

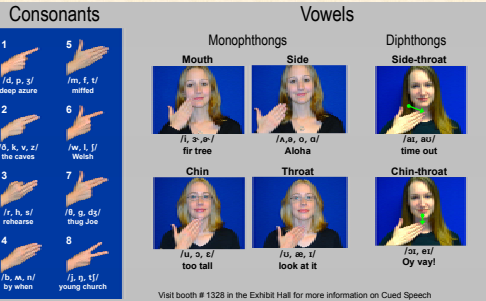
The Effect of Speaking Rate and Experience on Cued Speech Transliterating Accuracy

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-Background-

Cued Speech is a visual communication system that uses hand "cues" along with the mouth movements of speech to make the phonemes of a spoken language clear.

- Cues are synchronized with mouth movements
- Each cue corresponds to a consonant-vowel combination:
 - Handshapes convey consonants
 - Placements convey vowels



- Deaf people often use interpreters to facilitate communication. Types of interpreters vary with communication mode:
 - American Sign Language (ASL) interpreter
 - Signed English transliterator
 - Cued Speech transliterator**
- Many deaf children are mainstreamed and use an interpreter in school settings. However, few guidelines are implemented in the field of interpreting, and the ones that are in effect have no basis in research (Kluwin and Stewart, 2001)

-Accuracy vs. Intelligibility-

- When a deaf child uses an interpreter in a classroom, clarity of the "visual signal" that the student receives is a necessary element of successful classroom communication. That is, ...
 - The visual signal must be clear and received correctly (analogous to clarity of "speech" for spoken languages)
 - After the visual signal is correctly received, the student's language skills will play an important role in whether the meaning of the message is understood
- The clarity of the visual signal depends on the **two** channels in the communication pathway:
 - The amount of information preserved by the interpreter
 - The amount of information accessible to the student
- Clarity of the visual signal is easily quantifiable
 - Accuracy:** percent of message correctly *produced* by the interpreter/transliterator
 - Intelligibility:** percent of message correctly *received* by the deaf student
- A common misconception is that intelligibility is equivalent to accuracy:
- However, research in other modalities suggests that such a relationship is unlikely...
 - In speech, for example, the relationship is sigmoidal (e.g. French & Steinberg, 1947; Miller & Nicely, 1955)
 - The 50% intelligibility point depends on various factors
 - type of materials
 - amount of context
 - speaking rate
 - type of degradation

-Previous work-

- Few previous studies are available on interpreter accuracy
- Of the limited research available, most studies focus on American Sign Language (ASL)
 - Yet, 95% of classroom sign interpreters and transliterators use an English-based sign system in their jobs (Jones et al., 1997)
 - Research is needed on interpreters using English-based communication modes, including **Cued Speech transliterators**
- Moreover, most previous research tends to be qualitative
 - Qualitative ratings provide important accuracy data, often on a Likert scale (1-5), but finer resolution is needed to determine the relationship between accuracy and intelligibility
 - **Quantitative** research needed
- Factors that are likely to affect Cued Speech transliterator accuracy include
 - Rate:** in ASL (direct communication), rate of signing is inversely proportional to comprehension (Fischer and Reed, 1999)
 - Lag time:** for ASL interpreters, less lag time between the speaker and the interpreter results in more miscues (Cokely, 1990)
 - Experience:** increased accuracy would be expected with increased level of experience

-Purpose of Study-

- How does the accuracy of Cued Speech transliterators, measured by percent-correct cues produced, vary with:
 - Speaking rate:** slow, normal, fast
 - Experience:** novice, veteran
- Effect of lag time will be analyzed in follow-up work

-Methods-

- Participants**
- Six Cued Speech transliterators (CSTs), assigned to one of two categories based on level of experience
 - Two "**novice**" transliterators - had minimal or no certification and less than (the equivalent of) one full-time year of experience
 - Four "**veteran**" transliterators - had the highest level of certification and/or more than five years of experience
- Materials**
- Video recordings of the cued messages produced when each participant transliterated materials at three different speaking rates
 - Translitterators were presented with audio recordings of an 8th grade "lecture"
 - The lecture was presented in three segments, each at a different speaking rate
 - slow:** 88 wpm (recording expanded by a factor of 1.25)
 - normal:** 109 wpm (original)
 - fast:** 137 wpm (recording compressed by a factor of 0.8)
 - Speaking rate counterbalanced across segments
- Procedures**
- Translitterators were viewed in slow motion using Adobe Premiere Pro 1.5, and each cue produced was classified in one of four production categories
 - Correct cues**
 - Omissions**
 - Substitutions**
 - Insertions**

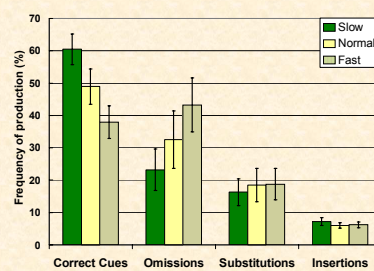
-Overall Results-

- On average, across all speaking rates and experience levels...
 - Correct cues had the highest frequency of occurrence (49%)
 - Omissions were the most frequent type of error (33%)

