Mixed Initiative Interaction

MPhil ACS module R230 - Alan Blackwell

What is Mixed Initiative?

A classic example of mixed initiative – predictive text

- Demo with discussion: Dasher

Principles of Mixed-Initiative User Interfaces

- Classic paper by Eric Horvitz:
  - Principles of mixed-initiative user interfaces.
  - In proceedings CHI 1999, pp. 159-166.
- Advocates elegant coupling of
  automated services with *direct manipulation*
- Autonomous actions should be taken only when an agent believes that they will have greater expected value than inaction for the user.

How to add value with automation

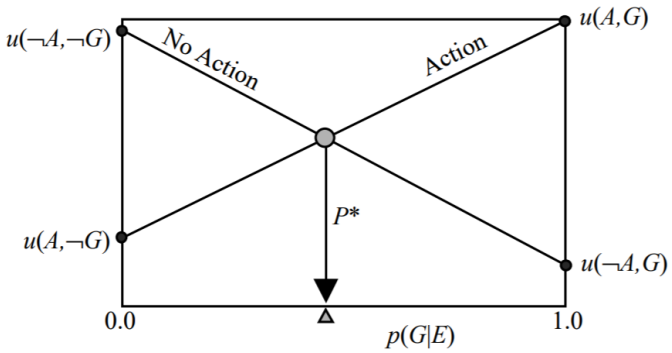
- Consider uncertainty about user's goals
- Consider status of user's attention in timing services
  - with cost/benefit of deferring action to a time when action will be less distracting.
- Infer ideal action in light of costs, benefits, and uncertainties
- Employ dialog to resolve key uncertainties
  - consider costs of bothering user needlessly
- Allow efficient direct invocation and termination
- Minimise cost of poor guesses about action and timing

Expected utility of automated action

- assume an agent can infer p(G|E)
  - likelihood of the user's goal
  - given observed evidence

	Desired Goal	Not Desired
Action	$u(A, G)$	$u(A, \neg G)$
No Action	$u(\neg A, G)$	$u(\neg A, \neg G)$

Expected utility threshold for action



A probabilistic view of user interaction

- Machine:
  - I know how to do several things.
  - I wonder which one the user wants me to do?
- User:
  - This machine can do a whole bunch of stuff.
  - What is most likely to make it do the right stuff?
- Machine:
  - I think the user has made a mistake
- User:
  - I think the machine has made a mistake

Bayes theorem (for Bayesian inference)

Posterior probability of **H**ypothesis *after* taking new **E**vidence into account

Prior inferred probability of this **H**ypothesis *before* new **E**vidence became available.

If Hypothesis is true, how *likely* is it that we would see this Evidence?

$$P(H|E) = \frac{P(E|H)}{P(E)} P(H)$$

What is the probability of seeing E, under all possible hypotheses?

H: Hypothesis
E: Evidence

Bayesian inference inference of user intention

Probability that user wants to delete all files, given that they just typed 'rm –rf'

(Prior) probability that user wanted to delete all files *before* we saw this.

If user does want to delete all files, how *likely* is it that they would type 'rm –rf'?

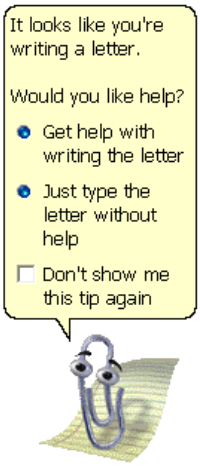
$$P(D|R) = \frac{P(R|D)}{P(R)} P(D)$$

What is the probability user would type 'rm –rf', under all possible hypotheses?

