Microsoft Research

Advances in computing and ALS*

Reflections on directions for enhancing the quality of life

Eric Horvitz

Invited Talk
International Symposium on ALS/MND
Birmingham, UK
November 2008

*Powerpoint version w/ videos available at: http://bit.ly/1qIqOyU

Opportunity

Creative application of computing…

to enhance the quality of life of people with ALS.

Opportunity

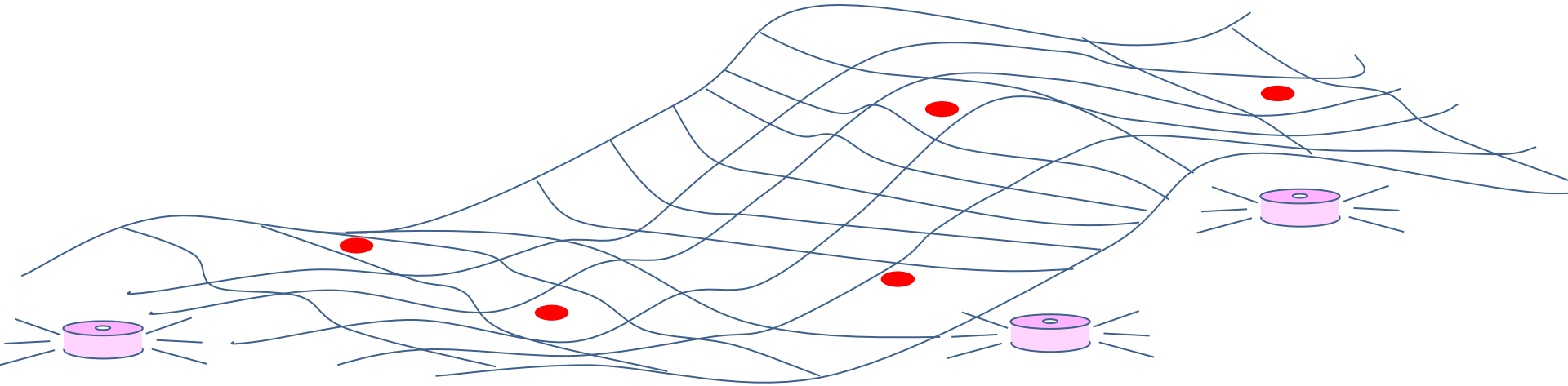
Creative application of computing…

- Human-computer interaction
- Machine learning & intelligence
- Connectivity & content
- Robotics

… to enhance the quality of life of people with ALS.

Trends

- Content, community, connectivity
- Sensing & interaction
- Machine learning & reasoning prowess
- Computation & memory



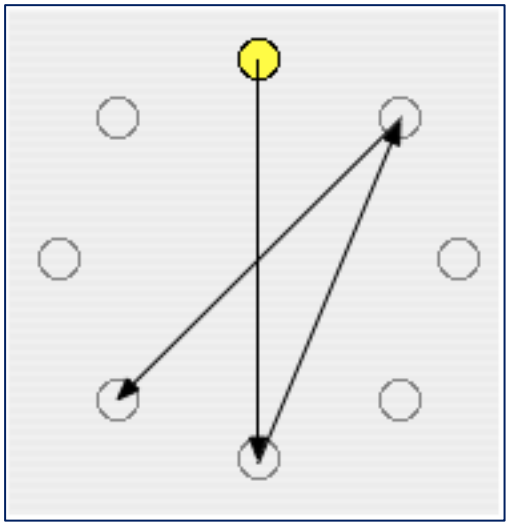
Promise of Adaptive Interfaces

- Observe motor skills, channels & affordances
- Optimize layout to minimize effort & frustration
- Track progression and adapt

Example: *Supple* Project

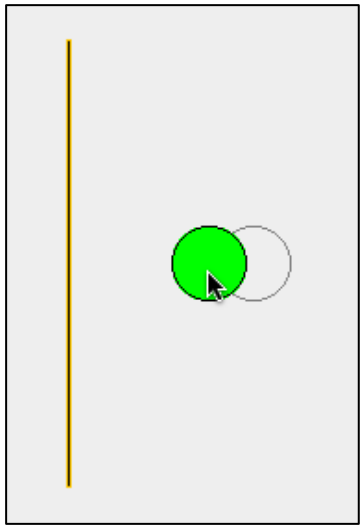
Assessing performance

Pointing

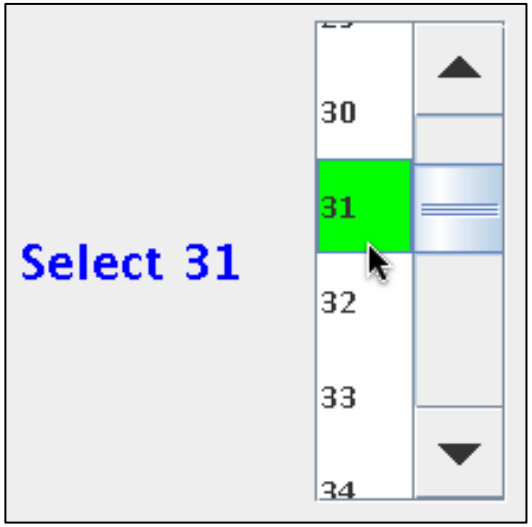


Clicking

Dragging



List Selection



Gajos, Wobbrock and Weld, 2007

Understanding Costs & Efficiencies

Participant	*Health Condition*	*Device Used*	*Controlled with*
MI01	Spinal degeneration	Mouse	hand
MI02	Cerebral Palsy (CP)	Trackball	chin
MI03	Friedrich's Ataxia	Mouse	hand
MI04	Muscular Dystrophy	Mouse	two hands
MI05	Parkinson's	Mouse	hand
MI06	Spinal Cord Injury	Trackball	backs of the fingers
MI07	Spinal Cord Injury	Trackball	bottom of the wrist
MI08	Undiagnosed; similar to CP	Mouse	fingers
MI09	Spinal Cord Injury	Trackball	bottom of the fist
MI10	Dysgraphia	Mouse	hand
MI11	Spinal Cord Injury	Mouse	hand

Gajos, 2008

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Gajos, 2008

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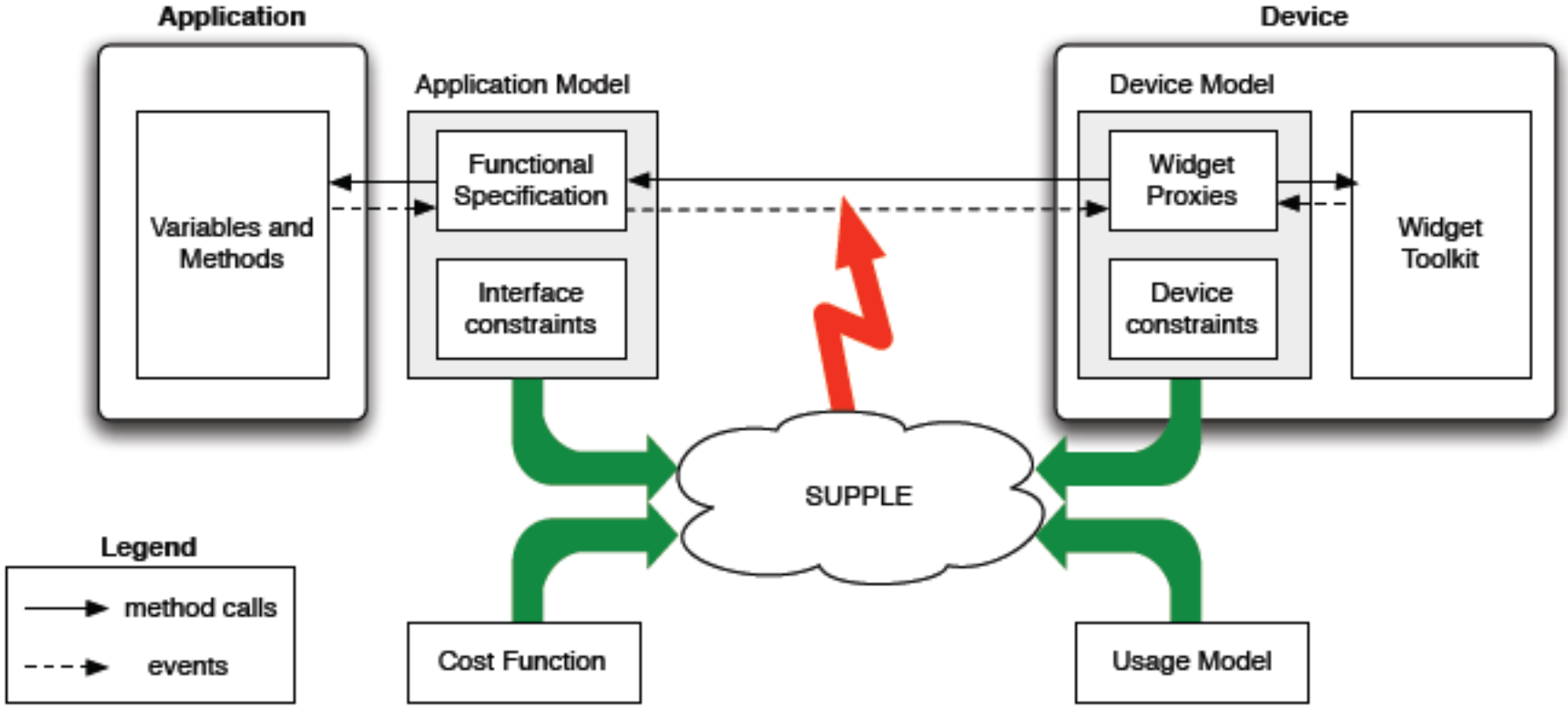
MI10	Dysgraphia		
MI11	Spinal Cord Injur		

