In Search of Touch-Typing Touchscreen Keyboards

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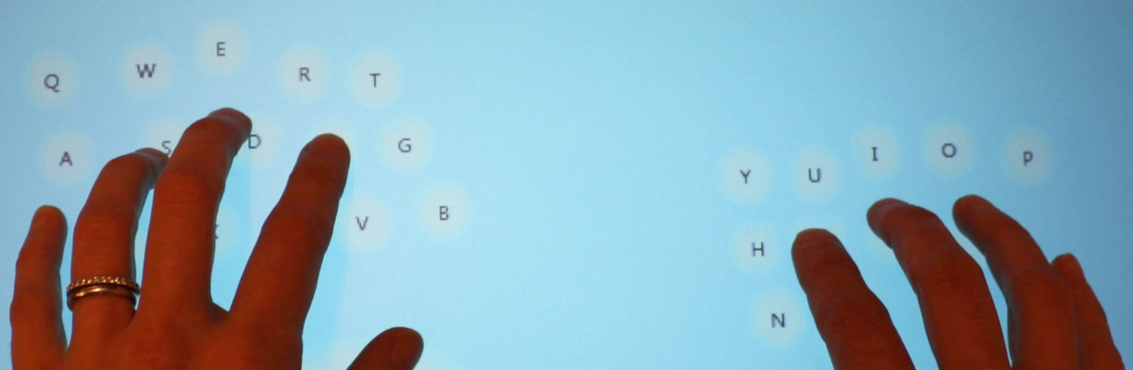
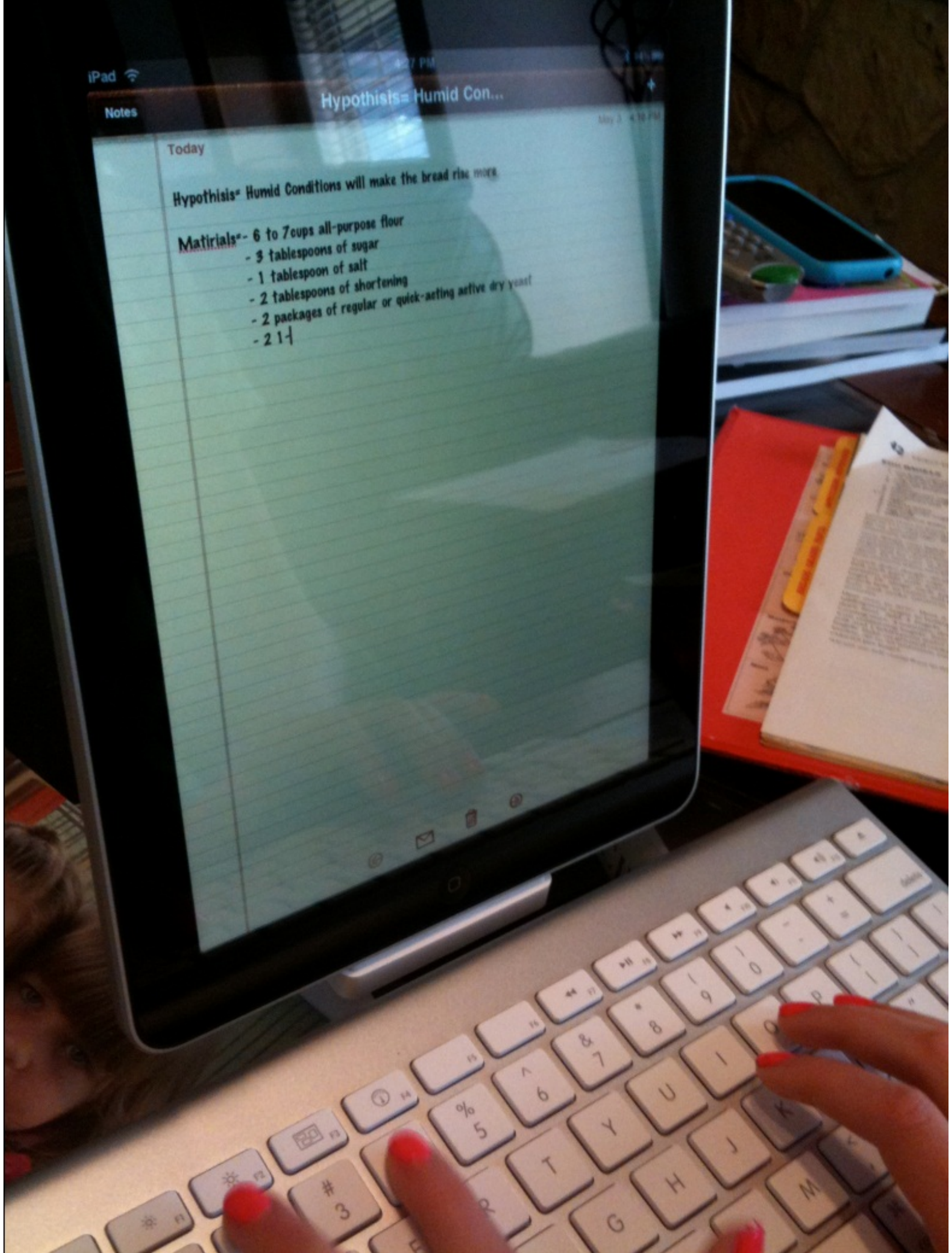


Who here can type faster on an iPad than a laptop?