D: User wants to **D**elete all their files
R: User has typed '**r**m –rf'

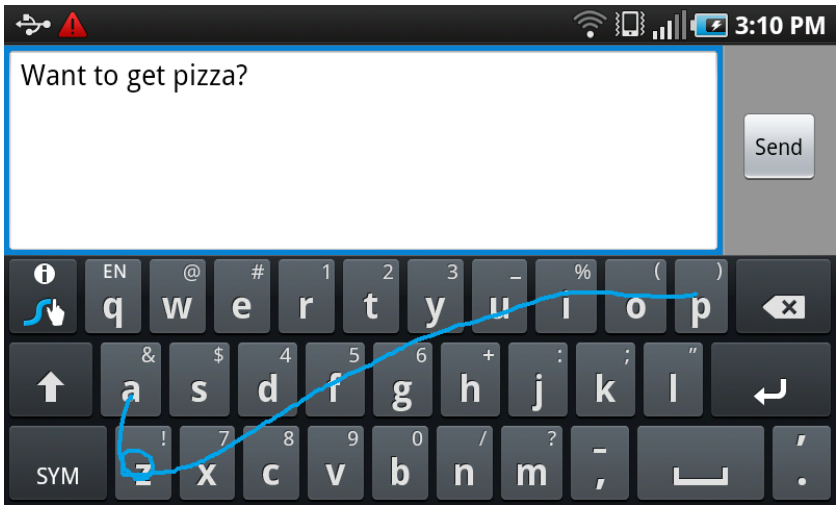
Another classic example of mixed initiative

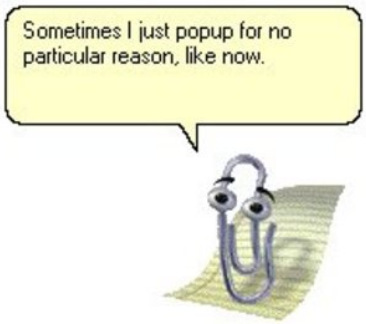
- https://www.youtube.com/watch?v=0ej4tVV7hLkE



Unobtrusive direct manipulation strategy: semantic pointing

Unobtrusive direct manipulation strategy: gesture keyboard



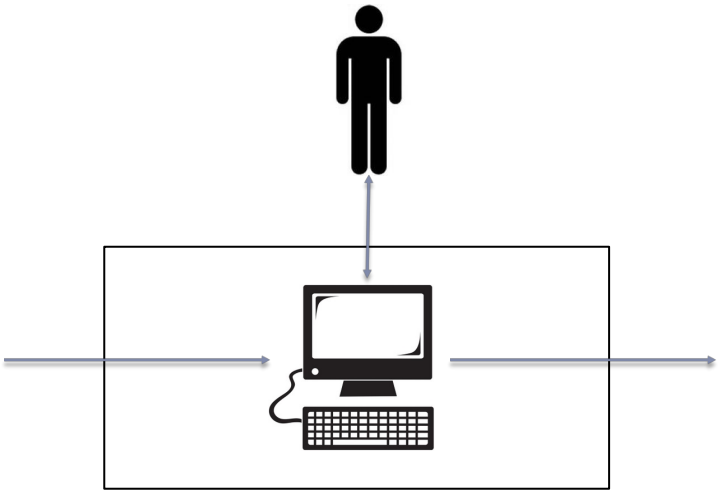


Information flow and mixed initiative

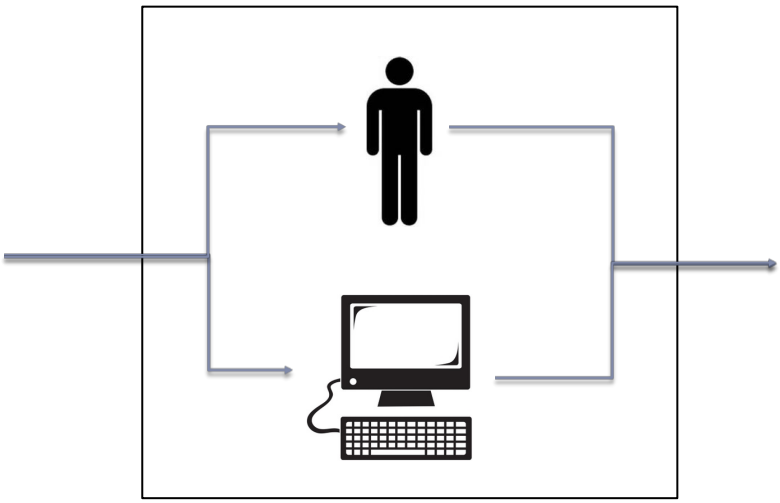
System boundaries – autonomous vehicle case

- Where does information enter the system?
  - User defines setpoint ("cruise control")
  - Supplier offers features ("active braking")
  - Regulator defines policy ("following distance")
  - Government provides infrastructure ("lane markings")
- Notes:
  - Even if the system includes "autonomous" closed loop control algorithms, information is acquired through more or less costly interactive processes outside the system boundary.
  - All closed loop control systems do machine learning (reacting to error signal, tuning gain and stability etc), but as interaction with such systems becomes routine, these *cybernetic* components are no longer considered intelligent.