Gajos, 2008

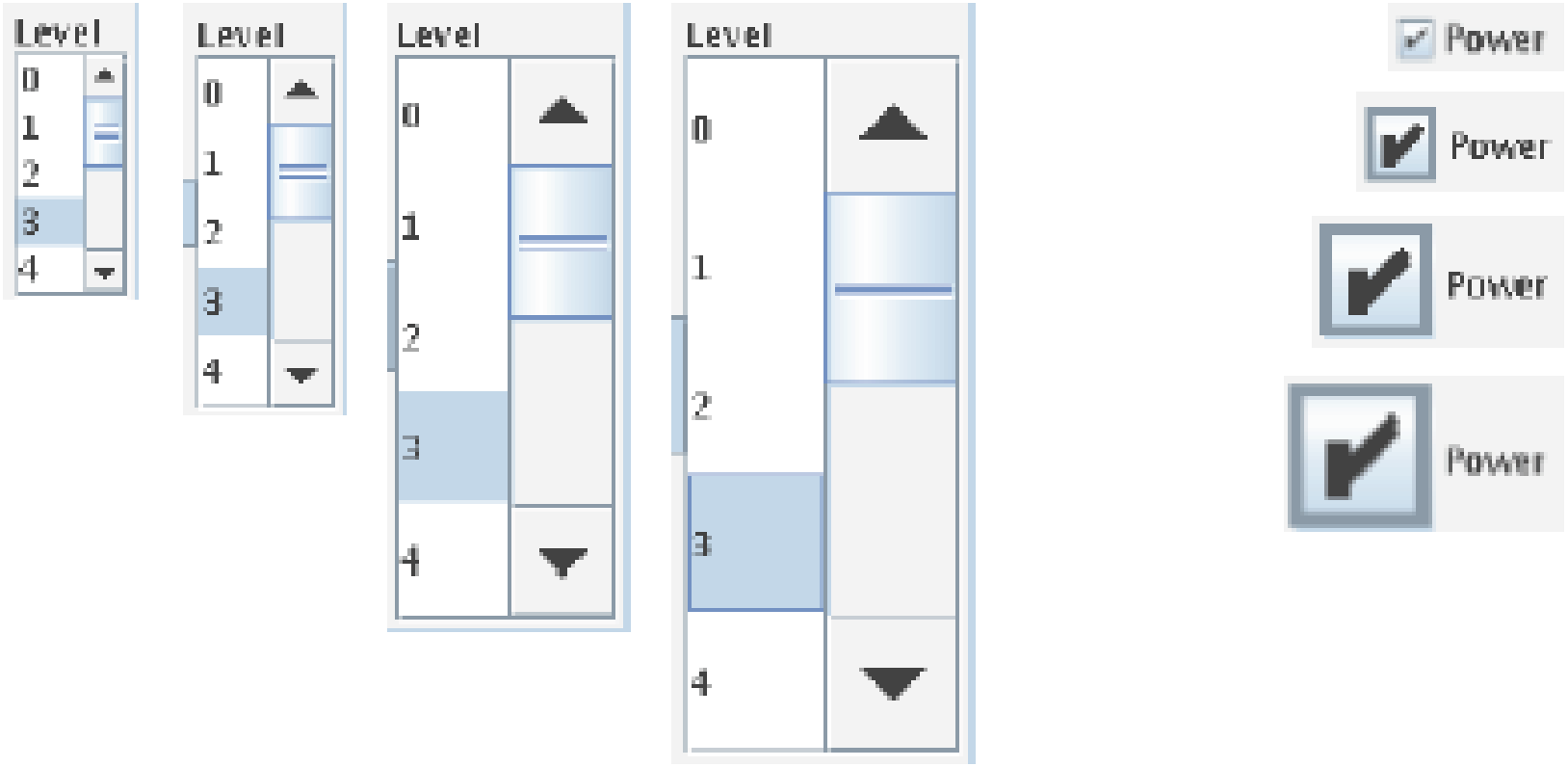
Optimizing for Efficiency

Optimization to identify cost-minimizing design



Gajos, 2008

Sizing, Spacing, Layout



Gajos, 2008

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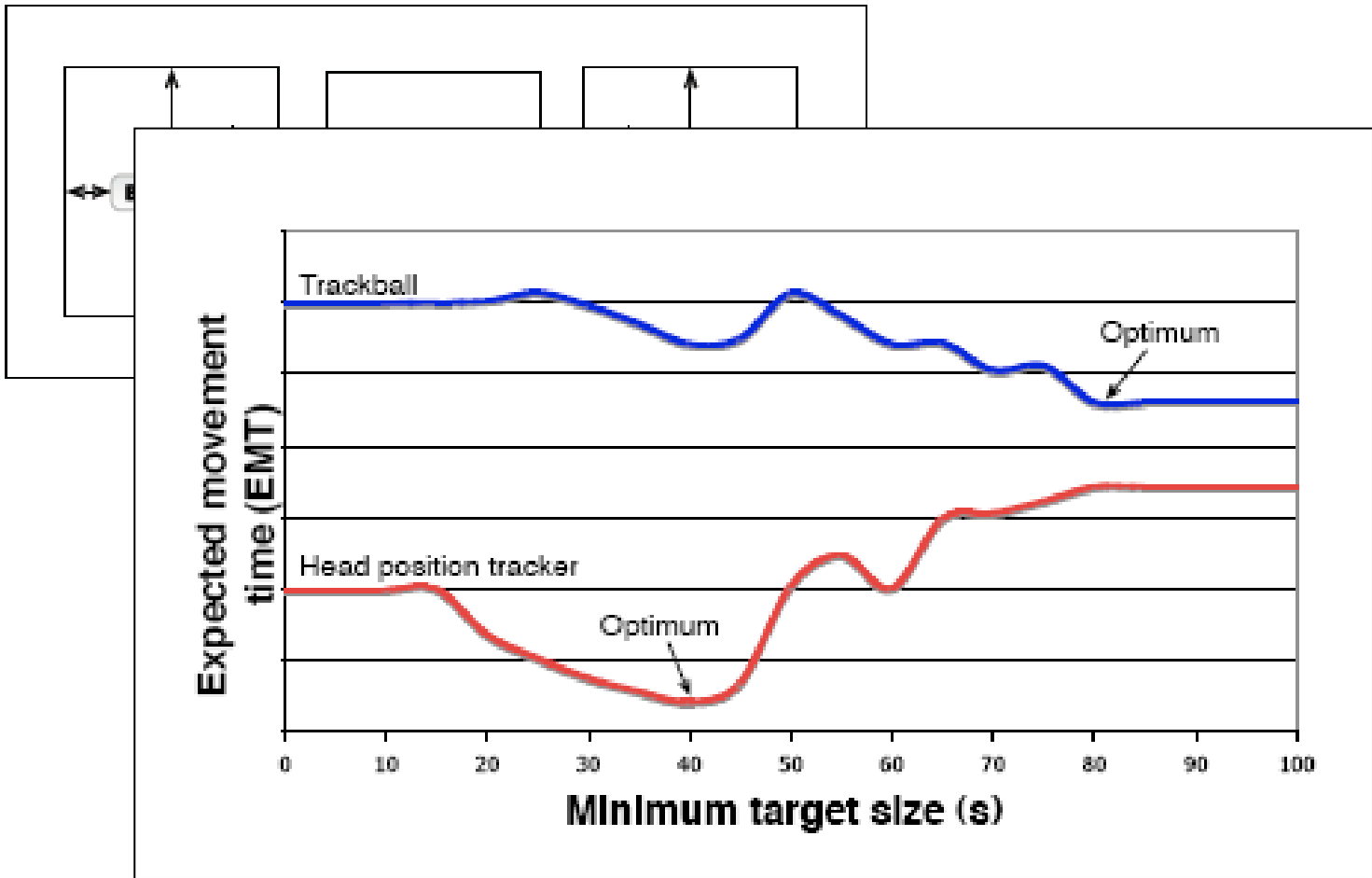
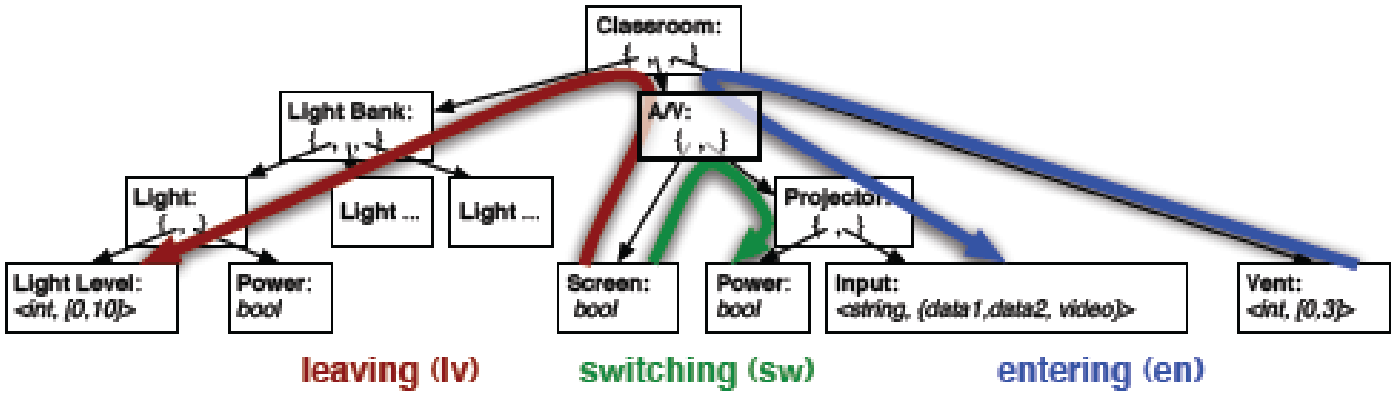
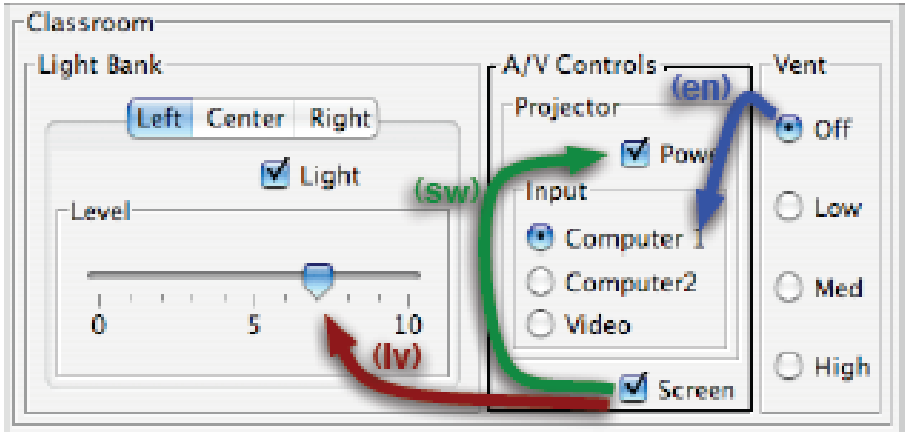


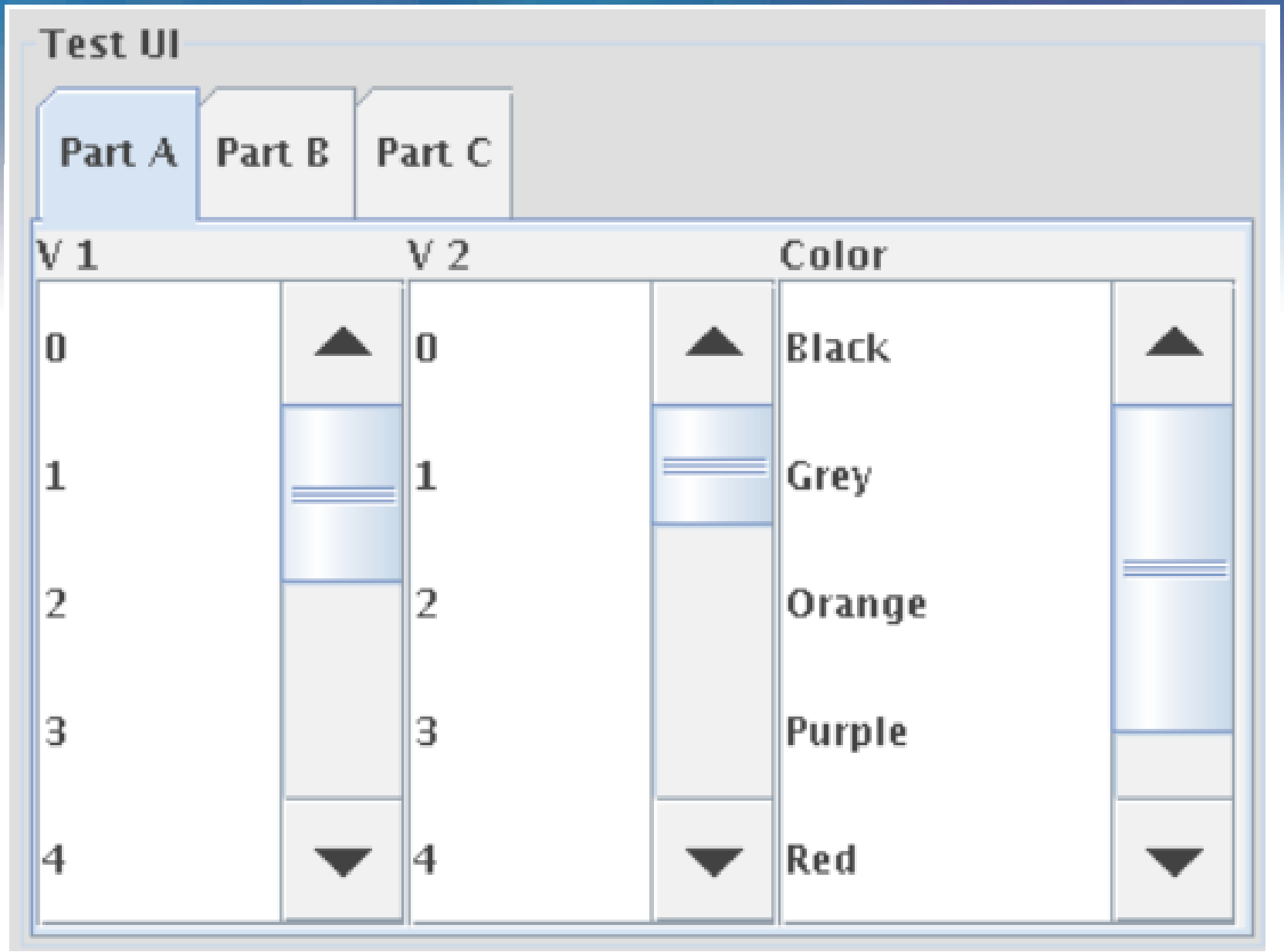
Gajos, 2008

Search for a Cost-Minimizing Design



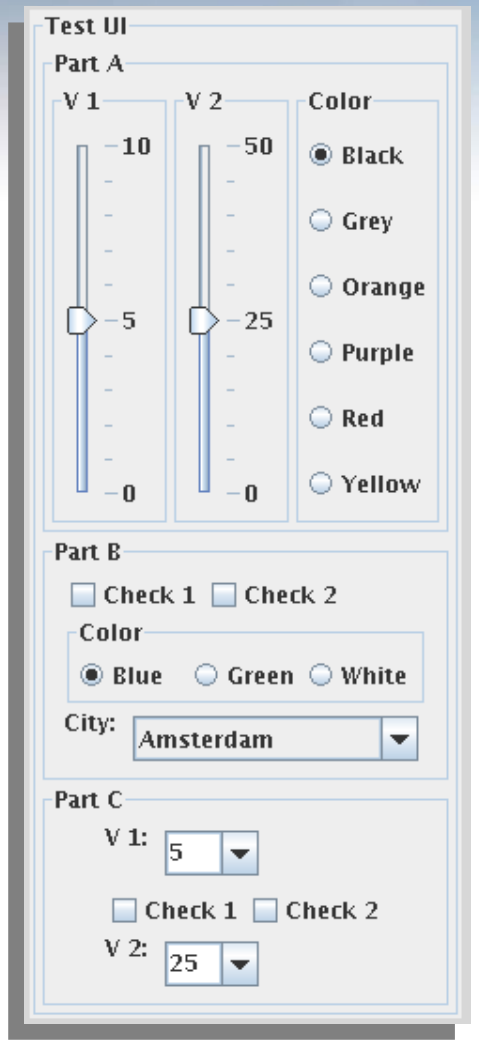


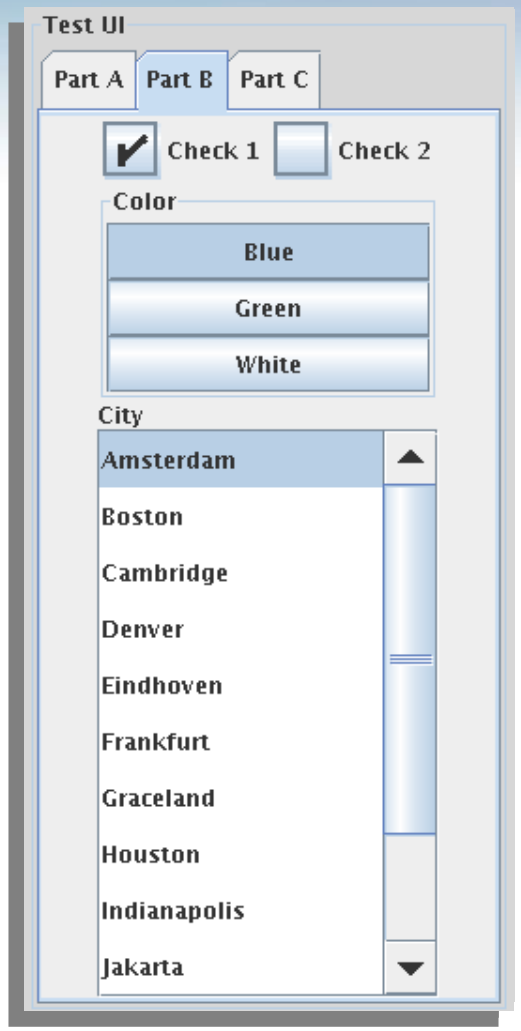
Gajos, 2008


Test UI
Part A
Part B
Part C
V 1
V 2
Color
0
1
2
3
4
0
1
2
3
4
Black
Grey
Orange
Purple
Red