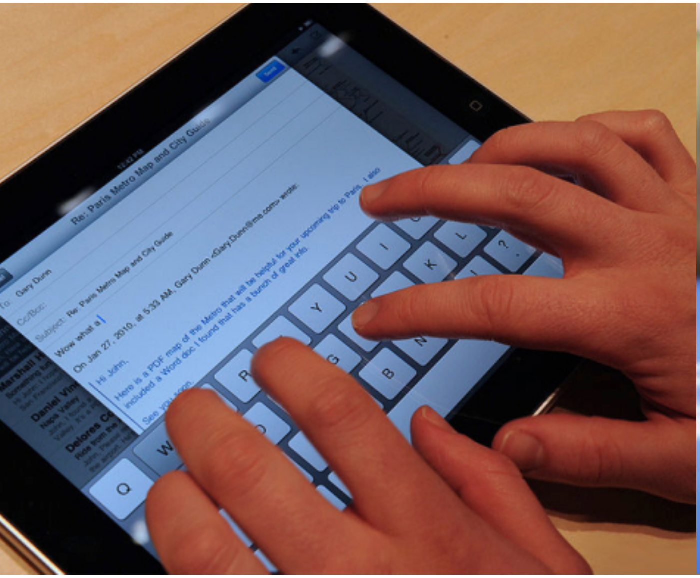


[Apple keyboard]

[ikeyboard]

