Evidence-Based Principles for Selecting Eye Gaze AAC Technology

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Overview on session: Evidence-Based Principles for Selecting Eye Gaze AAC Technology

• Focus on principles and evidence

• Identify candidates for eye gaze

• Identify features of eye gaze systems

• Discuss collecting clinical & personal evidence
Focus on principles and evidence to guide clinical decisions for selecting eye gaze technology
Remote Eye Gaze Technology

• Vision-controlled direct selection technique

• More than bright and dark pupil tracking
The important details

- **pupil-center/corneal-reflection** method

- **LED** reflects a small bit of light off the surface of the eye’s cornea

- The light reflects off of the retina and causes the pupil to appear white

- Pupil effects are methods used to determine the **gazepoint**
Viewing the Eye

- Sclera
- Conjunctiva
- Cornea
- Pupil
- Iris
- Ciliary Body
- Choroid
- Fovea (center of the macula)
- Area of the Optic Disk
- Optic Nerve
- Central Retinal Artery and Vein

Vitreous Chamber
Glint-Pupil Vector

(a)  (b)  (c)
How our eyes work

- Eye movement while reading
- Saccades and fixations
- Visual perception and language processing
- Errors: losing place, skipping words or not adequately processing visual information
- Poor readers: language skills vs. eye movement control
Eye Movements During Reading Text

The ferry departs from Wellington for Picton every day
According to a research at an [Ellen] university, it doesn't make a difference that the doors in a room and the only dimension being measured is the first and last letter is at the right place. The risk can be a small one and you can still read it without problem. This is because we do not read every letter by itself but the word as a whole.
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IDENTIFYING CANDIDATES APPROPRIATE FOR EYE GAZE AS A SELECTION TECHNIQUE.
Overview of clinical populations

- Amyotrophic Lateral Sclerosis (ALS)
- Traumatic Brain Injury (TBI)
- Cerebral Palsy
- Multiple Sclerosis (MS)
- Muscular Dystrophy (MD), spinal muscular atrophy, Werdnig-Hoffman Syndrome
- Spinal cord injuries
- Strokes
User considerations: Vision

• Good control of at least one eye.

• Common eye movement problems
  – Nystagmus
  – Alternating strabismus
User considerations: Vision

- Adequate vision
- Corrected with glasses
- Inadequate visual acuity
- Soft contact lenses
- Diplopia
- Blurred vision
- Cataracts
- Homonymous hemianopsia
User consideration: Vision

- Absence of side effects from medication
- Baclofen
  - Anticonvulsants
  - Antidepressants
Physiology Affecting Eye Tracking

Top image: ptosis (drooping) eyelid

Bottom image: early cataracts visible over both pupils
User considerations: Physical

- Positioning
  - Ability to maintain a position in front of the eye gaze screen/camera

- Continuous, uncontrolled head movement
User considerations

• Cognition
• Memory
• Language
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THE DESIGN AND FEATURES OF EYE GAZE SYSTEMS
Primary components

- Language representation methods
- Vocabulary
- Method of Utterance Generation

Secondary components

- User Interface
- Selection method
- Outputs

Tertiary components

Hill & Scherer, 2008; Hill, 2010 in press
Examination of eye gaze technology as a selection technique

- Infrared exposure
- Calibration & defaults
- Gaze point predictions
- Dark versus light pupils
- 1 versus 2 cameras
- Narrow versus wide angle camera lens
- Sitting or reclining
Camera Moveability & Position
Flexible cameras allow unique client positions
Another unique position
On-screen eye image display

- Eye images are displayed for the user.
- Decreases frustration: user knows what the camera sees. This is not a feature on many systems.
Environmental issues affecting eye tracking

- Figure on left: light from window reflecting on eyeglass lens
- Figure on right: reflection eliminated by changing angle of earpieces
User interface considerations