Gajos, 2008

Gaze Tracking



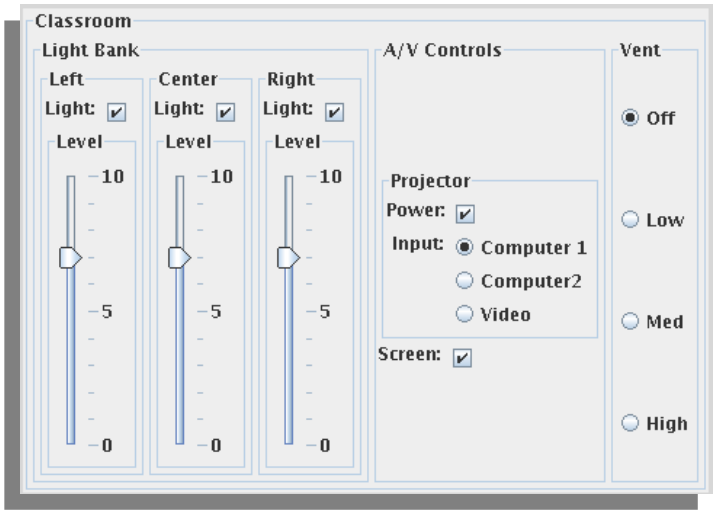


Gajos, 2008

Default UI

Gaze tracking

Gaze Tracking



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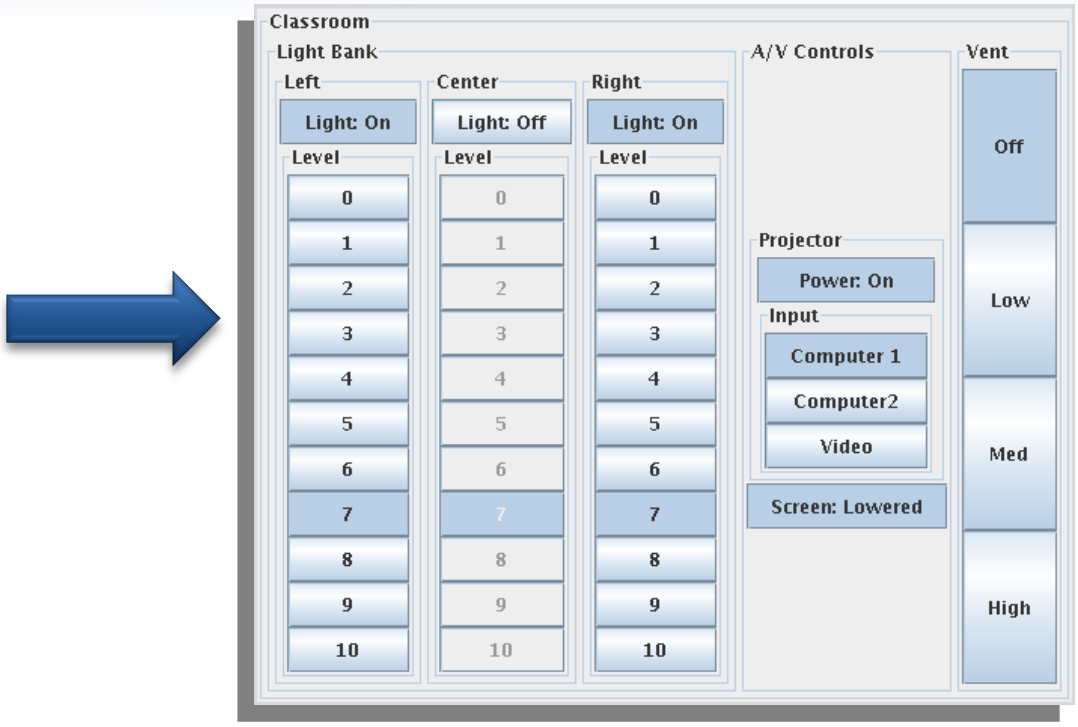


Gaze-tracking

Gajos, 2008

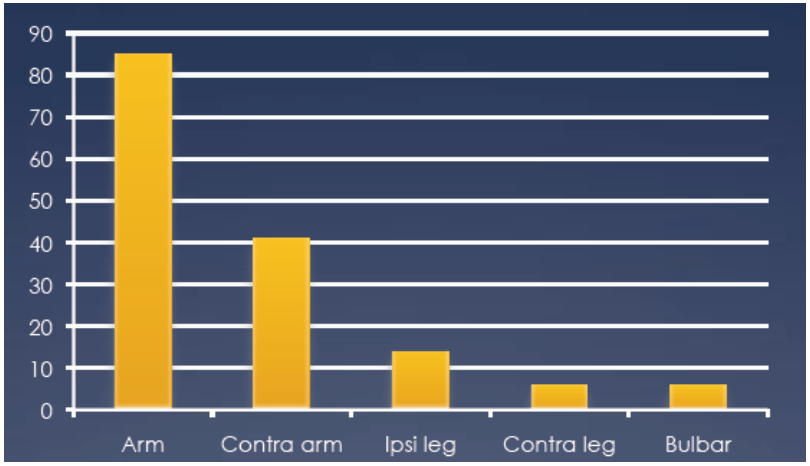
Supple Study

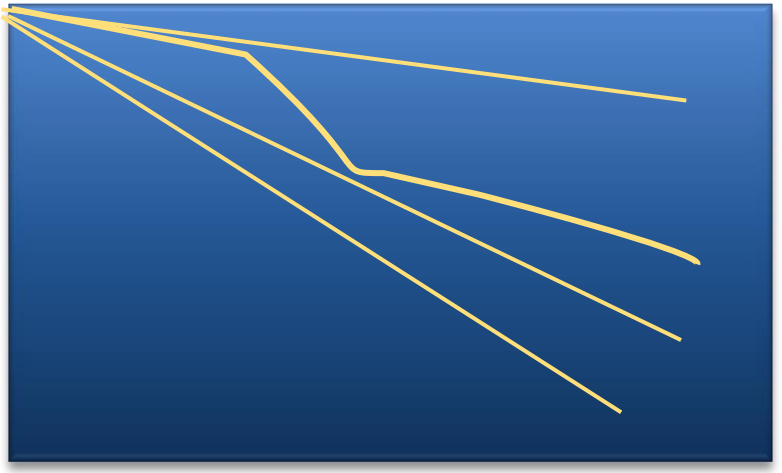
- 11 motor-impaired participants
  - Consistently faster (by 26%)
  - Closing significant portion of gap (63%) with healthy subjects.
  - 73% fewer errors
  - Strongly preferred

Gajos, 2008

ALS: Tracking & Dynamic Optimization

- Observe current motor skills
- Optimize layout & sizing to minimize effort & frustration
- Consider likely clinical trajectories and minimize costs of transition

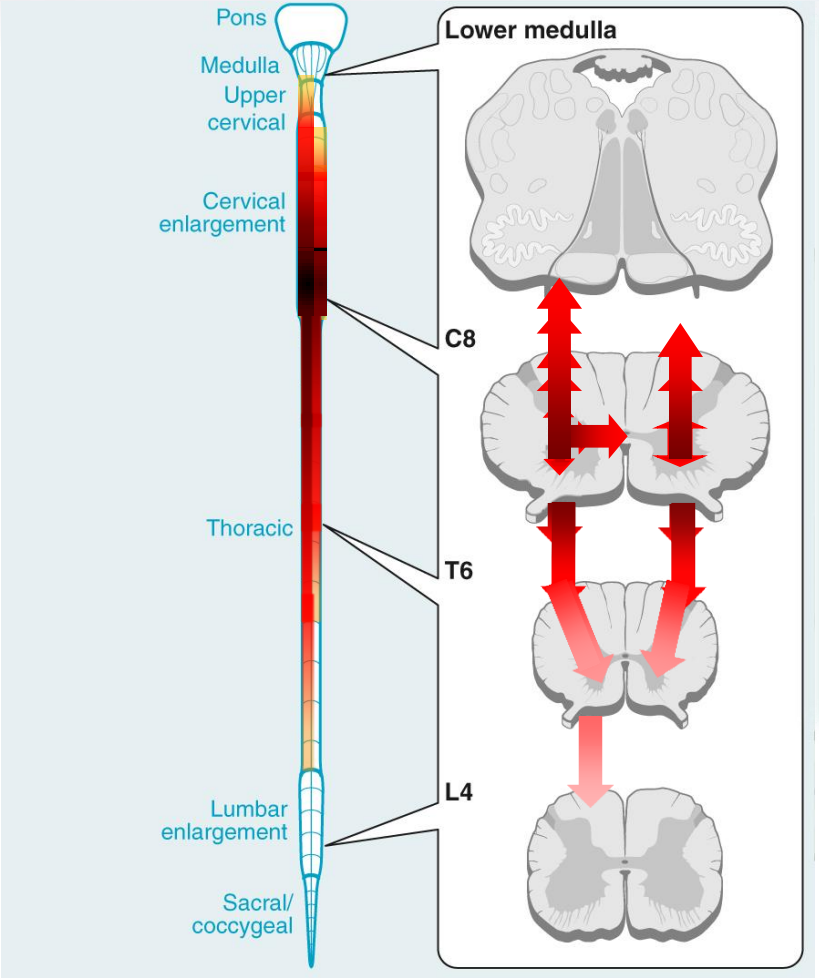


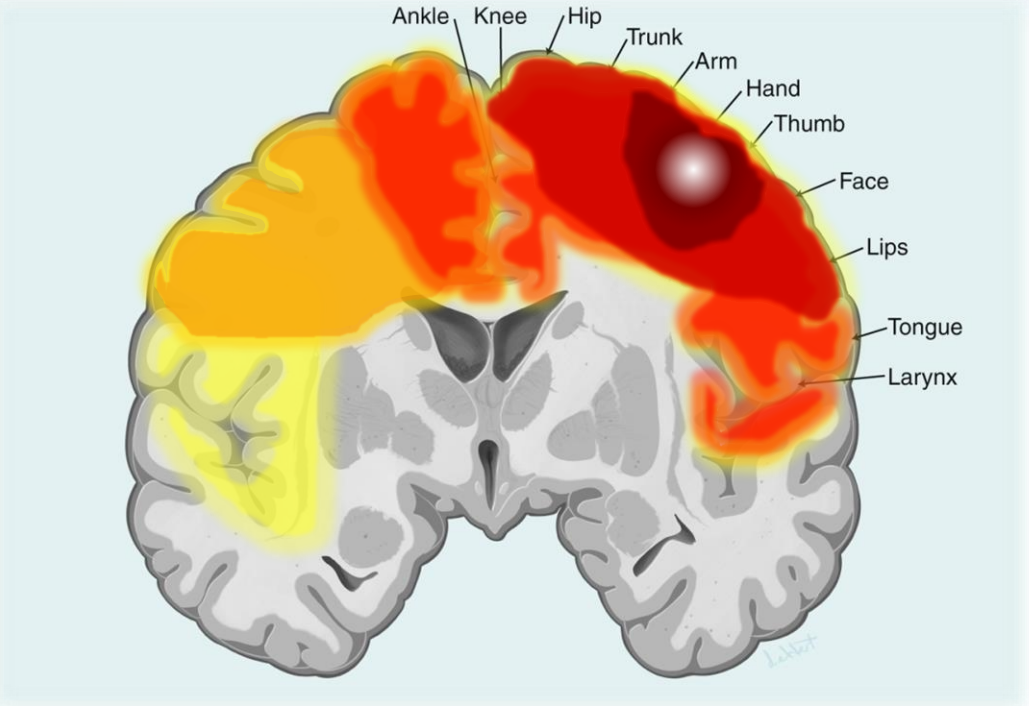


Gajos, 2008

Models of Progression (courtesy J. Ravits)

- ***e.g.*, Focal onset (e.g. right hand):**
  UMN & LMN share same body region
  Independent severities





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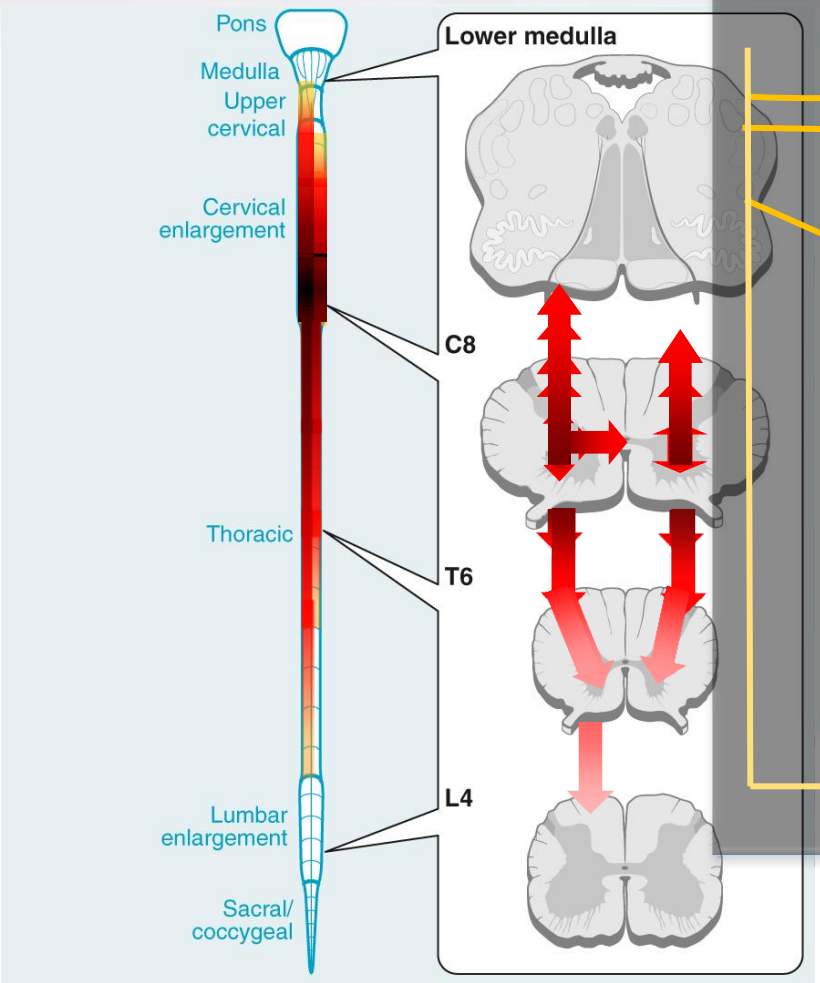
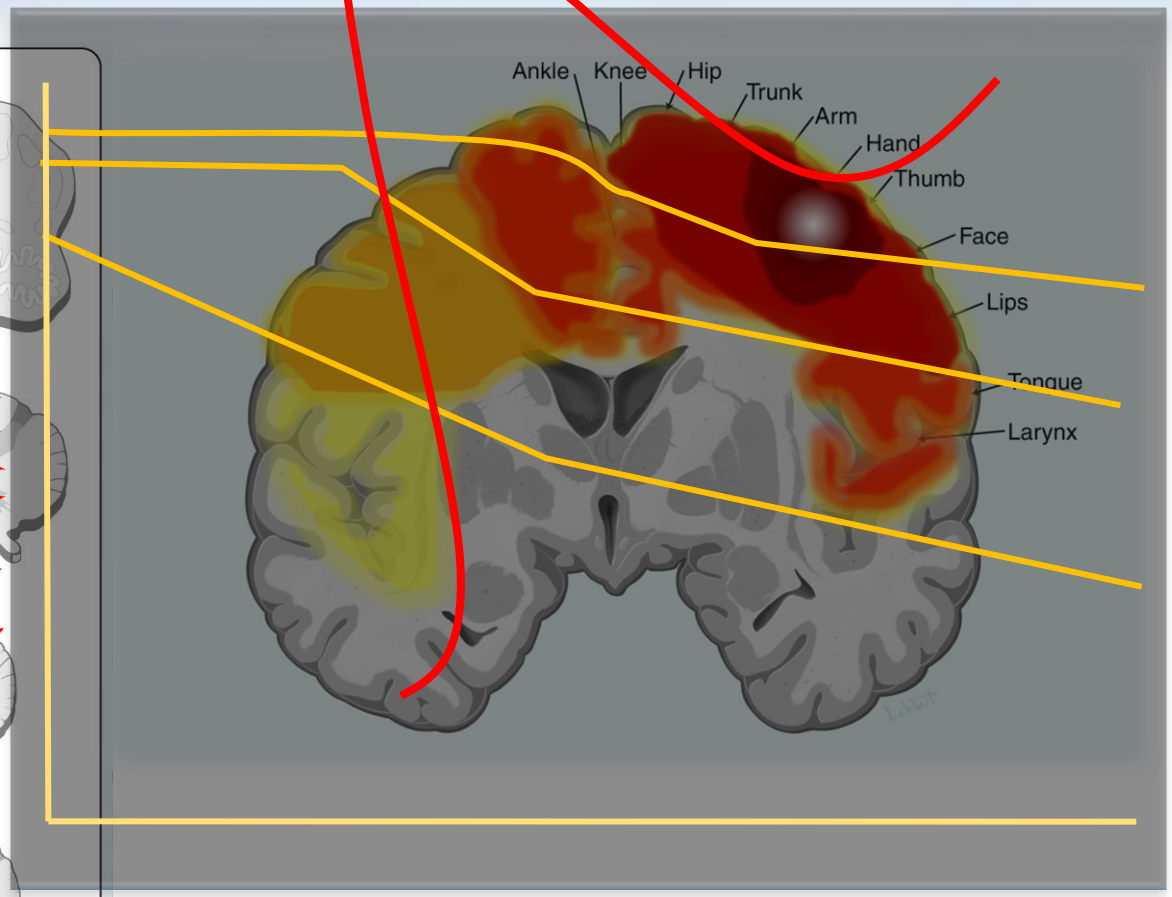
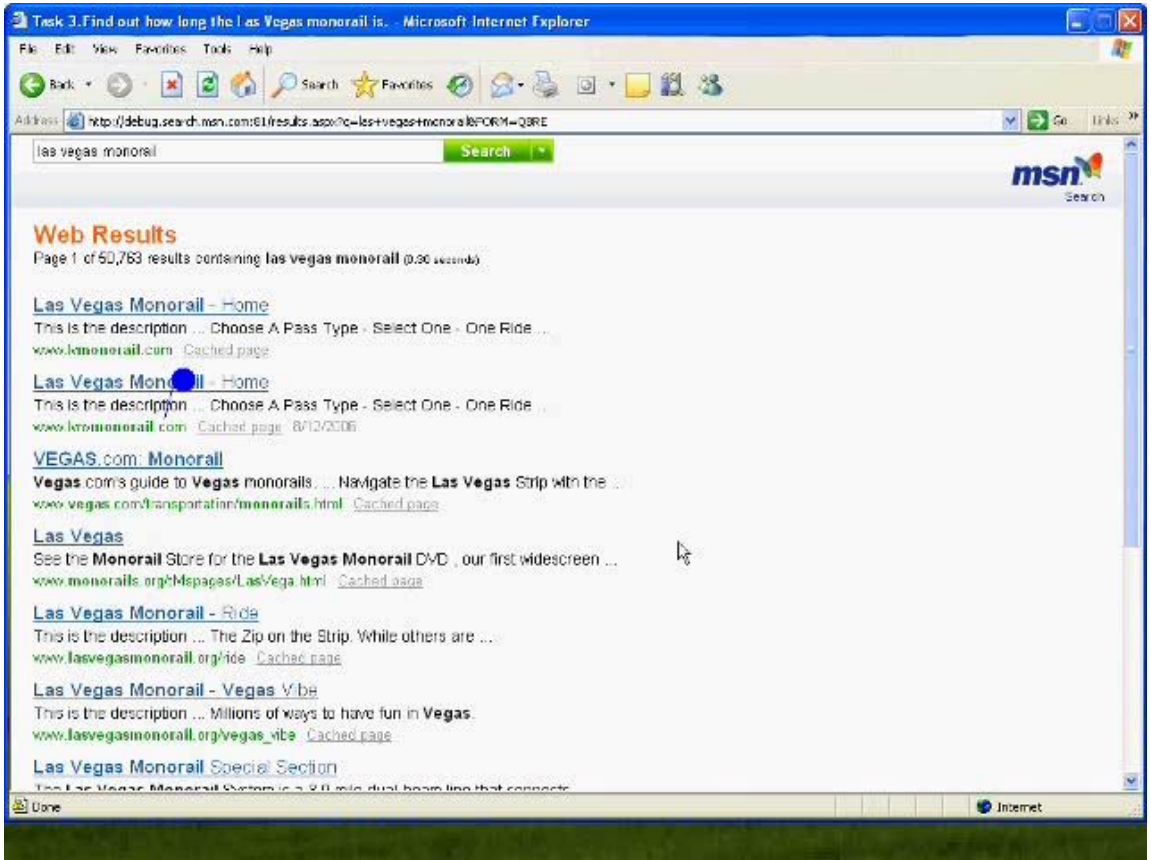




