The Effect of Speaking Rate and Experience on Transliterator Accuracy

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Background
• Many mainstreamed deaf children use interpreters in school settings
• Yet the amount of the teacher’s message typically available to students through interpreters is still unknown (Kluwin & Stewart, 2001)

The information pathway
• Information transferred from teacher to student depends on both channels in the information pathway
  – How much information is
    1. preserved by the interpreter?  
    2. accessible to the student?

The visual signal
• In both channels, many factors contribute to the successful transfer of information
  – pragmatics, prosody, etc.
  → the “language” level (i.e. meaning of message)
• A primary factor, however, is successful communication of the teacher’s words
  → the “visual signal” level (i.e. intelligibility of words, analogous to “speech” for spoken languages)

Accuracy vs. Intelligibility
• Information transfer at the “visual signal” level is easily quantifiable
  – Accuracy: percent of message correctly produced by the interpreter/transliterator
  – Intelligibility: percent of message correctly received by the deaf student
Accuracy vs. Intelligibility (cont)

- A common misconception is that intelligibility is equivalent to accuracy.
- However, research in other modalities suggests that such a relationship is unlikely.

Accuracy vs. Intelligibility (cont)

- In speech, for example, the relationship is sigmoidal (e.g., French & Steinberg, 1947; Miller & Nicely, 1955).
- The 50% intelligibility point depends on various factors such as:
  - type of materials
  - amount of context
  - speaking rate
  - type of degradation

Implications

- To ensure appropriate information transfer in interpreted situations, it is necessary to determine how intelligibility varies with:
  - accuracy
  - speaking rate
  - communication modality

Scope of project

- Three English-based communication modes (ASL to follow), 12 transliterators / mode
  - CS: Cued Speech (Cornett, 1967)
  - SEE: Signing Exact English (Gustason, 1972)
  - CASE: Conceptually Accurate Signed English (Winston, 1989)
- Experiment 1: Accuracy
- Experiment 2: Intelligibility, 8 receivers / mode

Transliterator accuracy

- Few previous studies focus on accuracy of interpreting process:
  - Most of the research that does exist focuses on American Sign Language (ASL).
  - Yet 95% of K-12 sign interpreters and transliterators use an English-based sign system in their jobs (Jones et al., 1997).
- Research needed on the accuracy of transliterators.

Transliterator accuracy (cont)

- Previous reports on interpreter accuracy tend to be qualitative:
  - Important descriptive information regarding interpreter accuracy, e.g., Strong and Rudser (1986) for ASL.
  - Insufficient gradation of accuracy abilities (e.g., scale 1-5) for determining psychometric functions.
- Quantitative research needed.
Transliterator accuracy (cont)

- ASL studies suggest accuracy may be affected by:
  - rate: rate of signing inversely proportional to the comprehension (Fischer and Reed, 1999)
  - lag time: in ASL, a shorter amount of lag time between the speaker and the interpreter results in more miscues (Cokely, 1986)
- Another factor likely to affect accuracy is:
  - experience: increased accuracy would be expected with increased level of experience

Experiment 1: Accuracy

- For each communication mode (CS, SEE, CASE)...
  - How does the accuracy of transliterators vary with:
    - speaking rate: slow, normal, fast
    - lag time: time (in seconds) between the presentation of the spoken message and the production of the corresponding cue
    - transliterator experience

Participants

- Six (of 12) Cued Speech transliterators (CSTs) recruited to date
- Transliterators had varying levels of experience and were assigned to 1 of 3 skills categories:
  - Novice (2 transliterators)
  - Experienced
  - Veteran (4 transliterators)

Materials

- Videotape of each participant’s transliteration of an 8th grade lecture
  - Life Cycle of Plants (SYNCAP, 1989)
- Lecture divided into three segments
  - Transliterators presented with all 3 segments, each at a different speaking rate
  - Speaking rate counterbalanced across segments

Procedures

- Each Cued Speech transliterator (CST1-CST6) video viewed for analysis using Adobe Premiere Pro 1.5
- Each cue produced classified in one of four production categories
  - correct cues
  - omissions
  - substitutions
  - insertions

Overall Results

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Avg Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct cues</td>
<td>49%</td>
</tr>
<tr>
<td>Omissions</td>
<td>33%</td>
</tr>
<tr>
<td>Substitutions</td>
<td>18%</td>
</tr>
<tr>
<td>Insertions</td>
<td>6%</td>
</tr>
</tbody>
</table>

- Correct cues had the highest frequency of occurrence
- On average, only 49% of the message was cued correctly
- Omissions were the most frequent type of error
Effect of Speaking Rate

- Negative relationship exists between speaking rate and the number of correct cues executed.
- Positive relationship exists between speaking rate and number of omissions.