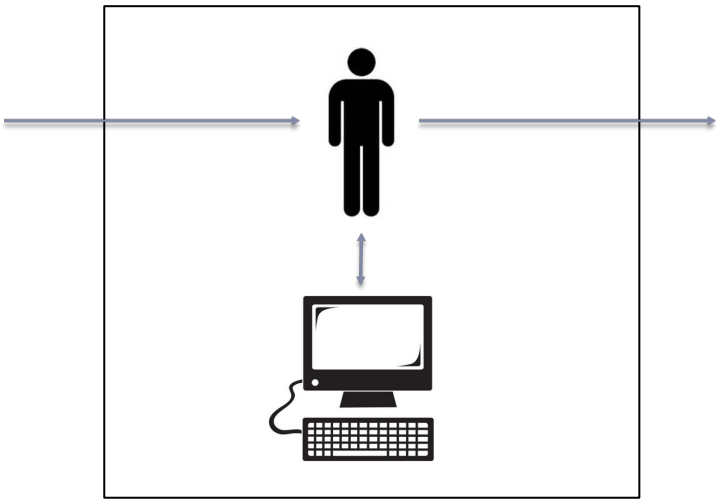
Conventional system design



Hybrid system design



Human-centric system design



Studying Agency and Control

The ***experience of agency*** is defined as:

- *The experience of controlling one's own actions and, through this control, affecting the external world.*
- It is the experience of ourselves as agents that allows us to instinctively say:

"I did that"

Haggard, P. & Tsakiris, M., *The Experience of Agency: Feelings, Judgments, and Responsibility.* Current Directions in Psychological Science, 2009.

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Fact vs. the experience of agency

- Passivity phenomena in schizophrenia
  - People feel that their actions - and sometimes their thoughts and emotions - are not under their own control. Rather they are under the control of some external force or agent.
- Mellor reports on a patient with schizophrenia saying:

"It is my hand and arm that move, and my fingers pick up the pen, but I don't control them."

Mellor, C.S., First rank symptoms of schizophrenia. Br J Psychiatry, 1970.

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Golden rules of HCI

Rule no. 7: **"Support an internal locus of control"**

This rule is based on the observation that:

"*Users strongly desire the sense that they are in charge of the system and that the system responds to their actions.*"

Shneiderman, B. & Plaisant, C. 2009
Designing the User Interface: Strategies for Effective Human-Computer Interaction.

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Developing a research agenda

- An implicit metric to measure peoples' experience of agency.
- Two experiments that apply this metric in HCI contexts.

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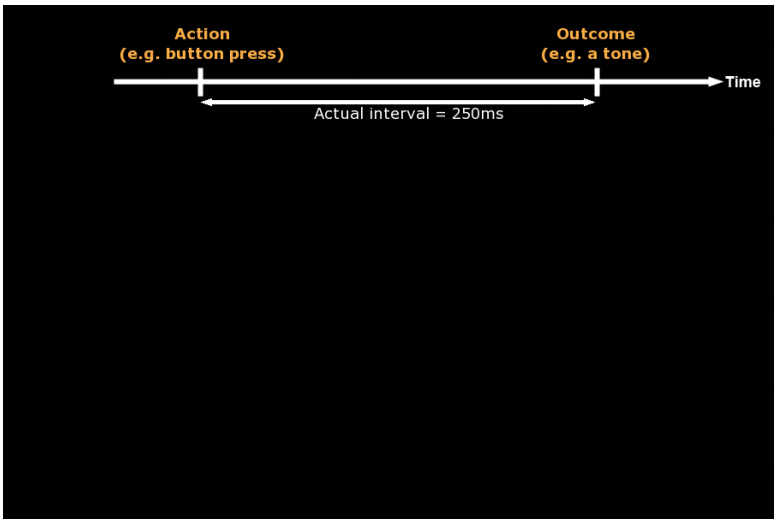
Intentional binding



Haggard, P. & Tsakiris, M., *The Experience of Agency: Feelings, Judgments, and Responsibility.* Curr Dir Psychol Sci, 2009, 18(4) p.242-46.