Challenges of Gaze-Centric Interfaces

Gaze-Based Interfaces: Opportunities

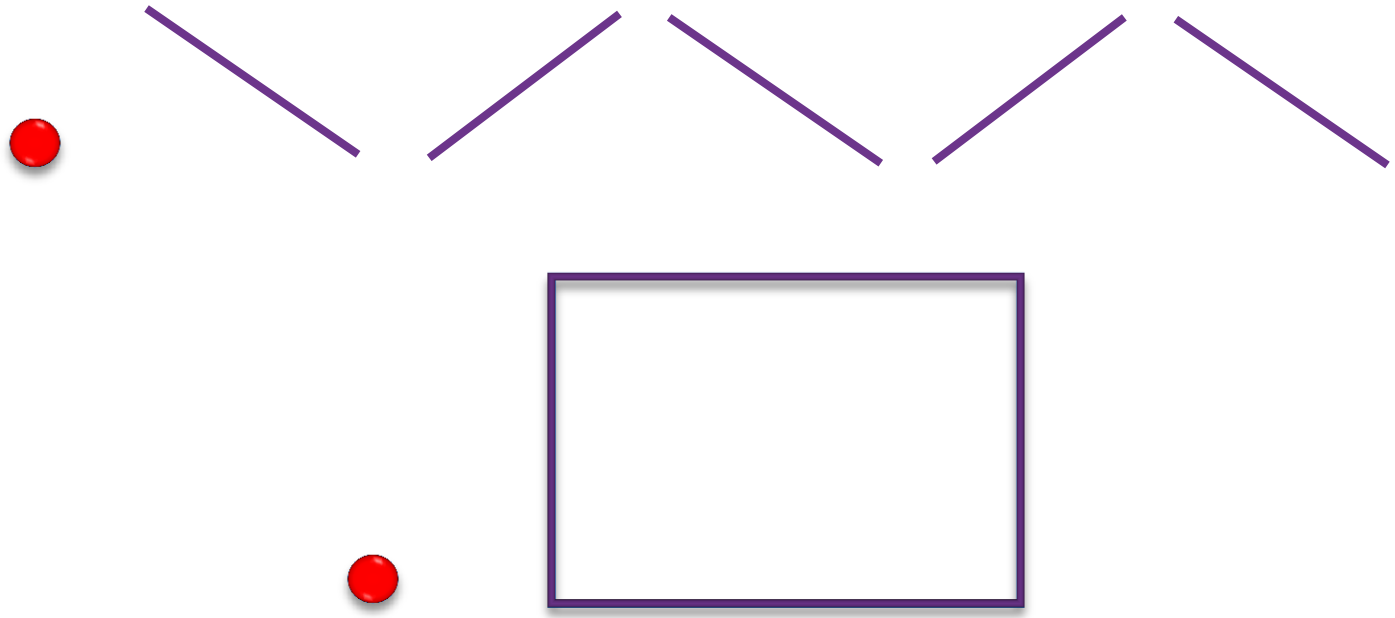
- Innovate beyond point & dwell
- Toward new UI designs, metaphors
- Adaptive techniques, inference about intent



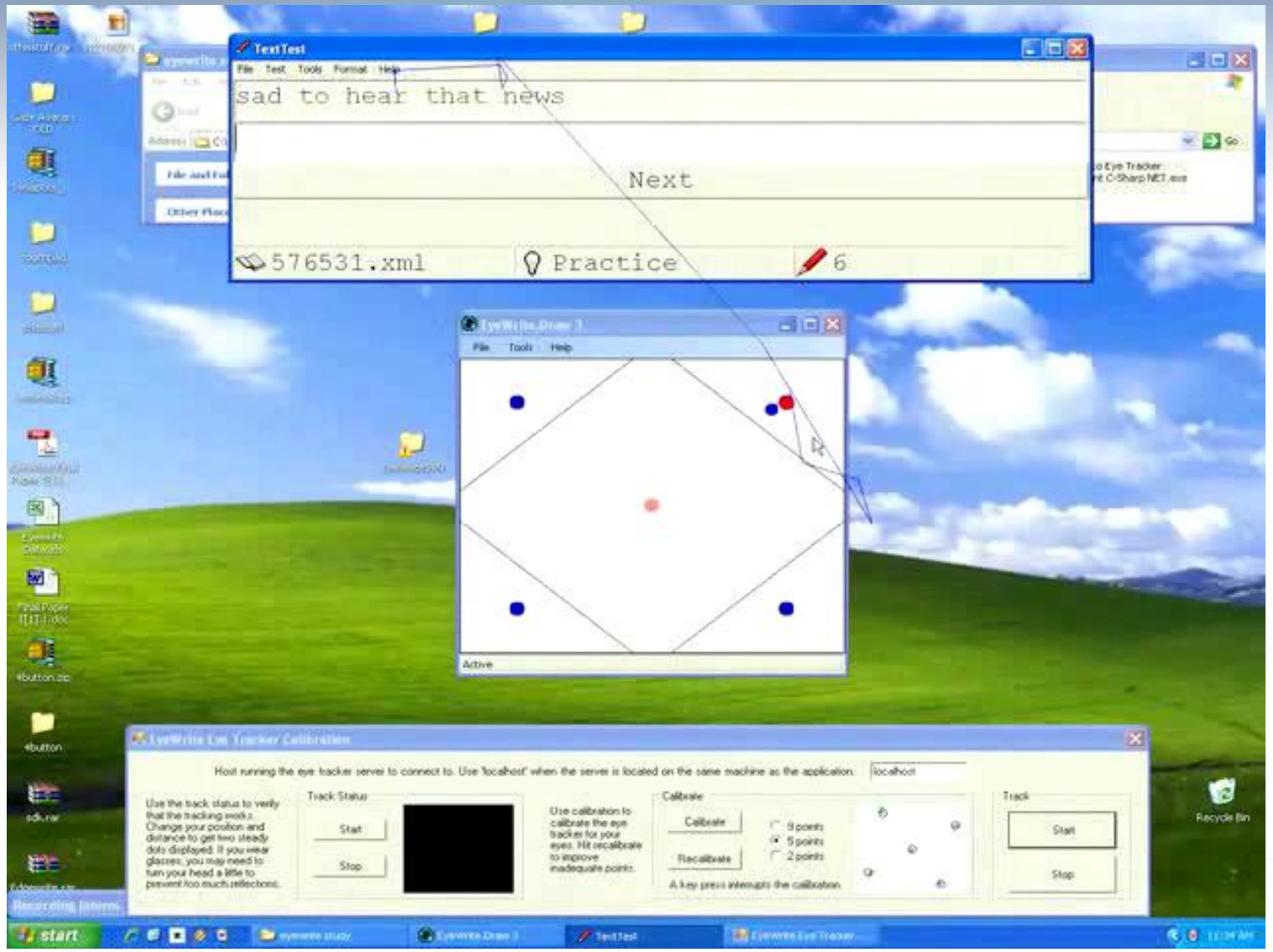
(video)

New Interaction Metaphors

- Beyond point and dwell
- Rich new languages for input
  - Crossing versus pointing
  - Stereotypical patterns



Example: EyeWrite (Wobbrock, *et al.*)



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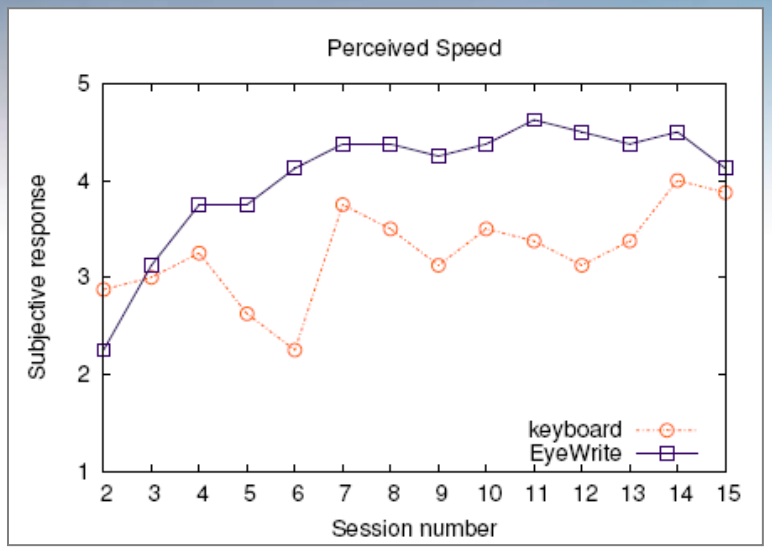
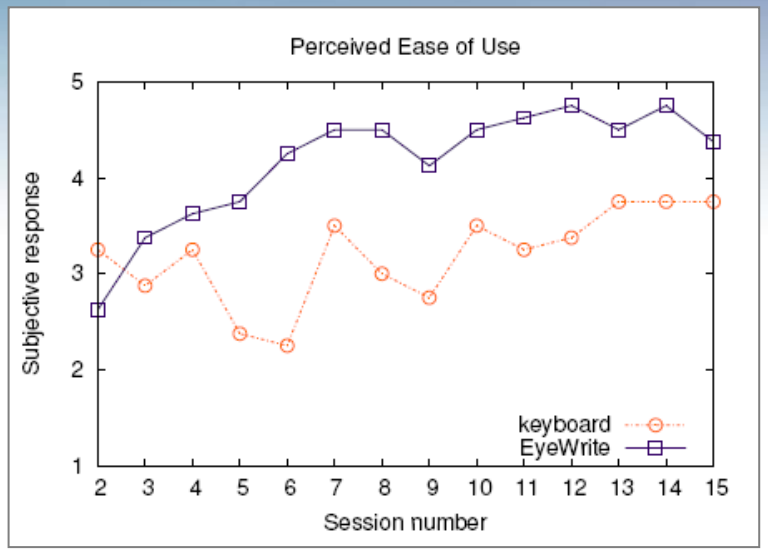
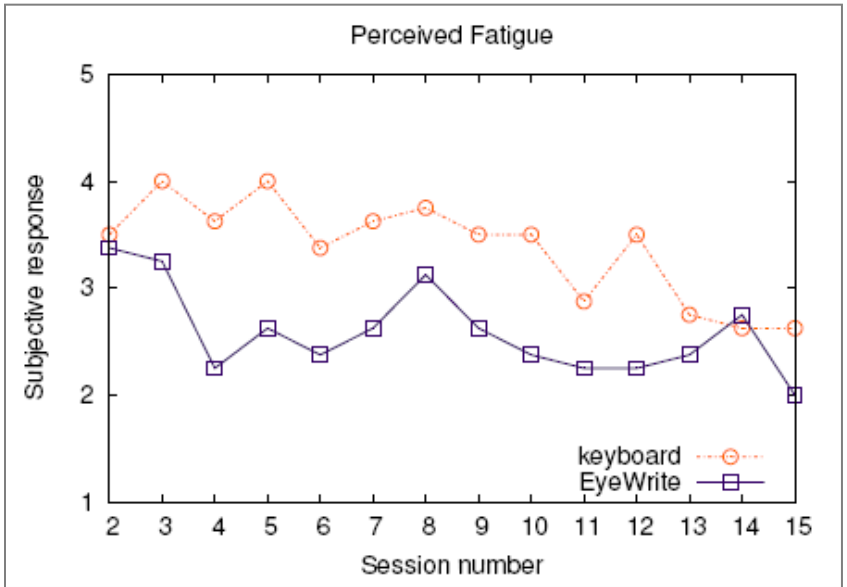