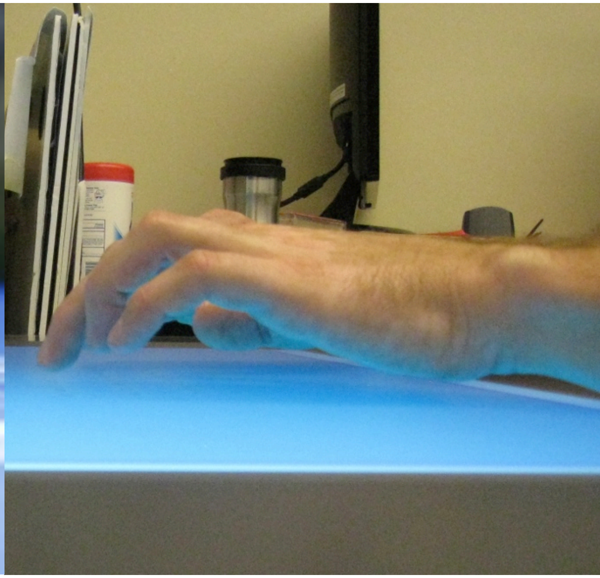
Touchscreen Typing Challenges

reduced tactile cues



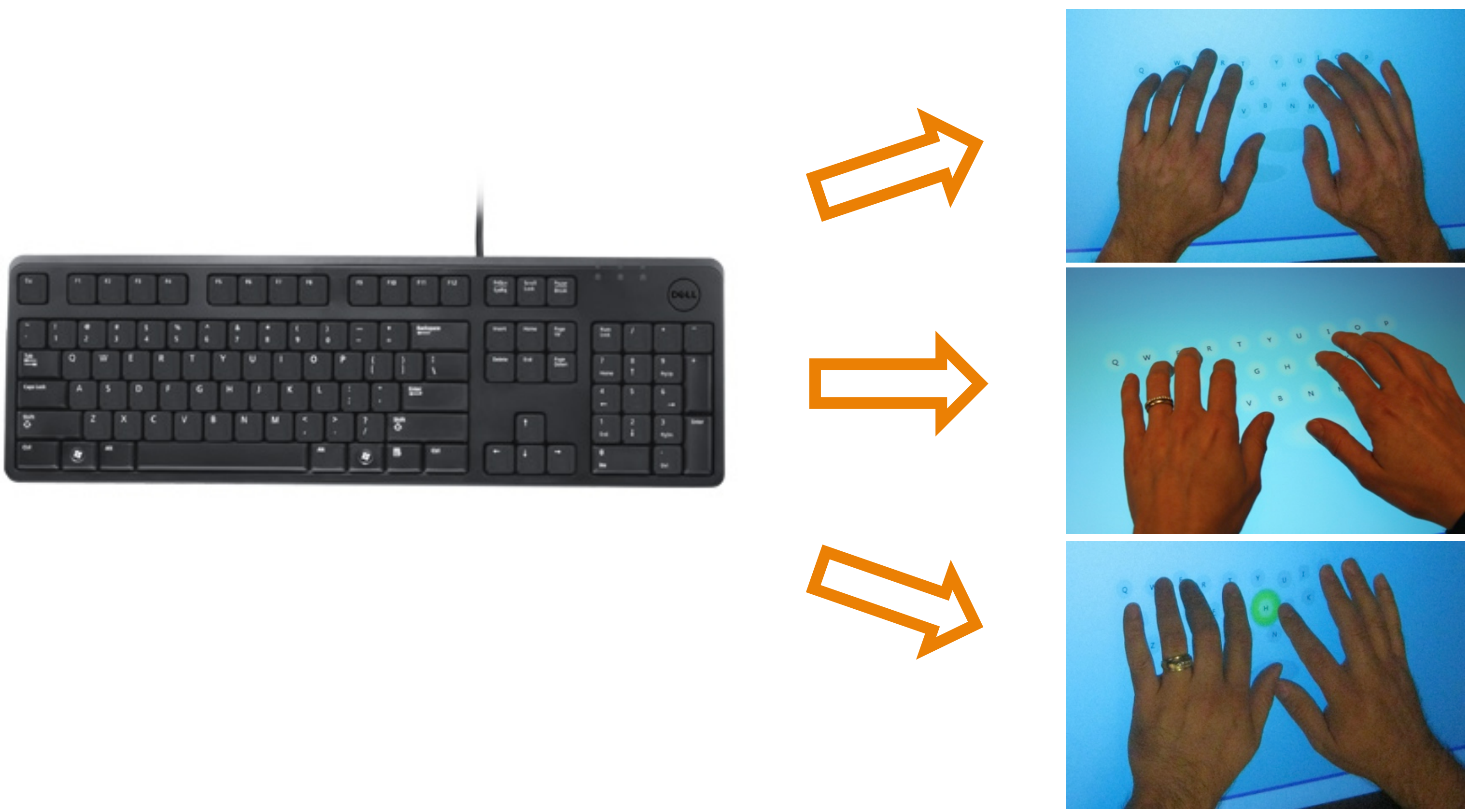
no travel distance

unintended input



Advantage: Software-based

Keyboard layout can **dynamically adapt** to each user



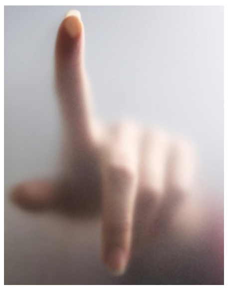
Can touchscreen text input be improved through **automatic personalization**?

Adaptation Using Language Models

This is not necessarily *personalization*

http://www.flickr.com/photos/horiavarlan/4268897748

Adaptation Using Language Models



touch model
+
language model

Combine the two sources to adjust letter probabilities [Goodman et al. 2002]

http://www.flickr.com/photos/horiavarlan/4268897748

personalized

OUR ADAPTIVE KEYBOARDS

Dimensions of adaptation

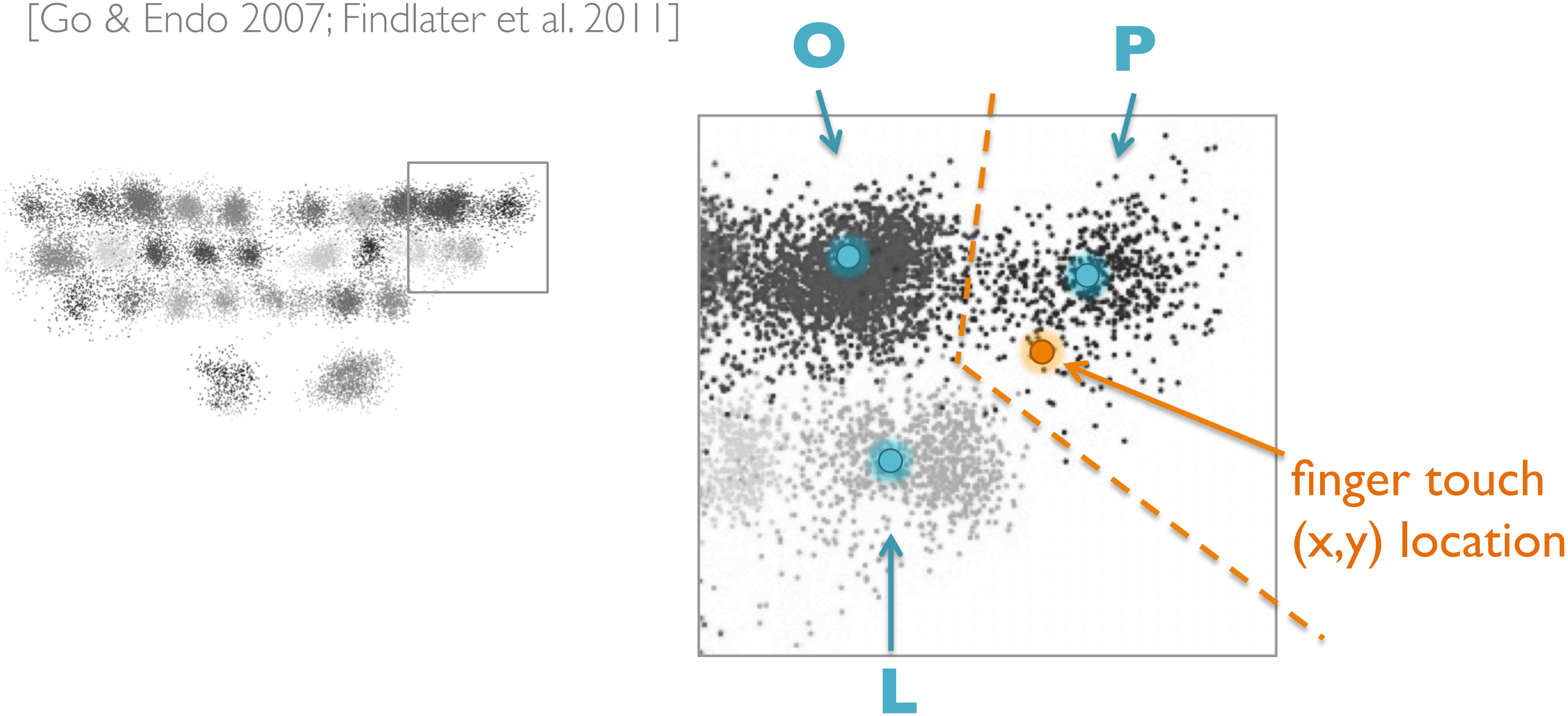
- Key-press classification model
- Visual representation
- Adaptation to location of hands