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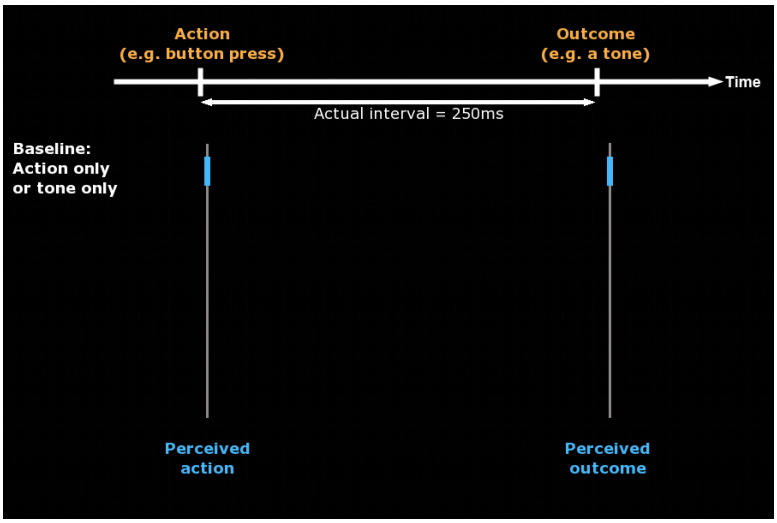
Intentional binding



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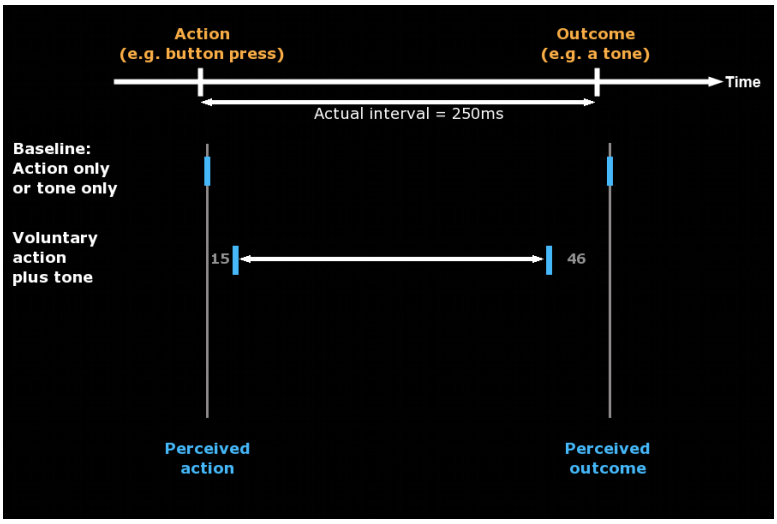
Intentional binding



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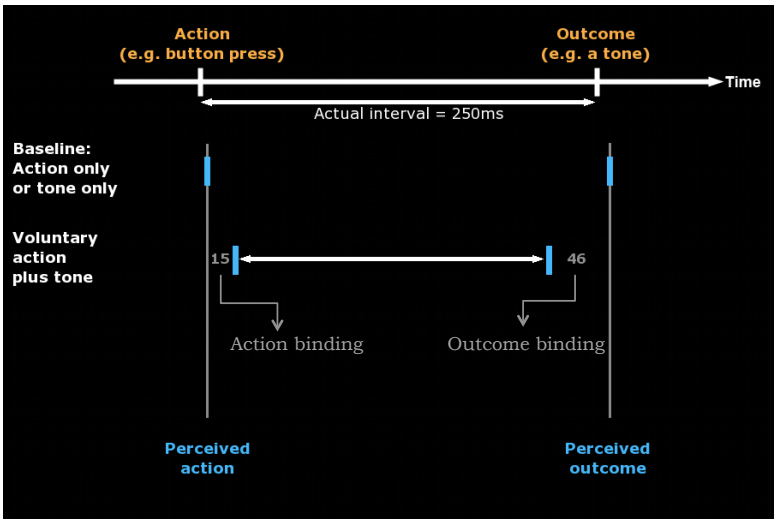