Longer-term: Beyond the Display

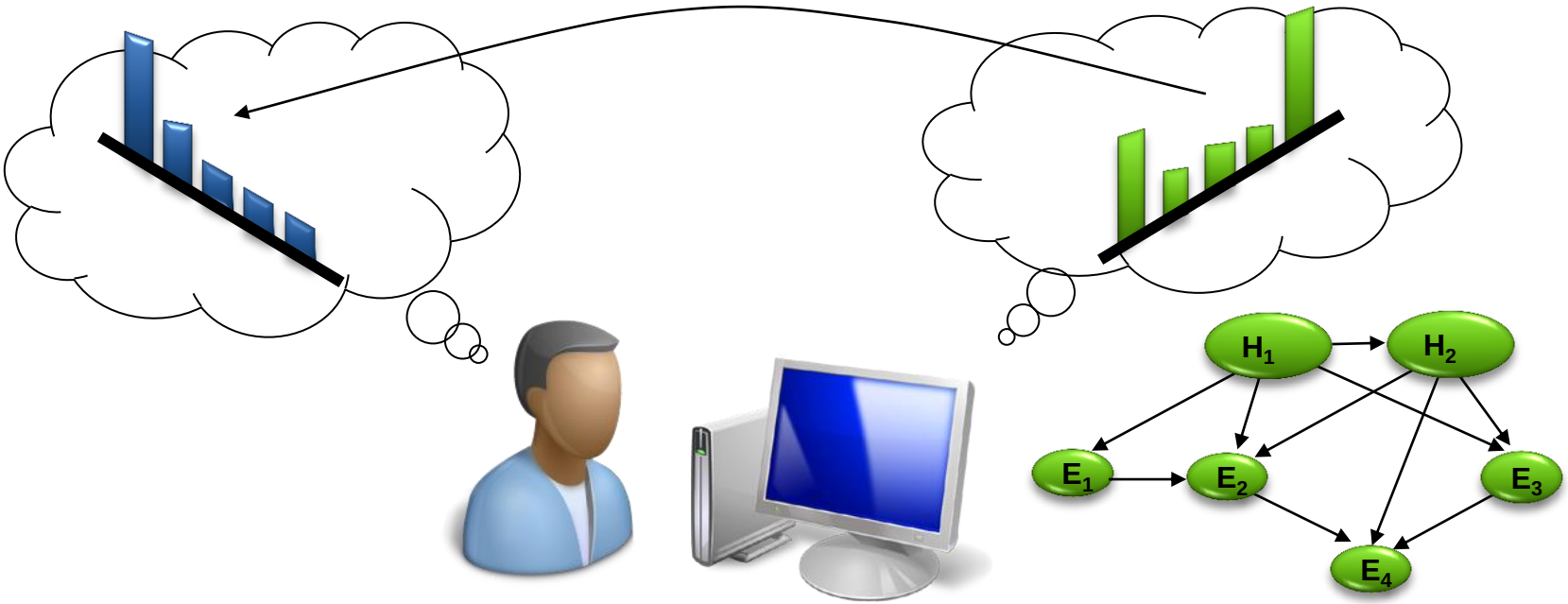
- Potential to move a gaze-controlled cursor into the world
  - e.g., Directions suggested by *WorldCursor* (A. Wilson)

Longer-term: Beyond the Display

(video)

Machine Learning & Reasoning

- Learning & reasoning about goals and needs
  - Learns by watching, sensing
  - Learns from corpora, patterns by time of day, time since last event / intervention *x*



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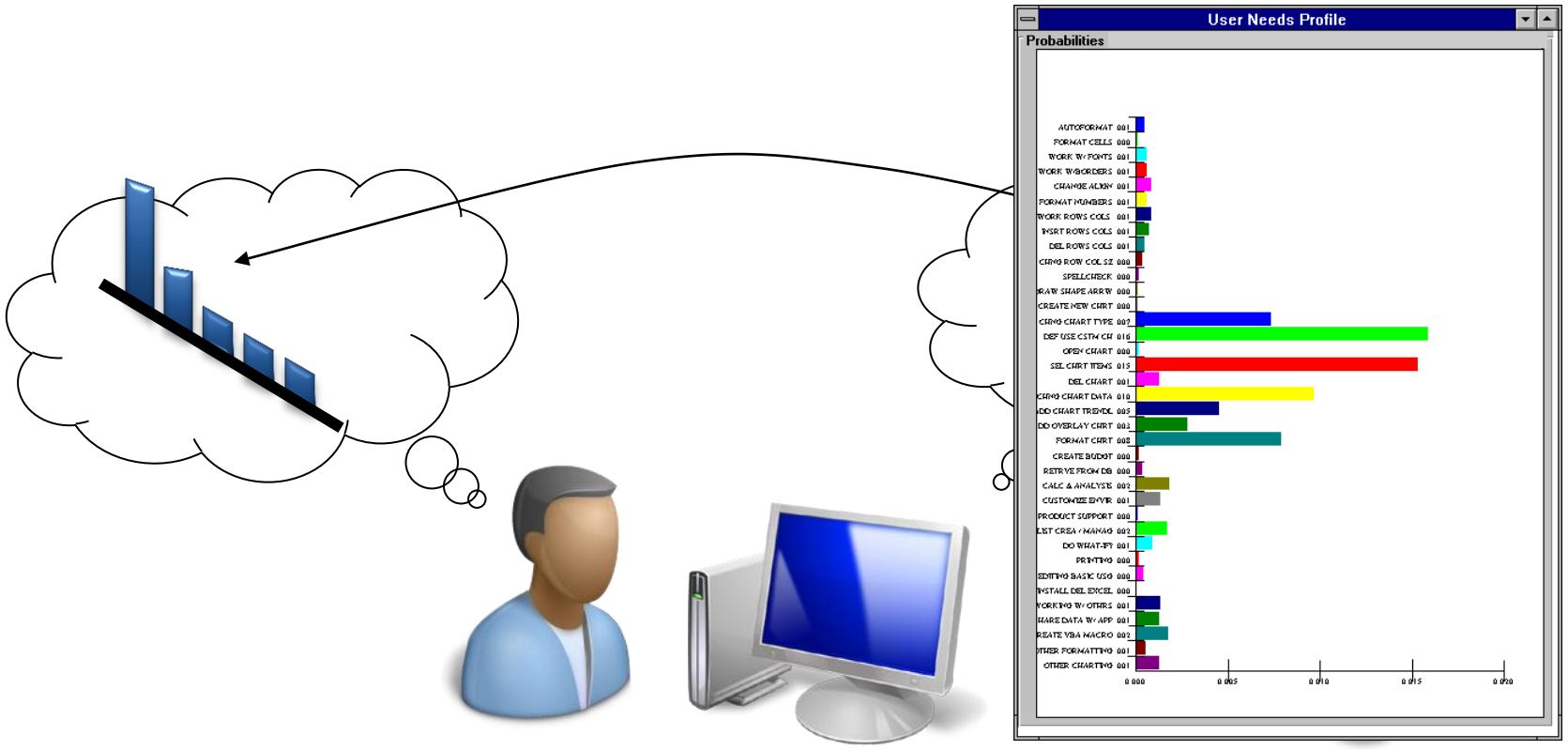
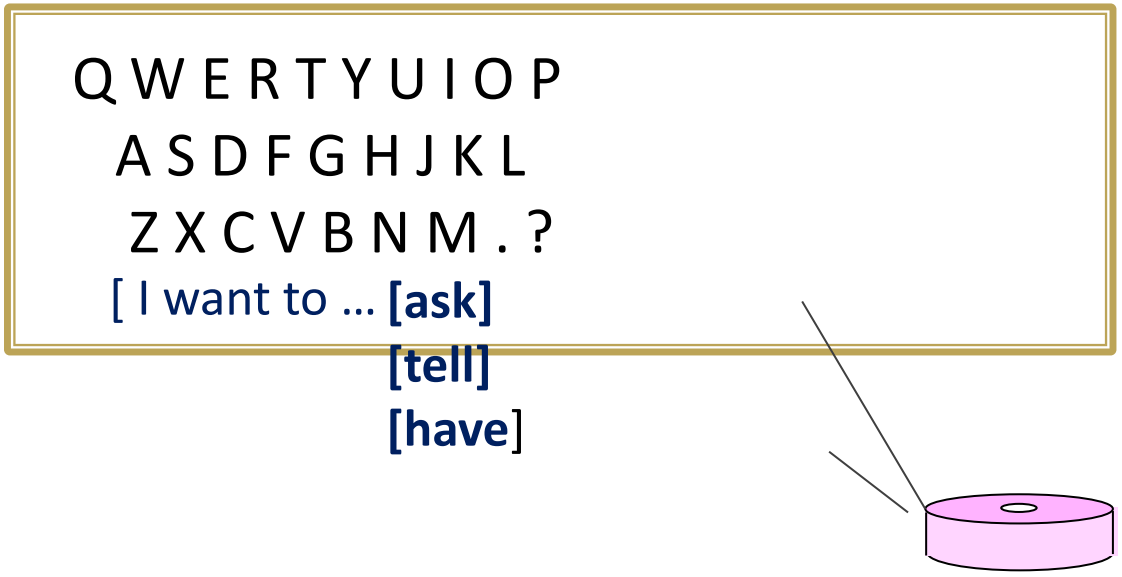


Machine Learning & Reasoning

- Learning to predict next words and phrases from rich corpora
  - Context, time since last intervention, etc.
  - Email store → predictive language model (Acero, etc al.)



Predictive language model with correction

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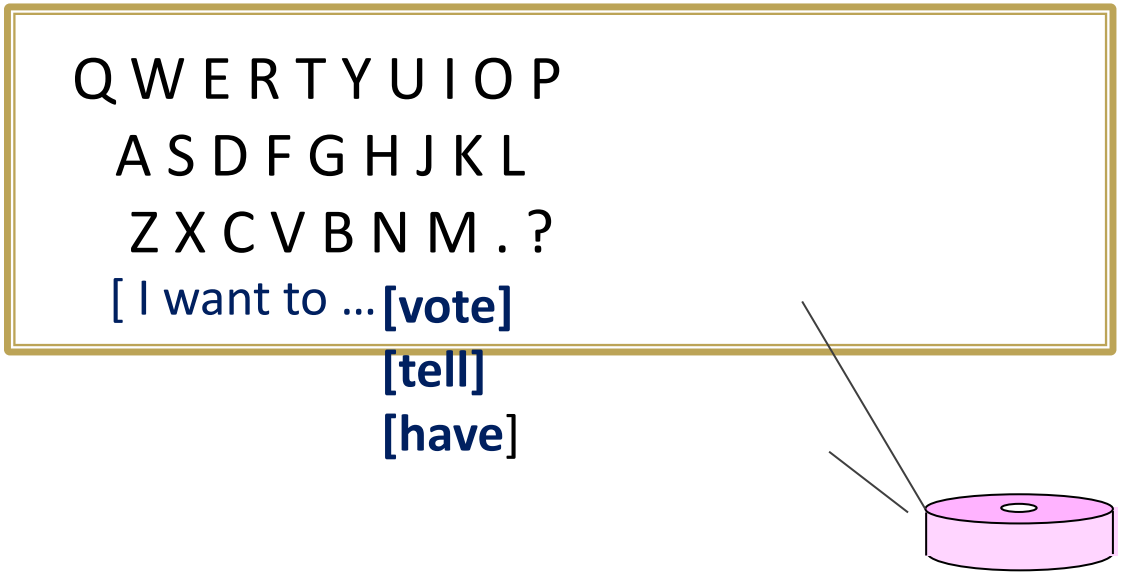

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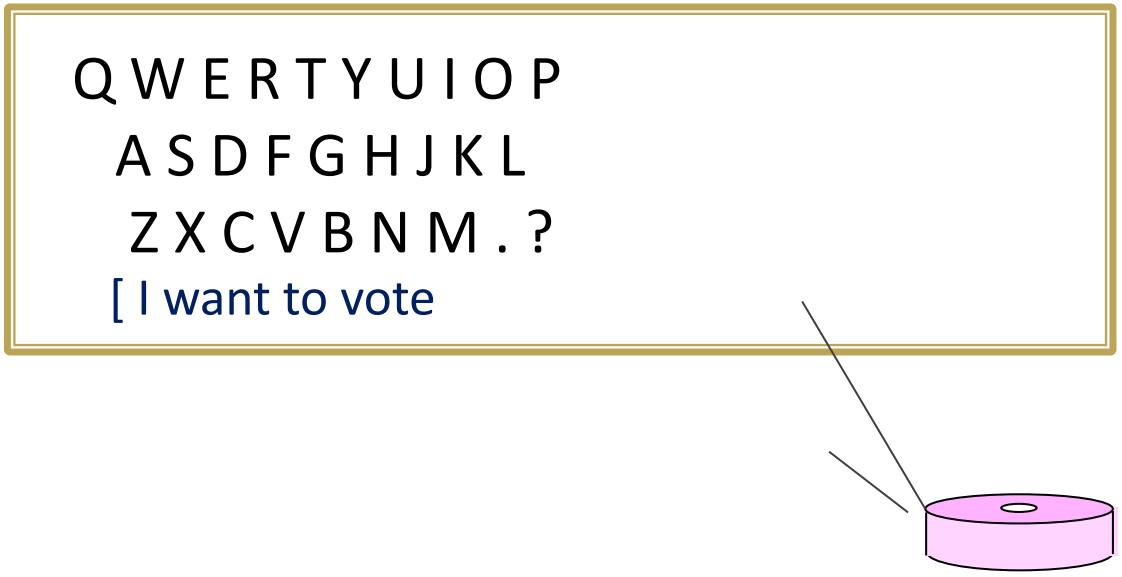