DIMENSION 1

Key-Press Classification Model

Previous work on ten-finger typing used **distance-to-centroid**

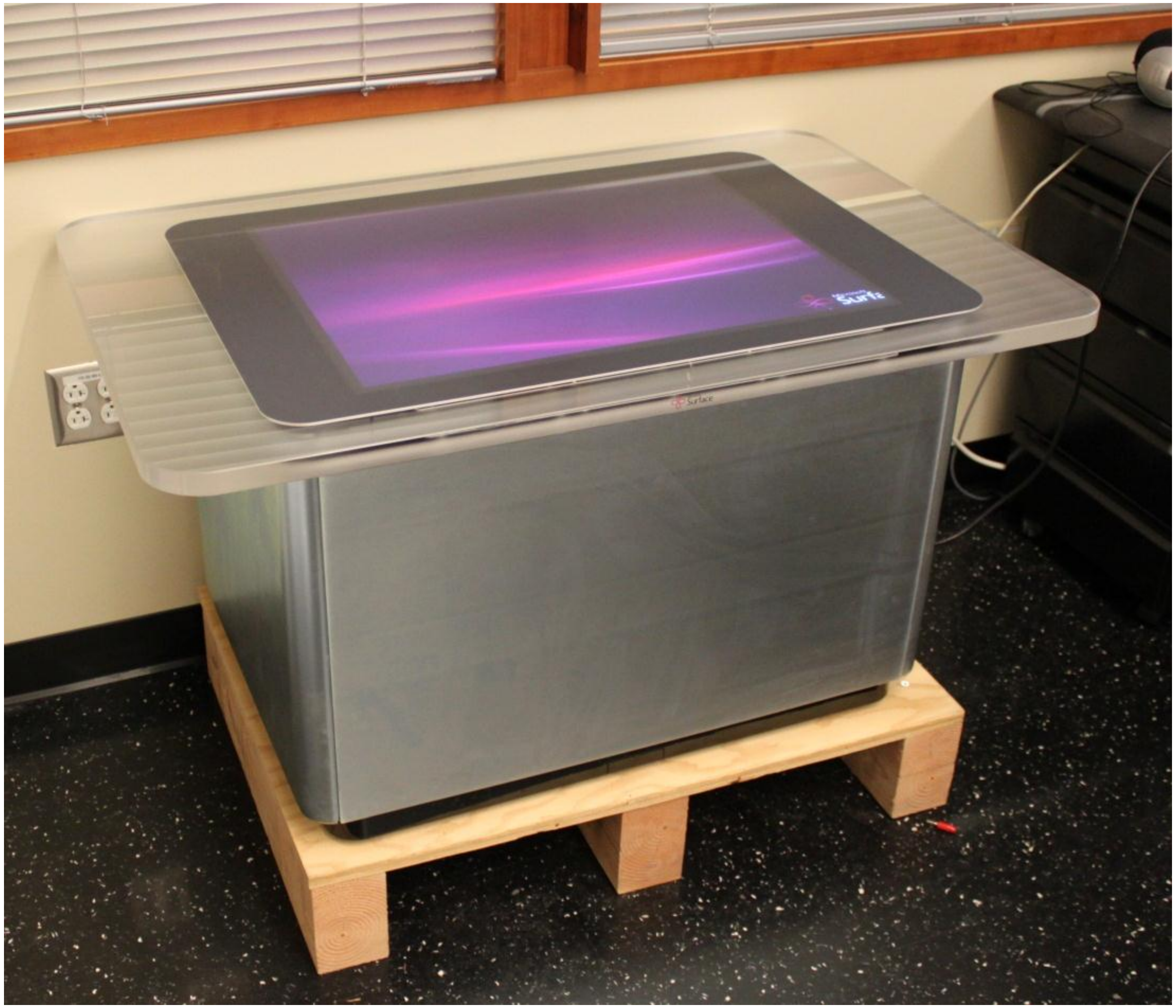
[Go & Endo 2007; Findlater et al. 2011]



Can we do better?