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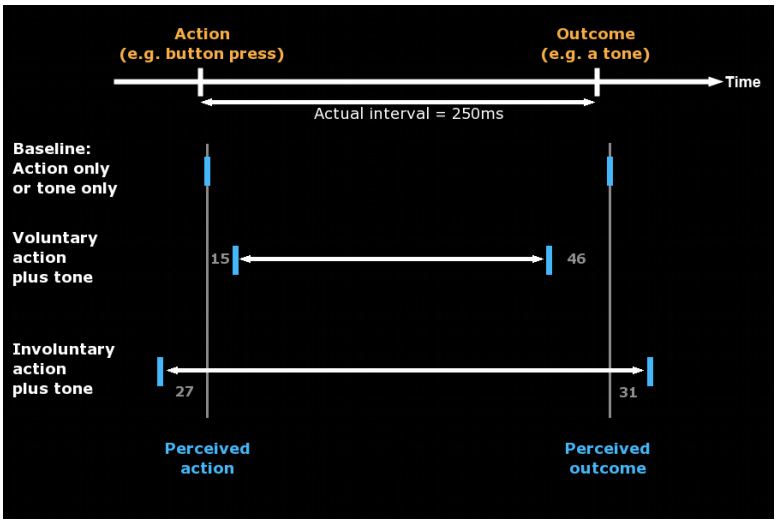

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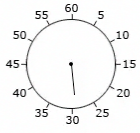
The Libet clock method



- Approx. 100px in diameter.
- Shown at the centre of screen.
- Arm rotates once every 2560ms.

Strengths:

- Provides robust measures.
- Detailed breakdown of where binding occurs.

Weaknesses:

- Not suitable for visual tasks.
- Time consuming: 4 blocks of trials per condition.

Interval estimation

Participants estimate the time between their action and an outcome.

Strengths:

- Suitable for visual tasks.
- Less time consuming:
  1 block of trials per condition.

Weaknesses:

- Less robust measure.
- No breakdown of where binding occurs.

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An experimental manipulation

- Skinput: appropriating the body as an input surface.
  - Harrison, Tan, & Morris. CHI 2010.

Images: © Chris Harrison

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Experiment 1

What's it like to be a button?

Do changes in the input modality of an action have an impact on the sense of agency?

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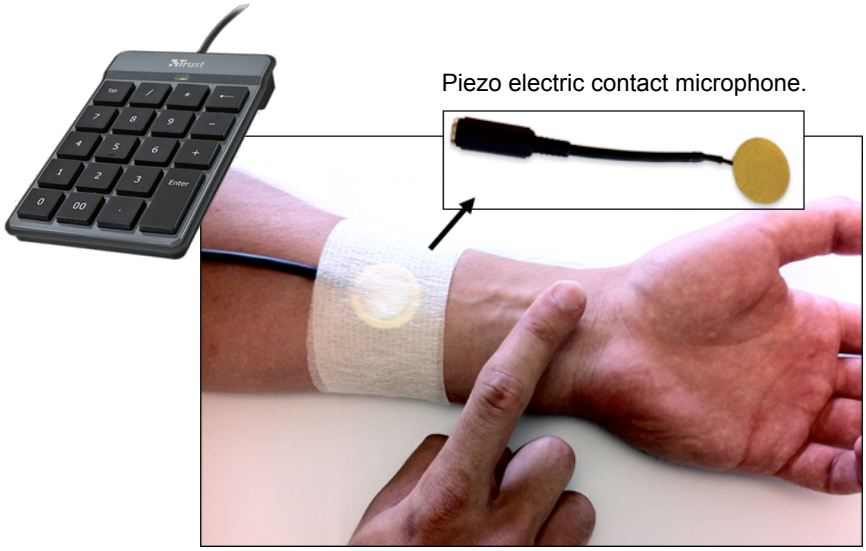
Two input conditions: button and skin-based input.