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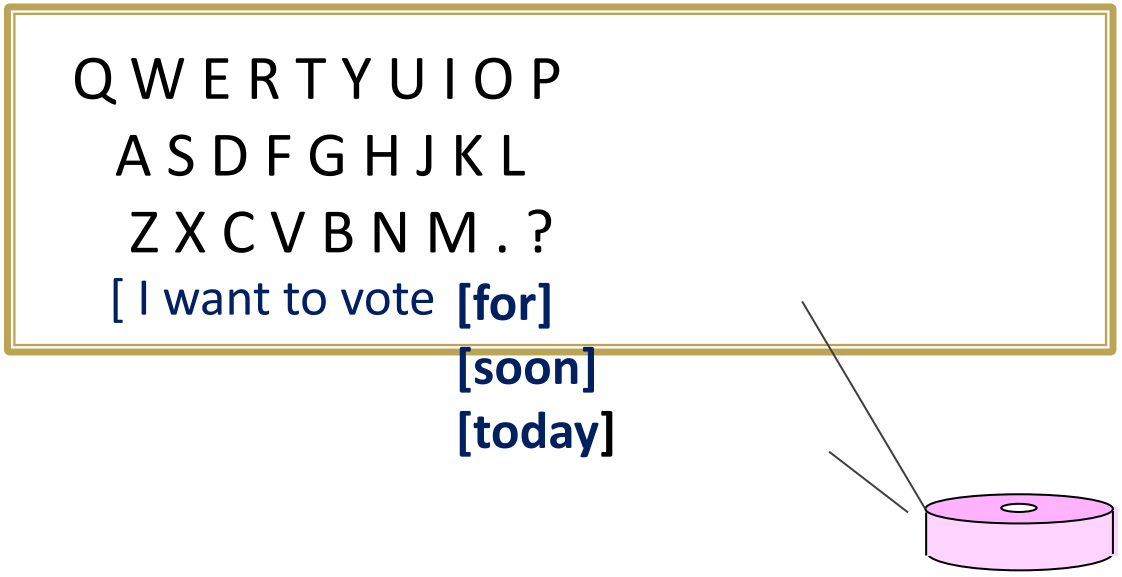

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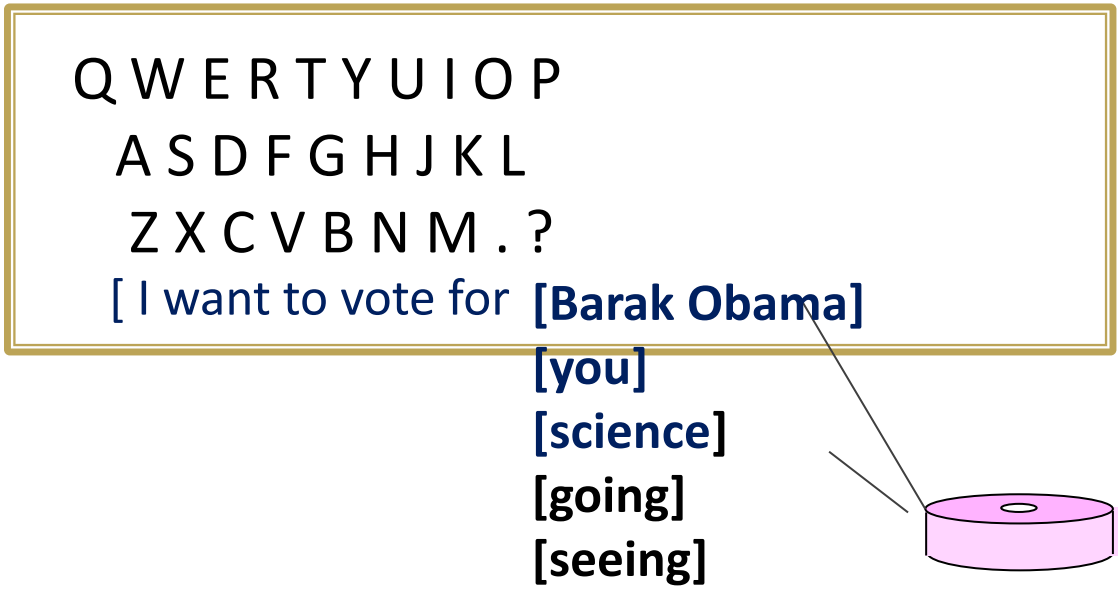

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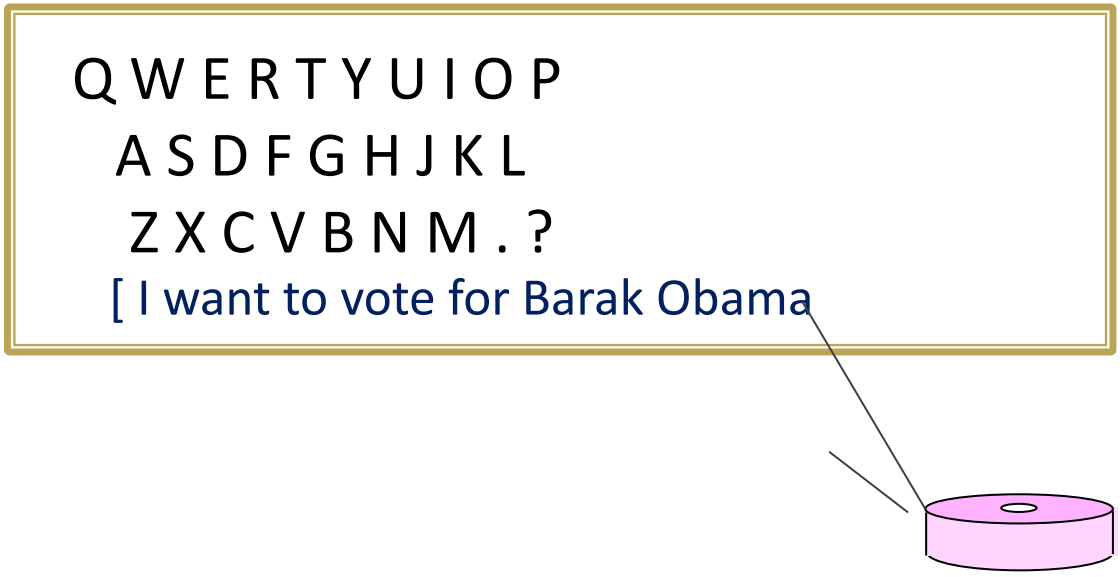

Predictive language model with correction

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- Dasher: Combining visual flow, with predictive modeling (D. MacKay, et al.)

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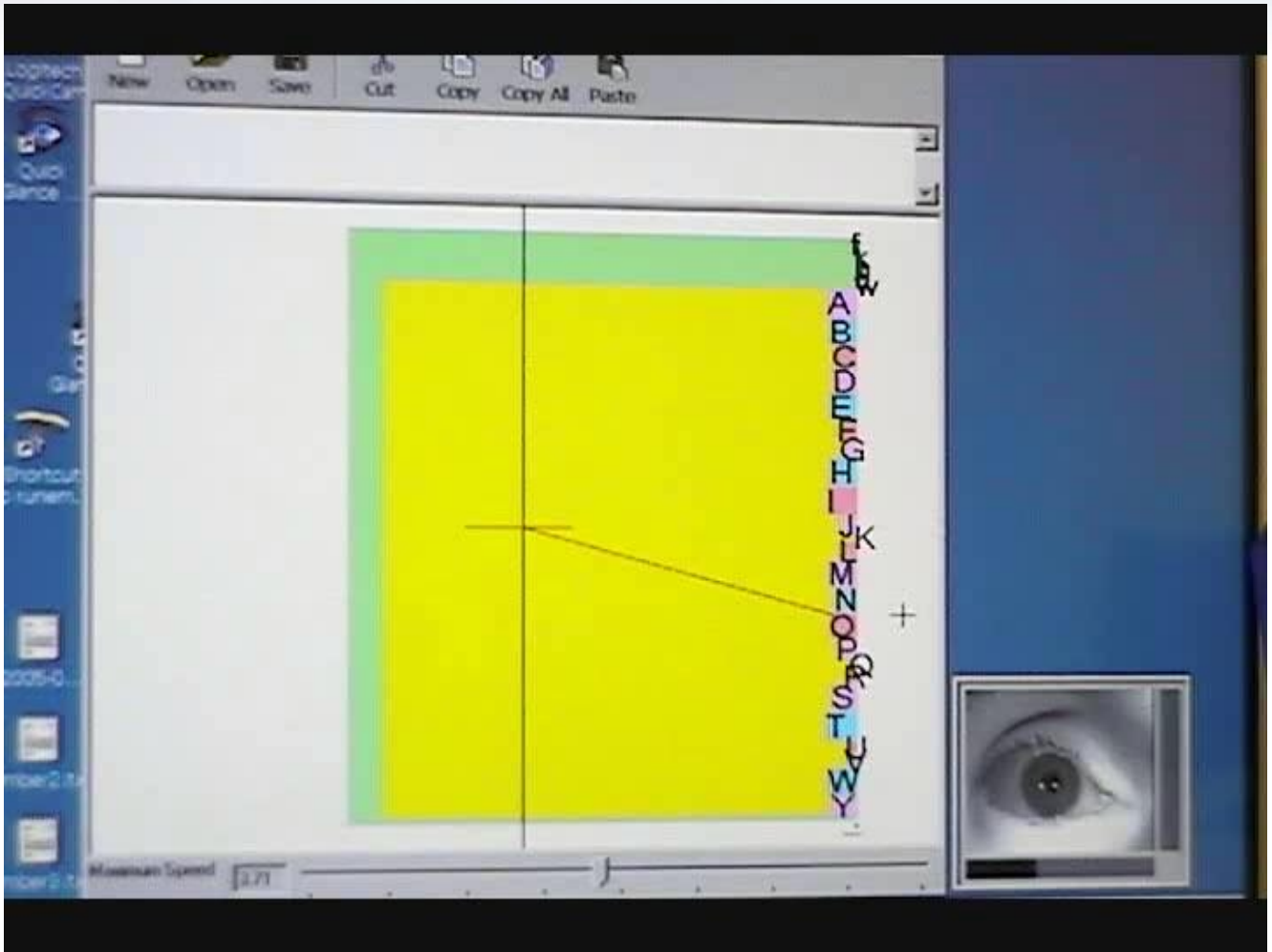


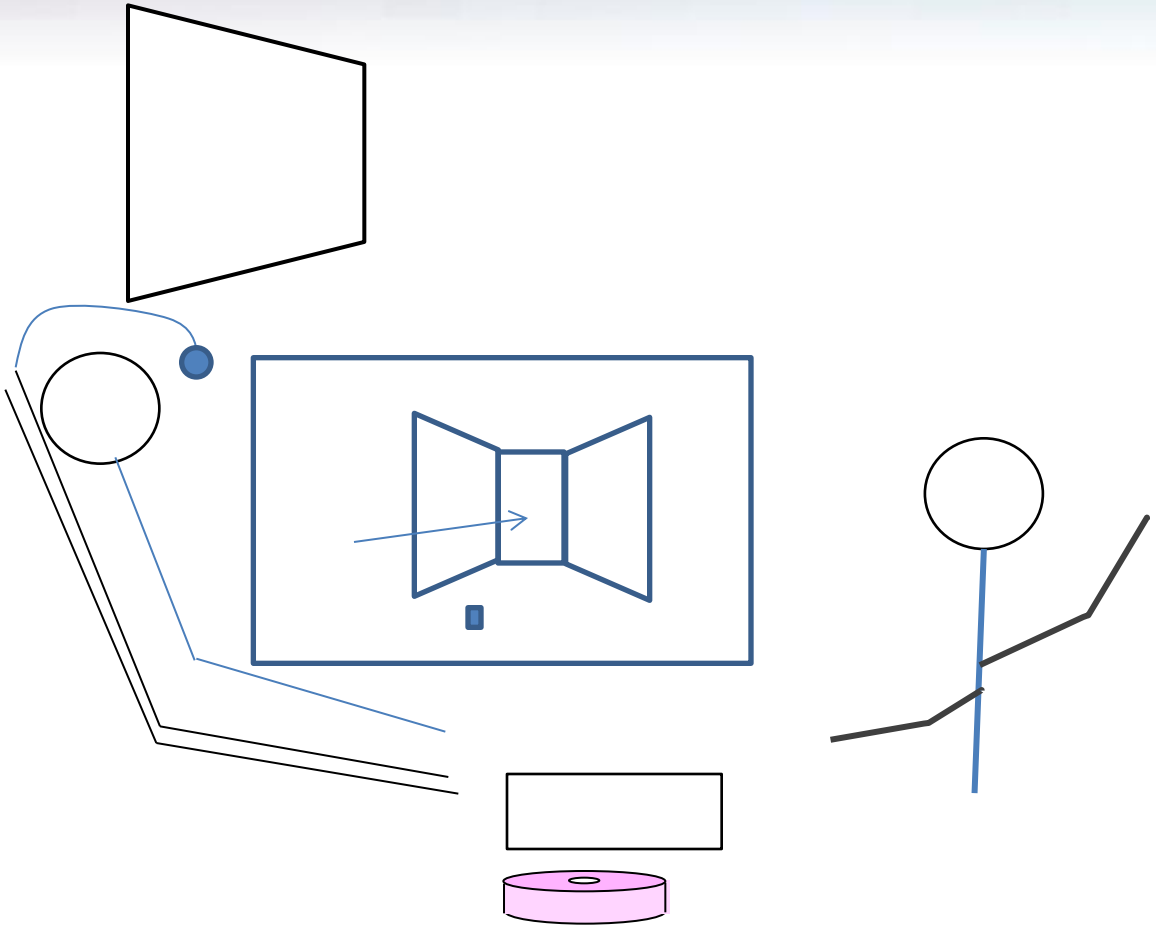
(video)

Content, Retrieval, and Experiences

- Web as rich portal
- Conferencing, collaborations, gaming with friends, family, colleagues
- Personalized search
- Simulations, virtual travel
- Presence and interaction virtual worlds