DIMENSION 1: KEY-PRESS CLASSIFICATION MODEL

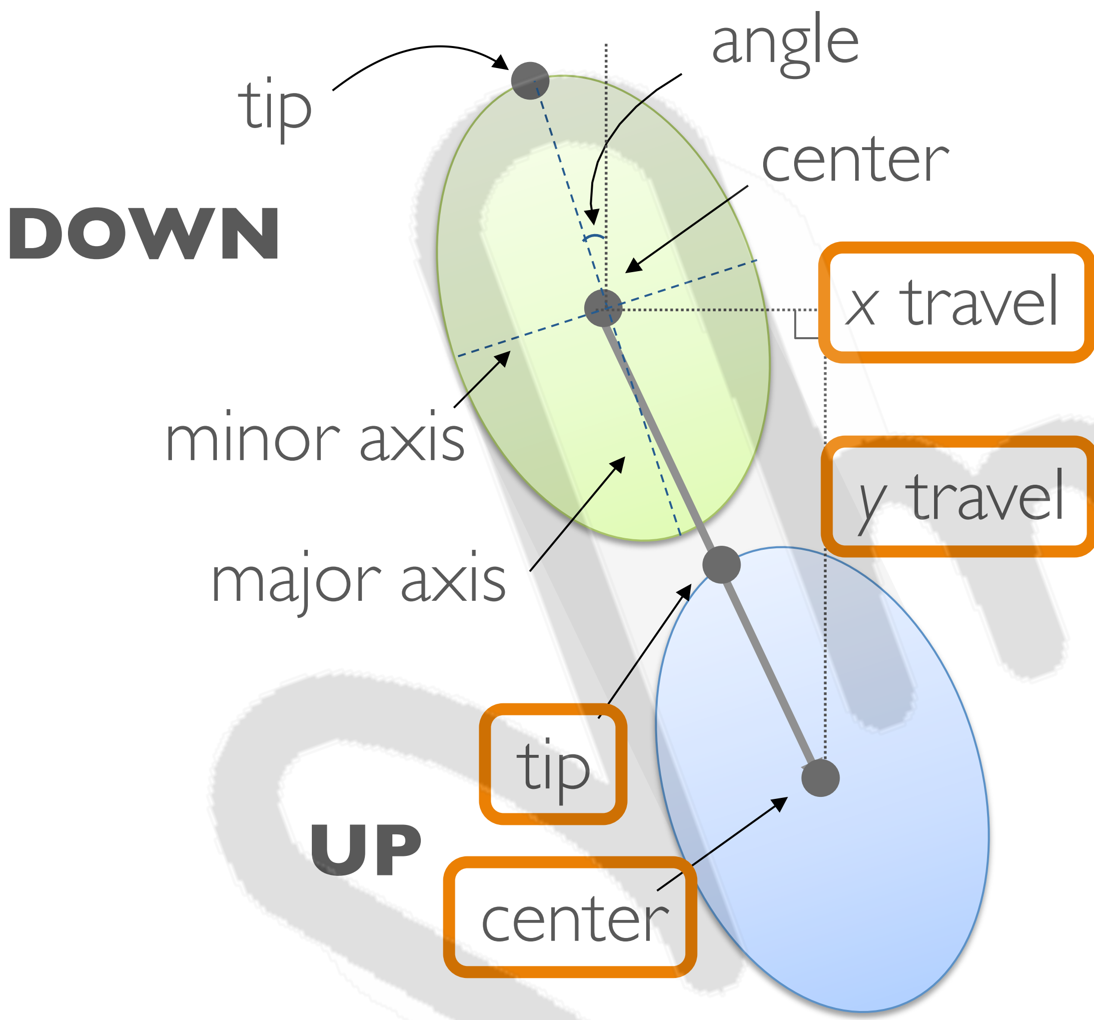
Touch Features Beyond (x,y)



Microsoft Surface

DIMENSION 1: KEY-PRESS CLASSIFICATION MODEL

Touch Features Beyond (x,y)



Other features
Location
Area
Movement
Previous touch
Hand & arm

J48 decision tree classifier

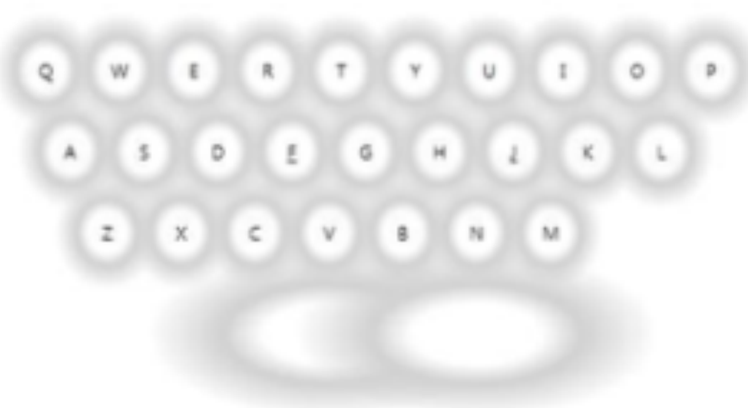
DIMENSION 2

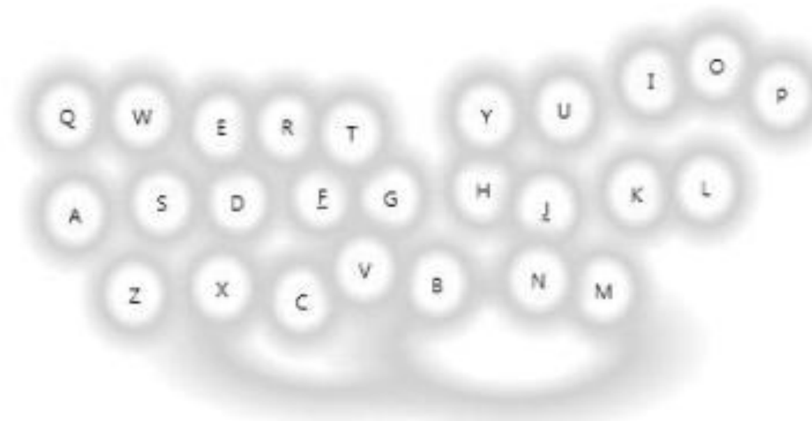
Visual Representation

Adapt underlying model, but retain static visual layout.

vs.

