External Evidence

Computer Access (Text Entry)

Heidi Horstmann Koester, Ph.D.
Koester Performance Research
Ann Arbor, MI
hhk@kpronline.com

RESNA 2004

Evidence-based Practice

- Make decisions based on evidence that relates to the client
  - External or field evidence
    - What are published outcomes for similar clients with similar needs?
  - Individual evidence
    - Clinical skills assessment
    - Client input
  - Knowledge and skills of the providers
    - What's worked well for similar clients that I've worked with?

Use of External Evidence in Computer Access:

- Long-term performance expectations
- Learning time expectations
- Comparisons between different candidate systems
- Performance under different impairment conditions (e.g., peers of the current client)
- May reveal new candidate systems for this client
- Client education

Quality of External Evidence

- Largely determined by methods

- Subjects
- Training and Experience
- Design (e.g., within vs. between subjects)
- Choice of control interface, selection set, and selection method
- Task (realistic, consistent, etc.)
- Time series?

- To what extent is this study a reasonable proxy of my client's situation?

Challenges

- Methods not consistent between studies
- Methods often not even internally valid
- Inherent variation in human impairment makes generalizing results difficult
- Simplified use of evidence may be misleading
- Yet, a simplified summary is often necessary

Why do AT researchers employ able-bodied subjects?

- Some advantages include:
  - Convenience, larger N
  - Less variation between subjects
- May serve as an initial "screen" for an idea
- May accurately represent at least part of the target population
- Can provide a useful reference point
- OK as a complement to an approach that involves members of the target population

When is it OK to use research involving able-bodied subjects?

- What question are you trying to answer, for whom?
- To what extent is an able-bodied individual a decent physical model for your client (or any of the target popul'n)?
- To what extent is able-bodied performance information a useful reference point?

Review of external evidence in text entry performance

- 14 studies, across 7 input methods
- 9 studies employed able-bodied subjects (total N = 57)
- 6 studies used subjects with impairments (total N = 36)
- Clinical usefulness?
  - Expectations
  - Comparison across input methods

Examples in text entry performance

- Client with C6 SCI
  - Knowledge that ASR may provide 25 to 30 wpm provides reasonable expectation.
  - Knowledge that experienced UE typing by others with C6 SCI may be 20 wpm helps motivate a straightforward approach.

Examples in text entry performance

- Client with C4 SCI
  - ASR info from able-bodied users may be less useful, more of a “ceiling”.
  - OSK and mouthstick typing data from able-bodied users complements smaller N from users with impairments. Similar results yield more confident expectation.

Text Entry Approaches

- Automatic Speech Recognition (ASR)
- Keyboard Typing
  - Upper Extremities (UE's), Mouthstick
- On-screen Keyboards
  - Mouse, Trackball, Joystick
  - Head-controlled mouse, Jouse, EMG Mouse
- Morse Code
  - Sip-puff, EMG Morse, 2-switch
- Tongue Touch
- Single-switch scanning
- Assume letter-by-letter input

Speech Recognition

- Karat et al. (1999, 2000)
  - 4 unimpaired users, with 20 hours of ASR use
  - Range 25 to 30 wpm
- Koester (2003)
  - 23 experienced users with unimpaired speech, physical impairments
  - Range 3 to 32 wpm
  - Average 16.7 wpm

UE Typing

- Koester and Levine (1996)
  - 5 experienced typists with C5 – C6 SCI
  - Average 20.4 wpm
- Koester (2003)
  - 5 touch typists with RSI: 20 – 60 wpm (35)
  - 7 typists with C5-C6: 4 – 18 wpm (12)
  - 2 with advanced MS: 2 to 7 wpm

Mouthstick Typing

- Levine et al. (1986)
  - 6 AB subjects, 30 tests, 11 - 13 wpm (12.6)
- Koester & Levine (1994)
  - 8 AB subjects, 7 sessions, 12.3 wpm average
  - 1 with C4 SCI, 19 wpm
- Koester (2003)
  - 2 with C4 SCI, 10 – 11 wpm (10.5)
  - 1 with tongue, 19.8 wpm
- Lau et al. (1993)
  - 4 with impairment. 2 – 10 wpm (8)
- DeVries et al. (1998)
  - 2 with impairment, 3 sessions, 5.9 to 7.2 wpm

On-screen Keyboards

- Anson (1993)
  - 8 AB subjects, 1 session, 6.6 - 10.0 wpm (8.7)
- Smith et al. (1996)
  - 1 AB subject, multi-session, 7 wpm
- Koester (2003)
  - 2 with hi SCI, 7 - 10 wpm
- Lau et al. (1993)
  - 4 with impairment, QWERTY, multiple sessions, 2 – 6 wpm (average around 5)
- DeVries et al. (1998)
  - 2 with impairment, 3 sessions, 4.9 to 5.9 wpm
- Adams (2001)
  - EMG Mouse, 6.5 wpm

Morse Code

- Levine et al. (1986)
  - 6 AB subjects, 30 tests, 5 – 11.5 wpm (7.9)
  - 1 with C4 SCI, 2 yrs experience, 12.4 wpm
- Adams (2001)
  - Muscle Morse, 5.2 wpm

Tongue-touch Keypad

- Lau et al. (1993)
  - 4 with impairment, 9 tests, <1 – 5 wpm
  - Average about 2 wpm
  - Remarkably little improvement with time

Row-col Scanning

- Damper (1984), Koester (1987)
  - Model simulations, 8 - 10 wpm max
- Koester (1994)
  - 6 AB subjects, 9 sessions, average 7 wpm
- Lesher et al. (2002)
  - 15 AB subjects, multi-session, 6 – 8.5 wpm
- Simpson & Koester (1999)
  - 8 AB subjects, 4 trials, average 4 wpm
- Koester (1990)
  - 1 inpatient with GBS, 4 wpm
- Koester (1995)
  - 1 experienced scanner with MS, 5 wpm

Summary of Text Entry Research

Input Method	Text Entry Performance (wpm)		
	Slow	Average	Fast
UE Typing, touch	20	30	60
Speech Recognition	< 10	16	30
UE Typing, C5-6	4	16	25
Mouthstick Typing	< 5	10 – 12	20
Morse Code	< 5	8	12
On-Screen Keyboard	< 5	6 – 8	10
Row-Col Letter Scanning	< 1	4	8
UE Typing, MS	2	?	7
Tongue-touch Keypad	< 1	2	5

Pointing Performance?

- Almost no external evidence available