Content, Retrieval, and Experiences

- Access to places and experiences
- Sharing joint trips with friends, family



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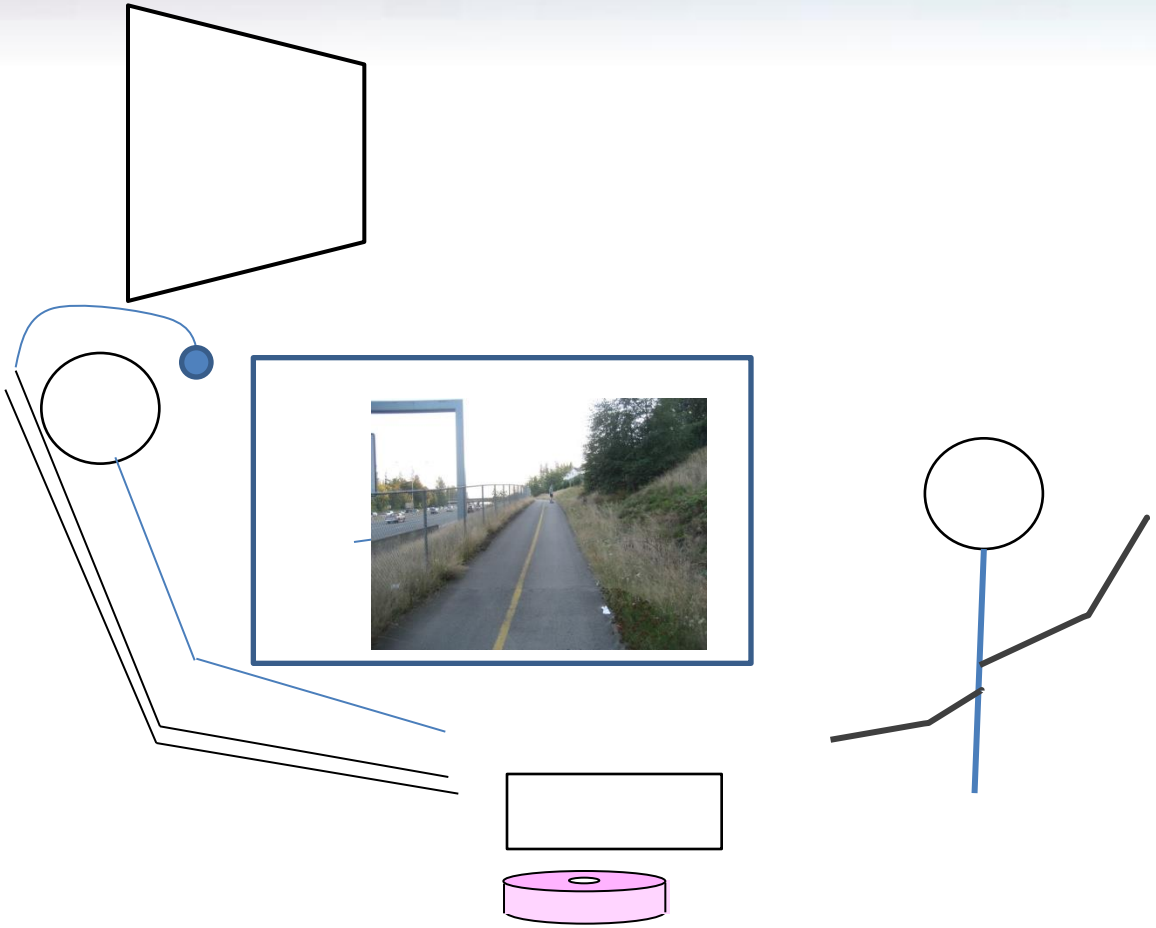


(video)


(video)

Engagement in Virtual Worlds

Research on gaze-directed interactions

(Vickers, Bates, Istance - De Montfort Univ., Leicester)

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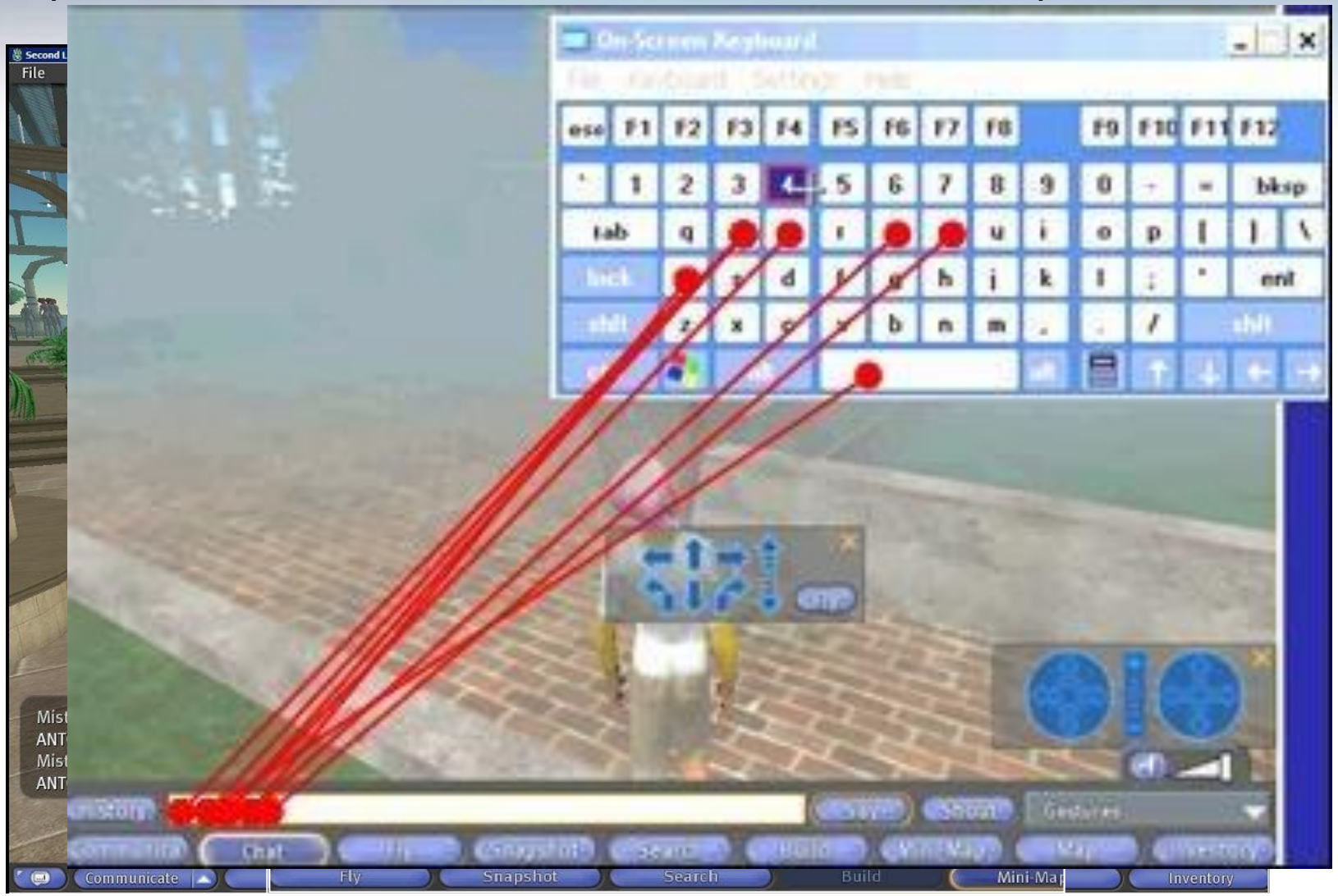


Engagement in Virtual Worlds

Research on gaze-directed interactions

(Vickers, Bates, Istance - De Montfort Univ., Leicester)

Task times and error counts based on task domain

	Control source; task time (s); error count	
Task domain	Mouse (baseline)	Gaze
Locomotion	48s (3 errors)	88s (4 errors)
Camera movement	50s	122s (10 errors)
Object manipulation	35s	71s (3 errors)
Application control	20s	194s (4 errors)
Communication	60s (11 wpm)	224s (8 errors, 3 wpm)

Engagement in Virtual Worlds

Research on gaze-directed interactions

(Vickers, Bates, Istance - De Montfort Univ., Leicester)

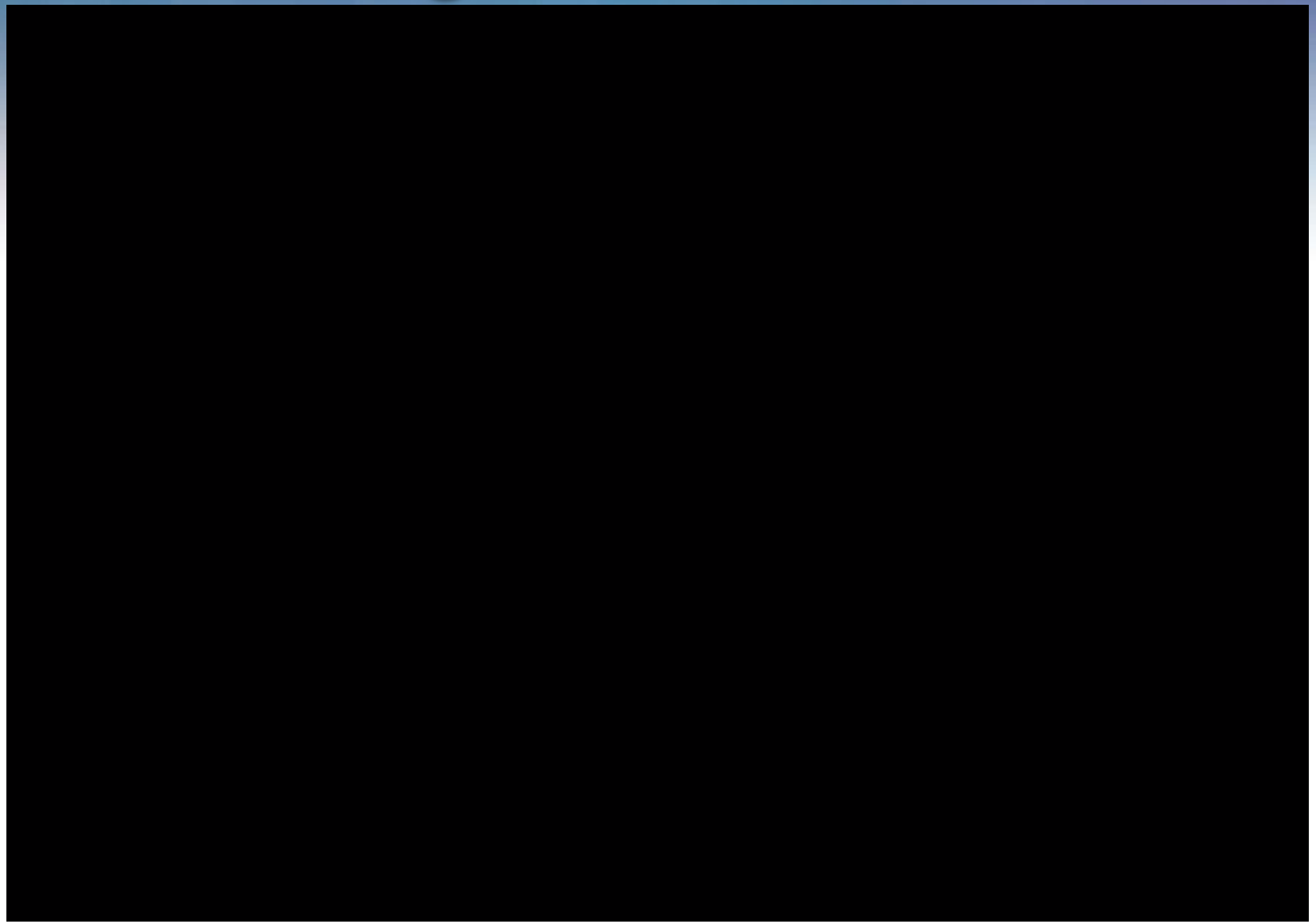
(video)

Participating in Multiplayer Games

Research on gaze-directed interactions

(video)

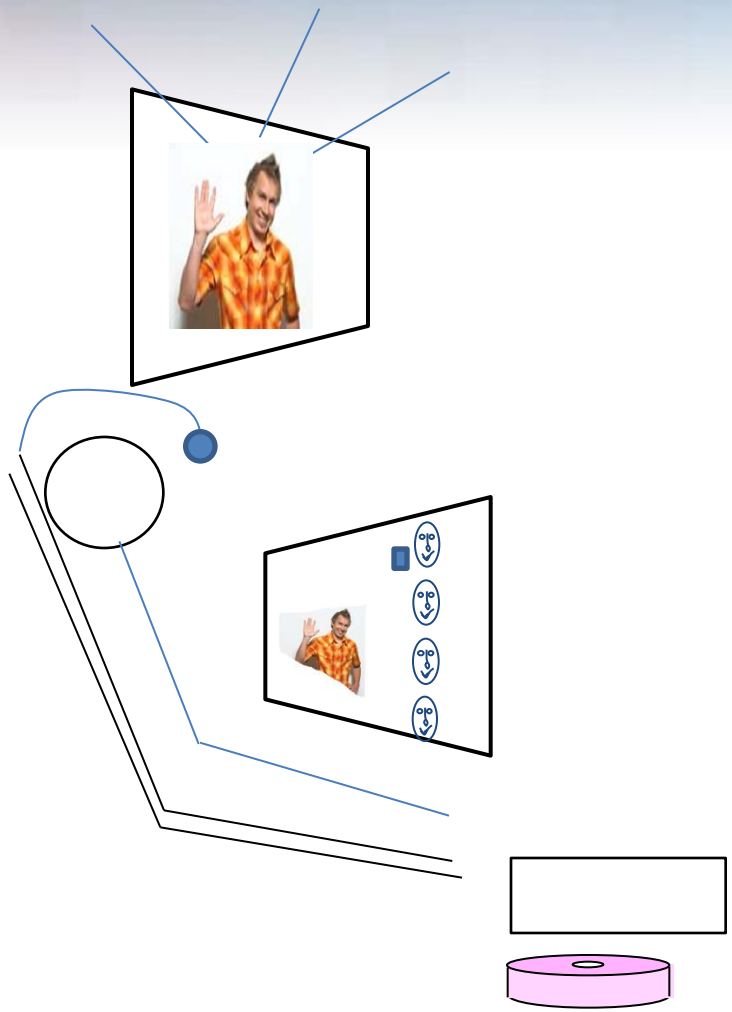
Reaching into Other Worlds



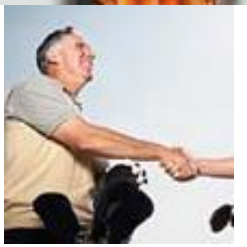
(video)

Access to Expressive Media

- Plan for rich communication of emotion



Social discourse library of videos and stills for sharing emotions, moods, gestures.