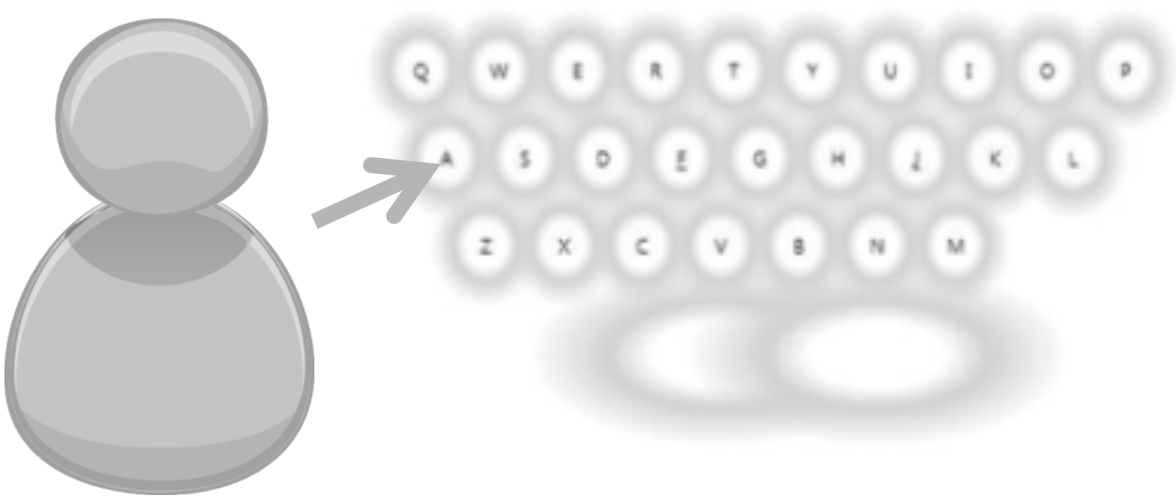
Adapt model <u>and</u> visual representation.



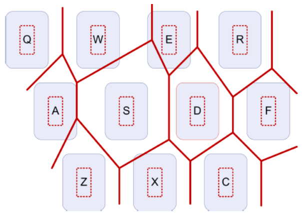


Challenges with adaptive user interfaces:
e.g., predictability

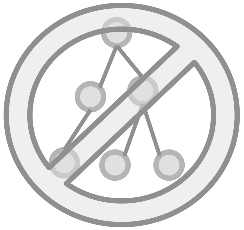
Predictability of "Aimed" Key Presses



Is the output **predictable**?



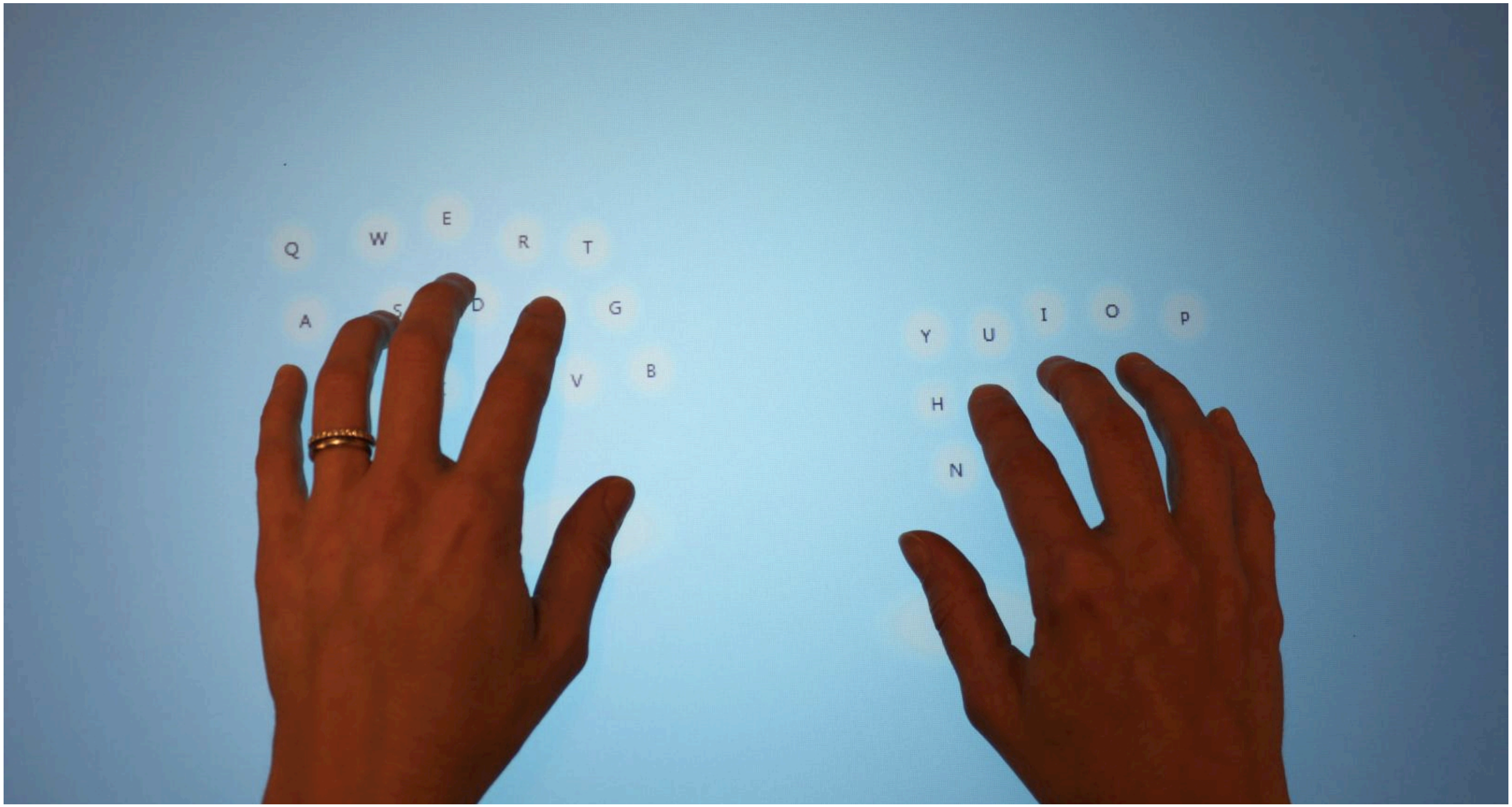
One approach: Use center anchors [Gunawardana et al. 2010]