Effect of Speaking Rate (cont)

- The accuracy (percent correct scores) of each transcriber follows this overall pattern.
- The decline of percent correct scores is mostly caused by an increase of omissions.

Effect of Experience

- It was expected that:
  - novices would perform similarly to each other
  - veterans would perform similarly to each other
  - novices would perform differently from veterans
  - veterans would achieve a higher level of accuracy than novices.

Effect of Experience (cont)

- Both novices performed similarly:
  - Omitted approximately 50% of the target cues
  - Showed comparable accuracy levels
  - Had 3% substitutions.

- Remaining veteran (CST4) had characteristics of both groups:
  - similar to veterans in substitutions (22%)
  - similar to the novices in omissions (50%).
Effect of Experience (cont)

- **Overall effect of experience**
  - Veterans (with one exception)…
    - more accurate than novices (60% vs. 45%)
    - produce fewer omissions than novices (15% vs. 50%)
  - All veterans…
    - more frequent substitutions than novices (22% vs. 3%)

Rate x Experience Interaction

- **Are novices and veterans affected differently by speaking rate?**
  - **Slope analysis:** calculated the slope of each transliterator’s performance across speaking rates

Rate x Experience Interaction (cont)

- **Correct cues:** declined more steeply for novices (compared to veterans) as speaking rate increased

Rate x Experience Interaction (cont)

- **Omissions:** pattern similar
  - increased more steeply for novices than for veterans as speaking rate increased
  - CST4 affected more than other veterans but less than novices

Rate x Experience Interaction (cont)

- **Substitutions:**
  - novices: steady or declining with increased speaking rate
  - most veterans: steady or increasing with increased speaking rate
  - CST4 performed similarly to novices

Rate x Experience Interaction (cont)

- **Insertions:** pattern inconclusive
  - Insertions are few in number
  - More data needed
Effect of Lag Time

- Data not yet available
  - Average data across 8-minute segment too coarse to capture relationship
- Accuracy and lag time data must be correlated at the individual sentence level (currently underway)

Conclusions

- The bad news: Accuracy of "typical" CSTs substantially lower than 100%
  - Increased transliterator training and professional development opportunities should be created to address these issues in working transliterators
- The good news: This is not likely to represent the intelligibility of these CSTs
  - Intelligibility likely to be somewhat higher (experiments needed to quantify)

Conclusions (cont)

- Factors that make it likely that intelligibility is higher than accuracy
  1. Accuracy scores reported here are conservative
     - Many substitutions are likely to be partially correct (e.g. right handshape, wrong placement)
     - No partial credit was awarded (will be analyzed later)

Factors in intelligibility (cont)

  2. Accuracy could be higher for key words than non-key words (will be analyzed later)
  3. Paraphrase could provide information (will be analyzed later)
  4. If words are mouthed, this information is available even if cues are wrong
    - Nature of omissions differs with experience level
      - Novices: fall behind, omit long sequences (no mouthing)
      - Veterans: omit cues within words or shorter sequences (continue to mouth)

Conclusions (cont)

- Increasing speaking rate decreases accuracy
  - Declines more sharply for novices than for veterans
- Increasing experience level is generally associated with increases in accuracy
  - But not necessarily, e.g. CST4
    - "Practice makes permanent"
- Effect of lag time on accuracy yet to be determined

Future Work

- Investigate effect of lag time
  - Collect data at sentence level to capture smaller-scale variations in accuracy, lag time
- Continue collection of accuracy data (more transliterators, at all experience levels)
- Evaluate intelligibility of videos that were analyzed for accuracy in this study
  - Present to deaf persons who use CS transliterators
Future Work (cont)

• Repeat experiments for other communication options
  – SEE, CASE… and eventually, ASL
  ➔ Applications:
    • ensure accessibility in all modes (regulations regarding accuracy and/or speed requirements)
    • more informed training, testing

Knowledge:
• increased understanding of intelligibility of visual signals
• more insight into modality-independent aspects of perception

Future Work (cont)

• Compare psychometric functions (key-word intelligibility vs. accuracy) across communication options
  ➔ Applications:
    • ensure accessibility in all modes
    • more informed training, testing

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