- Color and detail
- Alphabet displays
- Graphic symbol displays
- Navigation
- Automaticity
Examples of user interfaces
Examples of user interfaces
Examples of user interfaces
Comparing Eye Tracking Systems
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PROCEDURAL PROTOCOLS FOR EVALUATING EYE GAZE SYSTEMS – PERFORMANCE AND OUTCOMES DATA
Computer-based evaluations and LAM datalogging
COMPASS – Computer Access Assessment Software

- Assessment tool for computer access & AAC

- Eight skill tests

- Skills assessed include:
  - keyboard and mouse use
  - navigation through menus
  - switch use.
Copy Spell & Core Word Sentences

• Examples:
  – I want to think about that.
  – Why do you think that?
  – He helped her with that.
  – I can do this myself.
  – Do you feel cold?
  – She likes to be happy
  – Give it to me.
Self-Created Utterances/
Language Sample Context

• **Examples:**
  – Picture Description
  – Story Retell
  – Narratives
  – Conversation
Performance Measures

• Communication Rates
  – Ave. communication rate (wpm)
  – Peak communication rate (wpm)

• Rate by language representation method

• Selection rate (bps)

• Rate index (wpb)

• Accuracy
Video clip
Know your numbers
Know your numbers
Analysis of LAM data from ECO; Unity 144; Subject: K. Hill 26 January 2009 Task: Copy Core Sentences

<table>
<thead>
<tr>
<th></th>
<th>Keyboard: right index</th>
<th>ECOPoint</th>
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<tbody>
<tr>
<td>Acceptance time (sec)</td>
<td>-</td>
<td>0.7</td>
</tr>
<tr>
<td>Comm. Rate (average)</td>
<td>32.6</td>
<td>13.8</td>
</tr>
<tr>
<td>Comm. Rate (peak)</td>
<td>60.0</td>
<td>30.0</td>
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<tr>
<td>Fastest Utterance</td>
<td>Where would you like to go</td>
<td>I want to go there</td>
</tr>
<tr>
<td>Comm. Rate (SEM)</td>
<td>36.5</td>
<td>11.3</td>
</tr>
<tr>
<td>Comm. Rate (SPE)</td>
<td>20.9</td>
<td>6.7</td>
</tr>
<tr>
<td>Selection Rate (bits/s)</td>
<td>10.8</td>
<td>13</td>
</tr>
<tr>
<td>Errors (%)</td>
<td>0</td>
<td>5</td>
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User Satisfaction - Outcomes
Quest & PIADs

**QUEST**

- Self-administered 12-item questionnaire
- Evaluates user satisfaction
- Yields three scores:
  - Device,
  - Services,
  - total QUEST

**PIADs**

- 26-item, self-rating questionnaire
- Describes user experiences along three dimensions:
  - **Competence**: Measures feelings of competence and usefulness.
  - **Adaptability**: Signifies a willingness to try new things.
  - **Self-esteem**: Indicates feelings of emotional wellbeing and happiness
Surveying client preferences and satisfactions – outcomes data

Rating Scale:
SA = strongly agree; A=agree; N=no opinion, D=disagree; SD=strongly disagree

<table>
<thead>
<tr>
<th>I use multiple methods to communicate with family and care givers</th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>S</th>
<th>SA</th>
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</thead>
<tbody>
<tr>
<td>My most effective method of communication is my eye gaze system</td>
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<tr>
<td>I have no problems with calibration of my system</td>
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<tr>
<td>I use my eye gaze system to write and save messages/letters</td>
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<tr>
<td>I am very satisfied with my accuracy using my system</td>
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<td></td>
<td></td>
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</tbody>
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45
Authors using eye gaze systems
External evidence sources

- Text entry by gaze: Utilizing eye tracking. In I. S. Mackenzie & K. Tanaka-Ishii (Eds.)


- Additional References
Conclusions and Wrap-Up

- Safety and protection of clients
- Identify evidence-based marketing
- Need for data-driven decisions
- Suggest an ASHA technical paper
Questions and Discussion
Thank you!

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References