Our approach: Disable classifier after a backspace or when typing slower than 1 keystroke / second

DIMENSION 3

Adapting to Location of Hands



Online Adaptation Process

1

Start state

2

Adapt key-press classification model as user types

After 10+ strikes per key

History per key: 100 strikes

3

Optionally, adapt visual layout

STUDY METHOD

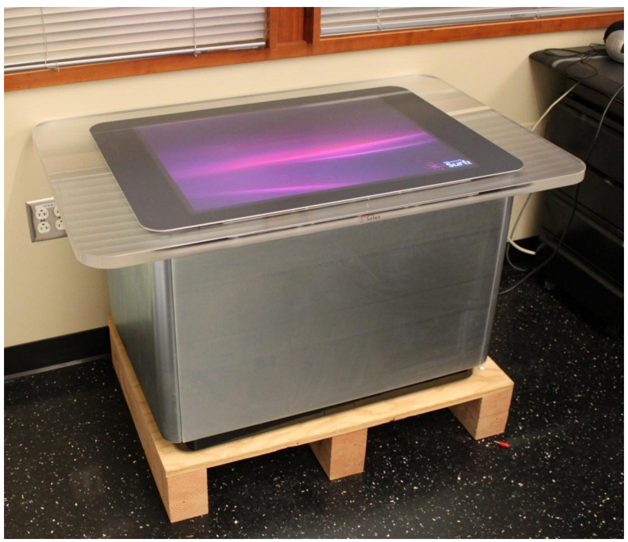
Do the personalized keyboards improve performance and subjective experience compared to a conventional keyboard?

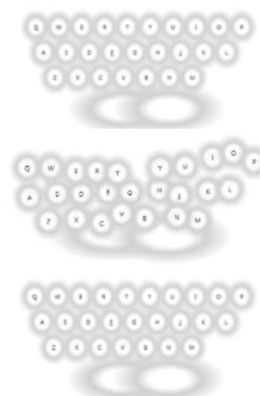
How does non-visual adaptation compare to visual adaptation?

Controlled lab study

Controlled lab study

Three keyboard conditions





- Adaptive, non-visual
- Adaptive, visual
- Conventional (static)

