Purpose

 To investigate the effects of multimodality inputs (auditory and gestures) on orthographic recall of pseudowords

Research Questions

 Does providing additional modalities facilitate orthographic recall?
 Which additional modality or combination of the modalities yields greater effects on orthographic recall?
 Which type of gestures (iconic or orthographic-syllabic gestures) demonstrate greater differences in orthographic recall?
 What are the learning curves of orthographic recall (over 4 sessions in two lab visits) among different additional modalities?
Method

- 32 Pseudowords:
  - Consisting of the same phonological complexity
  - Words were constructed to allow an equal similarity to English, French, and Dutch
  - N.B. the study is intended to be replicated with French and Dutch participants – this is currently ongoing, results are not available

- 32 pictures of concrete objects – easy to recognize.

Methods

- Auditory modality
  - Romanian female computerized voice

- Visual modality
  - Iconic gestures (manual signs)
    - Simplified Sign System, Dr. Bonvillian and his associates
  - Orthographic-Syllabic gestures
    - N.B.
      - The two types of gestures are demonstrated by the same person and recorded onto video clips, which allows us to standardize the given stimuli.
      - All stimuli in the six conditions are presented through the PowerPoint slides to provide consistency of all treatment conditions to all participants in all settings

Procedure

- First lab visit (20 minutes)
- Second lab visit (20 minutes)
- 5-7 day interval

Procedure (each session)

- Test 1: Learn 32 words with conditions
- Test 2: Learn 32 words with conditions
- Test 3: Learn 50 words with conditions
- Test 4: Learn 50 words with conditions
- Test 5: Learn 32 words with conditions
- Test 6: Learn 32 words with conditions

Orthographic Recall Test

Results US-group:
General Learning Curve

- Axis: Correct Rate

Capture and identify the moment in learning curve with maximal differential effect of modalities (to be detected in 2nd and 3rd probe)
Result: six conditions (2\textsuperscript{nd} Trial)

Descriptive Statistics

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<td>Total</td>
<td>23.60</td>
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1. No additional modality
2. Auditory modality
3. Iconic gesture modality
4. Orthographic-syllabic gestural modality
5. Auditory + iconic gestural modality
6. Auditory + orthographic-syllabic gestural modality

Statistical Analysis

Tests of Between-Subjects Effects

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<td>201.414</td>
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</table>

\( R^2 = .105 \) \( \text{adj.} R^2 = .673 \)

Statistical Analysis: Post-Hoc

Based on obtained means:

The error term is Mean Squared Error = 242.124

\(*\) The mean difference is significant at the .10 level

Results Belgian group (language: Dutch)

Discussion

- The present study intends to provide evidence for a model of multimodality and our understanding of its effects on Augmentative and Alternative Communication
- We need more information on (1) the nature of modality use during processing [cognitive overload, redundancy, reinforcement](2) the effect of modalities on learning curves;
- The preliminary data seem to suggest that multimodality effects on learning will vary depending on degrees of complexity of the stimuli

Limitations

- The study was conducted with college students as participants. This population may have a strong preference for and experience in orthographic learning – they may have limited need for supporting modalities. Furthermore, the learning curve is rather steep indicating fast learning gains (and limited need for intervening additional modalities)
- Number of pseudowords were not equal for each of the six conditions
- Participants did not include individuals with different age range or with disabilities
Clinical Applications

- This study provides evidence for the potential of auditory modality in establishing an internal phonology (and internal multimodal representations)
- The use of speech-generating devices may therefore be beneficial for more than direct person-to-person communication
- The use of speech devices could be integrated in therapeutic and educational activities that are geared at reinforcing internal phonological representations (including literacy-oriented activities)
- Iconic gestures have a greater learning effect

Further studies

- Examine the effect of multimodality inputs on long-term memory retrieval
- Examine the correlation between orthographic recall and learning preference (e.g., auditory or visual learners)
- Language learning experiences (e.g., numbers of second languages)
- For the application of AAC, it is recommended to include participants with special communication needs