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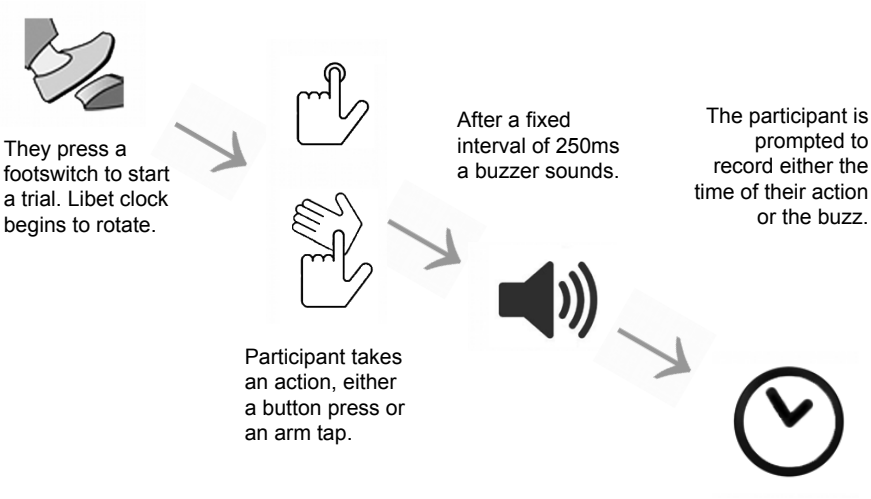
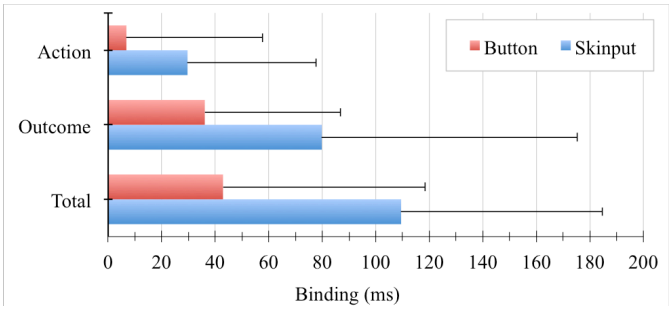
Procedure



Results

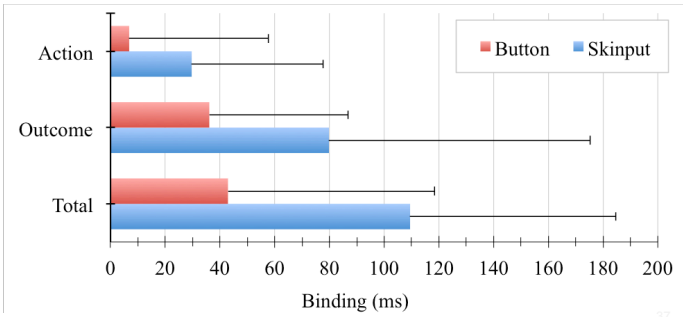
	Action binding	Outcome binding	Total binding
Button	6.81ms (45.6ms)	36.11ms (45.46ms)	42.92ms (67.43ms)
Skin-based	29.66ms (42.84ms)	79.82ms (91.23ms)	109.47ms (74.54ms)



t(18) = 4.05, p<0.01

Observations

- Yes, changes in the input modality can have an impact on the experience of agency.
  - Intention binding is a useful metric for design research:
  - It can be used it to compare and refine input techniques.
  - Compare experiences for a given input technique when other conditions of the interactions change.
- A question
  - Why is binding higher in the skin-based condition?



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Experiment 2

Intelligent interfaces:

What happens when a computer helps out?