Memories library from video and image photolibrary

Inferring Memory Landmarks: LifeBrowser

Most memorable — Least memorable

Query: Smartphlow

Time

Images & videos

Desktop & search activity

Appts & events

Locations

Whiteboard capture

Date	Events	Results by Time
Feb 4 2005 Fri	 privacy talk 2005.ppt priv_out.ppt	Micronews 5 to 1 JamBayes Discussion and Demo JamBayes Discussion and Demo
	Micronews 5 to 1.doc	
Thu	 lake-central-visualize.ppt C4 AUV.doc	Inrix folks 6 month check up.. :> Video... smartphlow.mpg
	NRAC Italy Meeting	
Wed	isometric_volumes_study.p LC_visual.ppt techfest.doc	Phlat c# filter & query controls Phlat c# filter & query controls Smartphlow/Caravel meeting recap
Tue	 Gates Invitation.doc	Smartphlow cannot start? Smartphlow cannot start? 6 month check up.. :> smartphlow exclamation.bmp
	20040525_C10.xls Farewell Party for David Weise	
Mon	MSMLS coordination	Asi dev status week of 1/17/2005 Questions about SmartPhlow

MemoryLens - LifeBrowser

File Options Advanced Help

Query 74 results

daniel avrahami

Mix

Images, meetings and file activity

Exact M 1000 Clear Submit

Week

memorable all

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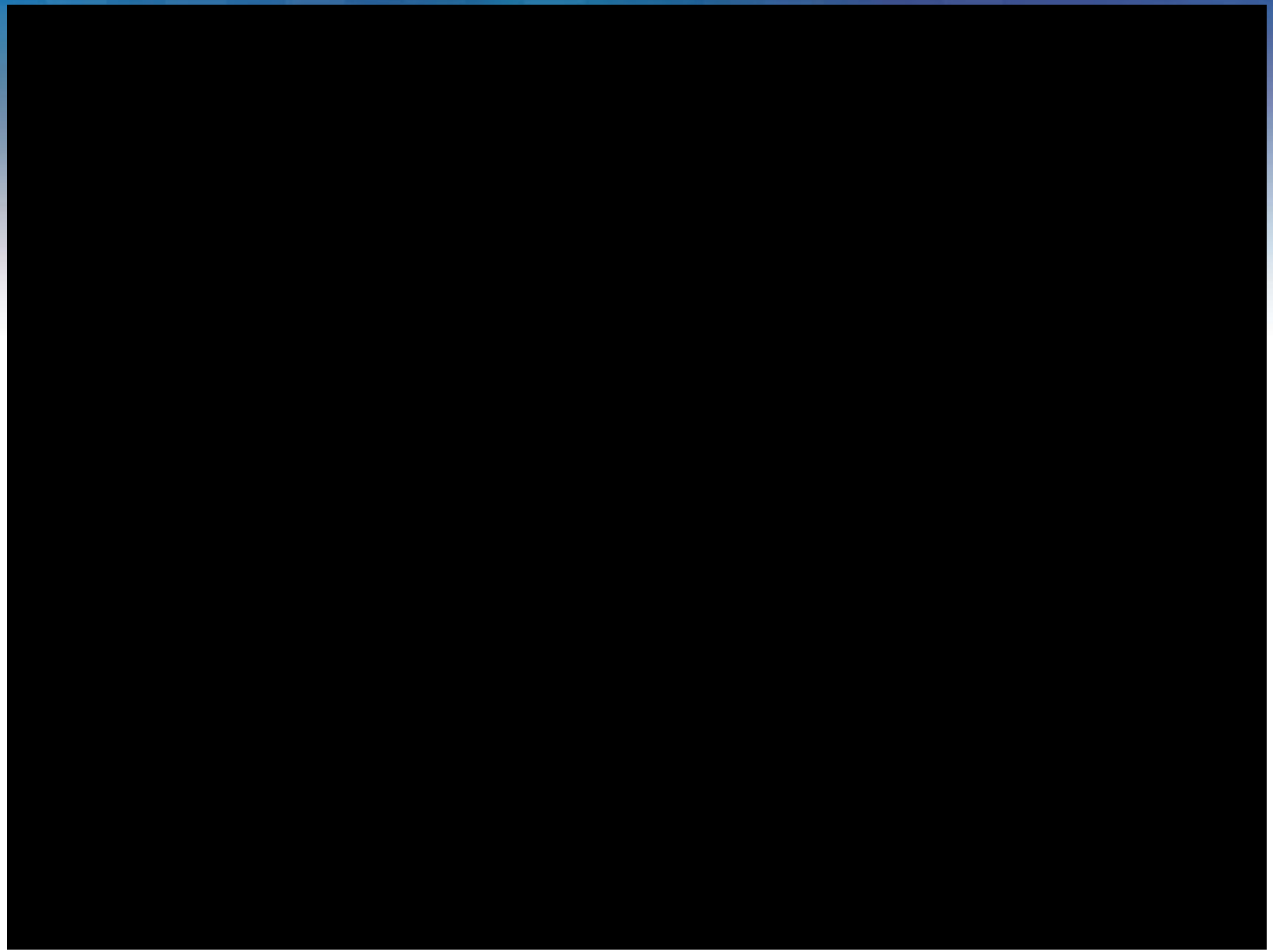
D:
E:

Date	Events	Results by Time
Aug 17 2006 Thu	www.pauleattar.com Daniel Avrahami's thesis proposal	Daniel Avrahami's thesis proposal
Wed	www.uscg.mil	avrahami
Tue	Strategy Conference Pre-Topic Mtg #1 - Computer Science Education	
Mon	Commitments 2006.doc 317615 Review.doc	
Sun	lead_tseng.doc	
Sat		
July 14 2006 Thu	ai50_chall_cut.ppt ai50_chall_new.ppt www.vnews.com	



(video)

Enabling Creative Expression

- Enabling guidance of painting, CAD, sculpting machinery, lathes, other artistry and crafts.

"These days, with only her eye movement unaffected by the disease, Peggy continues to live a full and creative life, enjoying time and laughter with her beloved friends, family, and caregivers."

Longer-Term: Assistive Robotics

- Assistance and action at a distance
- Exoskeletal components
  - Wearable exoskeletons

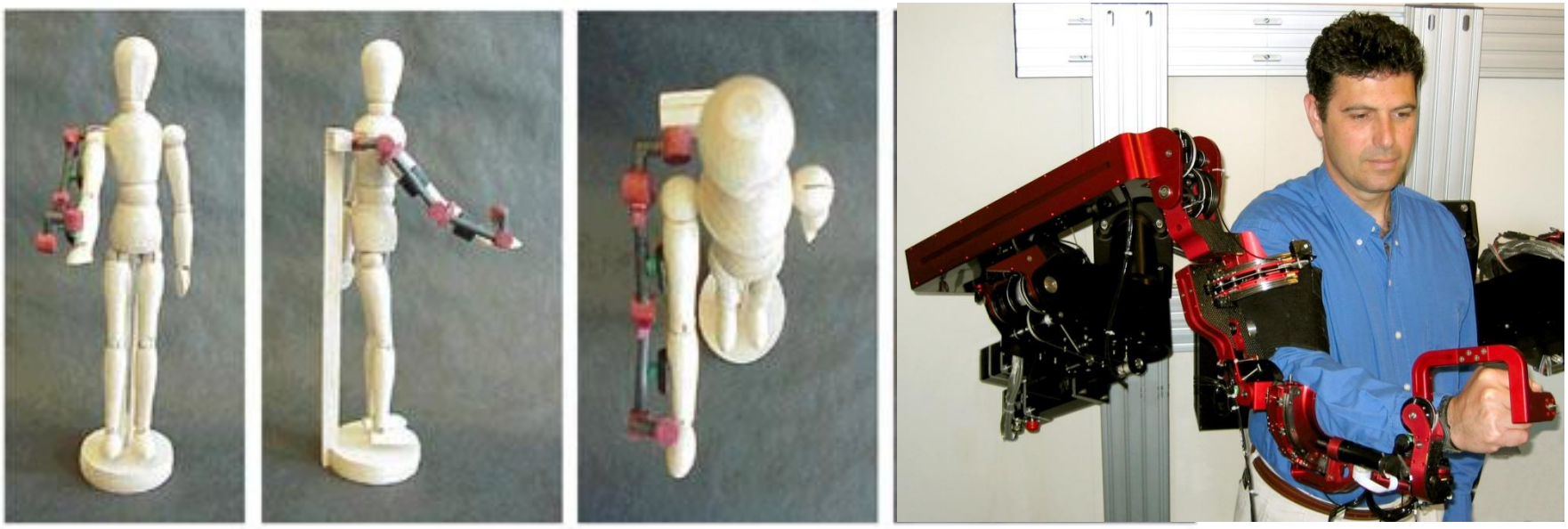
    e.g., Dynamic neck brace

Longer-Term: Assistive Robotics

- Assistance and action at a distance
- Exoskeletal components
  - Wearable exoskeletons

    e.g., Dynamic neck brace guided by gaze

    (Goal: enable support, natural turning, nodding, etc.)



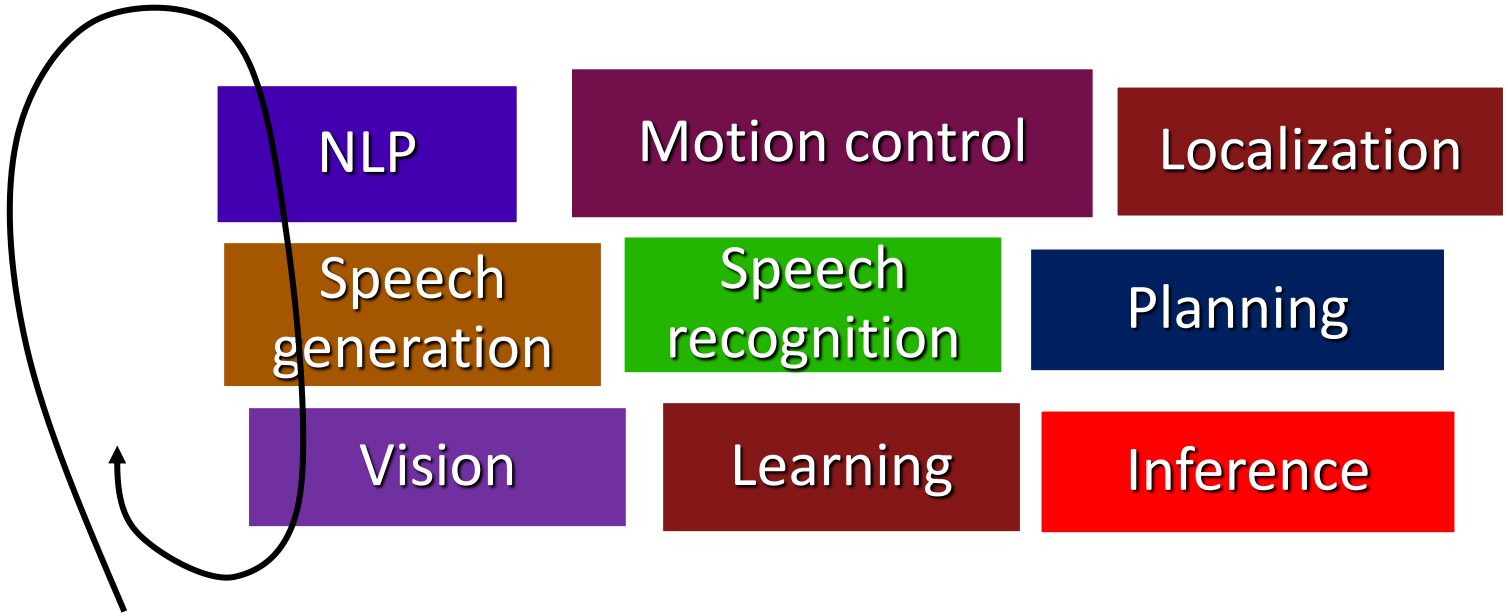
J. Rosen, *et al*

Longer-Term: Assistive Robotics

- Advances in multiple arenas
- Could enable assistance for patients and caretakers

Progress on "Integrative Intelligence"

- Richer dreams of fluid interaction
- Leveraging a tapestry of components



Advances: Gentle Robots in "Open Worlds"

- Ongoing learning to generalize and adapt

(video)

Klingbeil, Saxena, Ng, *et al*

Advances: Gentle Robots in "Open Worlds"

wide-angle camera

4-element microphone array

touch screen

card reader

speakers

Speech Synthesis

Avatar Synthesis

Speech Recognition

Tracker

Output Management

Conversational Scene Analysis

Behavioral control

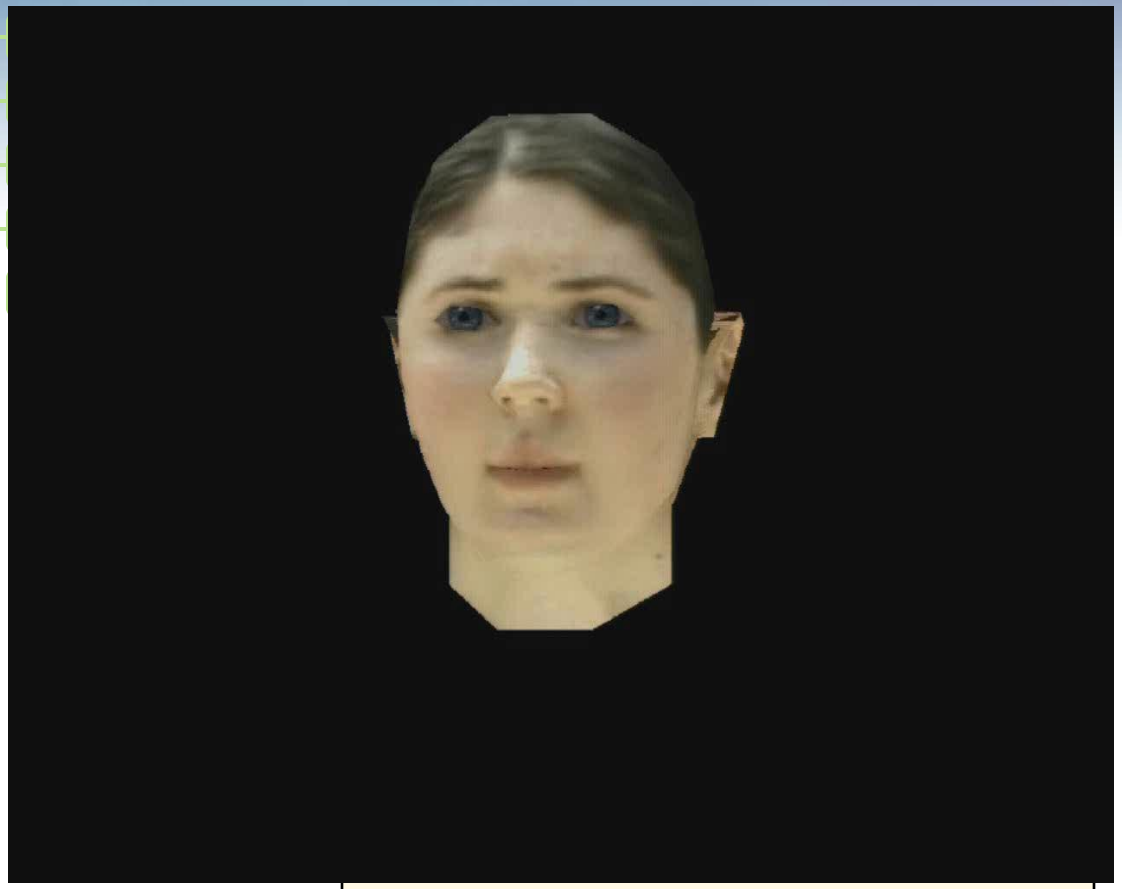
Dialog management & Interaction Planning

Models of user frustration, task time

Machine learning about interaction

Situated Intelligence: Bohus, Horvitz, *et al.*

Advances: Gentle Robots in "Open Worlds"



Dialog management &
Interaction Planning

Models of user frustration, task time

Machine learning about interaction

Situated Intelligence: Bohus, Horvitz, *et al.*

Summary

Toward creative application of interaction, intelligence, robotics, content to enhance the quality of life at all phases of progression.