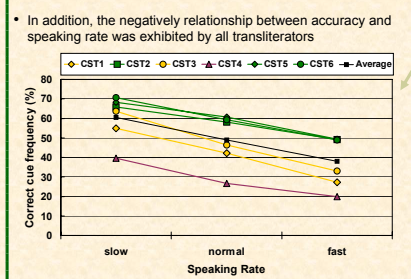
Production category	Frequency of production
Correct cues	49%
Omissions	33%
Substitutions	18%
Insertions	6%

-Effect of Speaking Rate-

- On average, across all experience levels...
 - Correct cues: positive relationship with speaking rate
 - Omissions: negative relationship with speaking rate
 - Substitutions and insertions: no effect of speaking rate



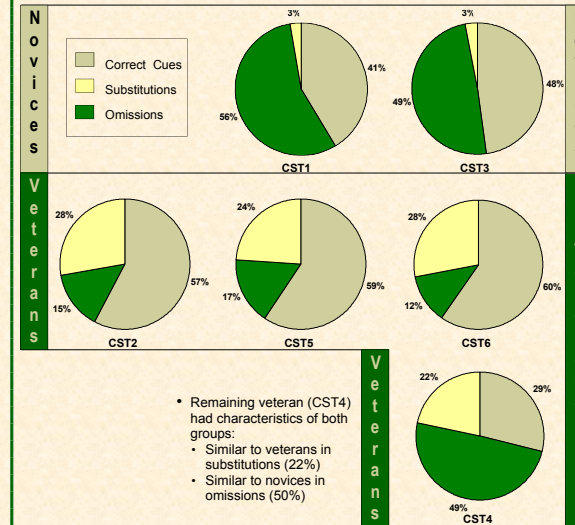
→ The decline in accuracy was mostly caused by an increase in omissions



-Effect of Experience-

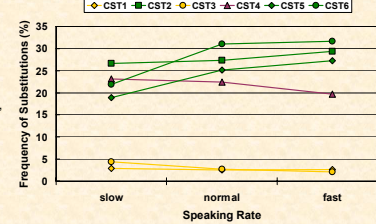
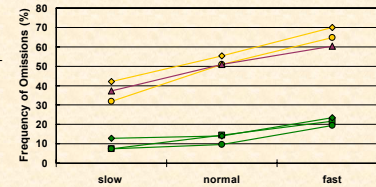
Overall Effect of Experience

- Most veterans (one exception)...
 - Were **more accurate** than novices (60% vs. 45%)
 - Produced **fewer omissions** than novices (15% vs. 50%)
- All veterans produced **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 as a function of speaking rate, measured in words per minute
- As speaking rate increased...
 - Correct cues: declined more steeply for novices than for veterans (-0.6% vs. -0.4% per wpm)
 - Omissions: increased more steeply for novices than for veterans (+0.6% vs. +0.3% per wpm)
- Substitutions
 - novices: remained steady or declined (-0.01 and -0.05% per wpm)
 - most veterans: generally increased (+0.05, +0.17, and +0.20% per wpm), but CST4 more like novices (-0.07% per wpm)
- Insertions: Given the low incidence of insertions, no pattern was apparent



-Conclusions-

Summary of Results

- Increases in speaking rate have a negative effect on accuracy
 - Accuracy declines more sharply for novices than for veterans
- Increases in experience level are generally associated with increases in accuracy
 - However, some veterans (e.g. CST4) may not follow this pattern
 - "Practice makes permanent," and all transliterators should be monitored for accuracy, regardless of experience level
- Nature of errors differs with experience level:
 - Novices have a higher number of omissions
 - Large chunks of the message are missing (from the mouth as well as the hands)
 - Apart from these omissions, cueing is very accurate
 - Veterans produce more substitutions
 - Omissions tend to be confined to cues within words or shorter sequences
 - Substitutions reduce overall accuracy, but vast majority of message is transliterated
- Accuracy vs. Intelligibility**
 - The bad news: **Accuracy of "typical" CSTs is substantially lower than 100%**
 - Some highly experienced veterans are likely to be much more accurate than the veterans examined in this study
 - However, these transliterators were randomly selected and are representative of at least some segment of "typical," working transliterators
 - Increased transliterator training and professional development opportunities should be created to address these issues in working transliterators
 - The good news: **Intelligibility is likely to be somewhat higher than accuracy**
 - Accuracy scores reported here are conservative
 - Many substitutions are likely to be partially correct (e.g. right handshape, wrong placement), and no partial credit was awarded
 - When words are mouthed, this information is available even if cues are wrong
 - Accuracy could be higher for key words than non-key words
 - Translitterators could have preserved message content via use of paraphrase

-Future Work-

- Collect additional accuracy data (more transliterators, more experience levels)
- Conduct further analysis of accuracy results (e.g. partial credit for substitutions)
- Evaluate intelligibility of videos that were analyzed for accuracy in this study (i.e. present to deaf persons who use CS transliterators)
- Repeat experiments for other communication options (SEE, CASE, ASL) so that
 - Accessibility can be ensured for all deaf children who use interpreters in the classroom, regardless of preferred communication mode
 - Training and testing of interpreters/translitterators can be fine-tuned based on evidence collected (e.g. most appropriate accuracy and/or speed requirements)
- Compare psychometric functions (key-word intelligibility vs. accuracy) across communication options in order to
 - Increase understanding of intelligibility of visual signals
 - Gain insight into modality-independent aspects of perception

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