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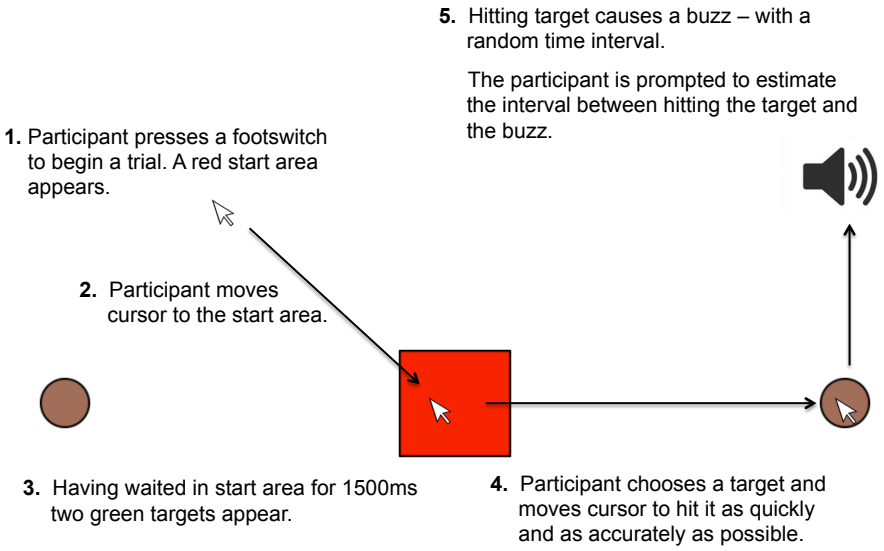
Procedure



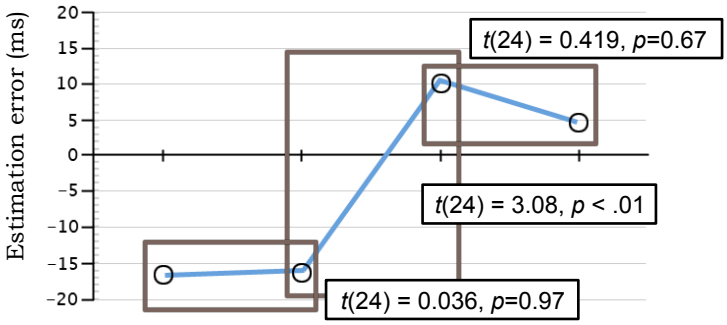
Experiment design

- Treatment: the assistance algorithm has the effect of adding "gravity" to targets.
  - Four levels of assistance: none, mild, medium, high.
- Within subject design, with:
  - 1 block if trials for each assistance level
  - 36 trials per block.
  - 24 participants.
- The order of the assistance level blocks was counter-balanced across participants.

Results

	No assistance	Mild assistance	Medium assistance	High assistance
Estimation error	-16.78ms (70.70ms)	-16.32ms (82.03ms)	9.93ms (85.92ms)	4.53ms (79.12ms)

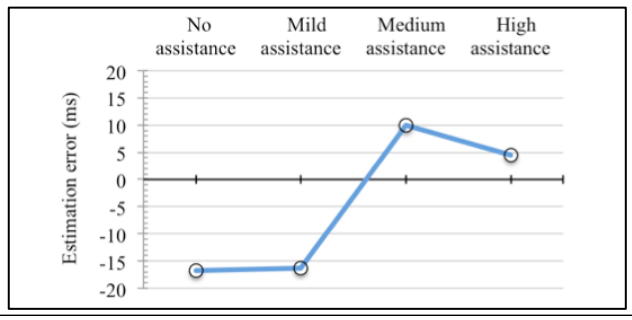
Greater sense of agency



Repeat measure ANOVA: $F(3,69) = 2.74$, $p=0.05$

Observations

- Up to a point, the computer gave assistance, but people retain a sense of agency.
- Beyond a certain point people experience a loss in sense of agency.
- This technique could provide an experimental means of mapping the personal agency characteristics of intelligent input techniques.



Overall conclusions

- Changes in the input modality and in levels of assistance can have a significant impact on users' experience of personal agency.
- Intentional binding can provide an implicit metric for probing and mapping experiences of agency.
- This metric can be applied is a wide range of design contexts. E.g.:
  - Comparison and refinement of different interfaces and assistance techniques.
  - Investigating the impact of uncertainty or different types of feedback.
  - Comparisons of user groups, e.g. different age groups, people experiencing mental health difficulties.

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Design for control

Case Study: Coda

- Mixed initiative interface being created for Africa's Voices Foundation
  - http://www.africasvoices.org/ideas/newsblog/introducing-our-latest-analysis-tool-coda/

- Recently completed PhD by Christine Yu Guo explored effects of shared rhythm when using this style of interface

Coda (work in progress)