Controlled lab study

Three keyboard conditions

Three 1.5-hour sessions per participant

3 x 3 within-subjects factorial design

Controlled lab study

Three keyboard conditions

Three 1.5-hour sessions per participant

Twelve participants

Touch-typists on physical keyboards

79.2 WPM (SD = 16.6)

0.2% (SD = 0.2) uncorrected errors

All had experience with touch devices

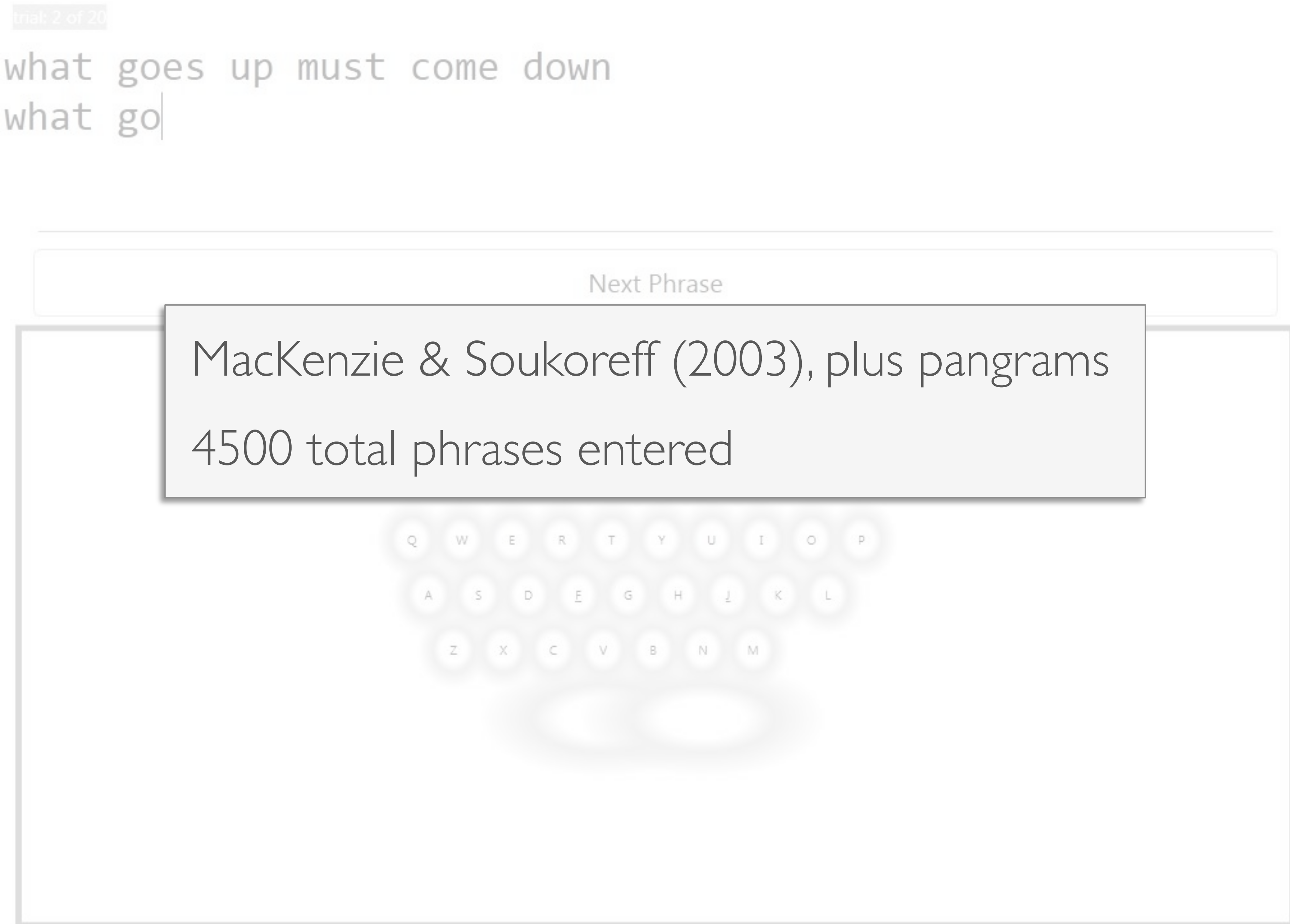
Controlled lab study

Three keyboard conditions

Three 1.5-hour sessions per participant

Twelve participants

Phrase transcription task



MacKenzie & Soukoreff (2003), plus pangrams

4500 total phrases entered

Controlled lab study

Three keyboard conditions

Three 1.5-hour sessions per participant

Twelve participants

Phrase transcription task

Controlled lab study

Three keyboard conditions

Three 1.5-hour sessions per participant

Twelve participants

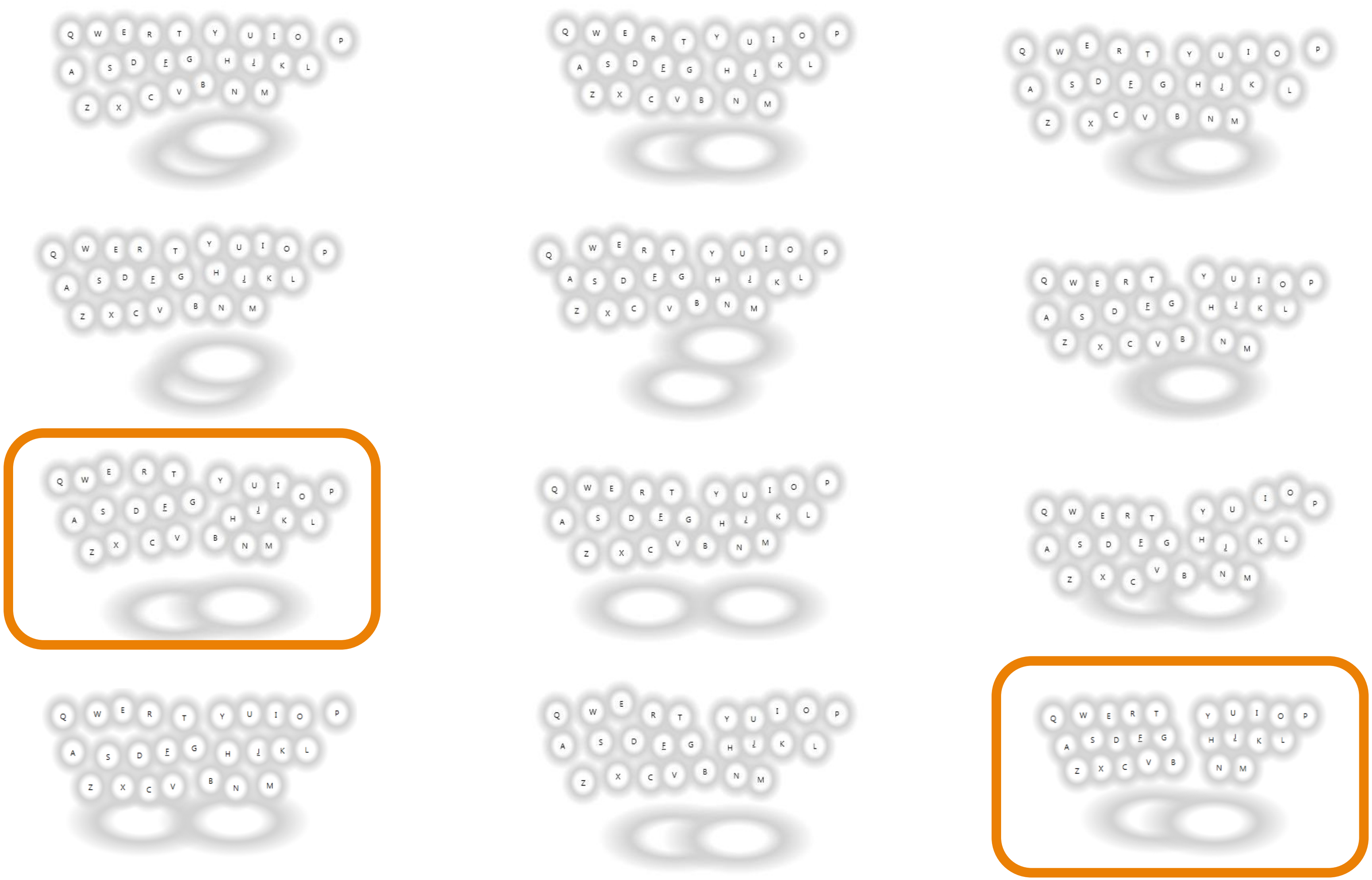
Phrase transcription task

Instructions

Participants were not told which keyboards were adaptive, only that the keyboards may or may not adapt based on their typing patterns

RESULTS

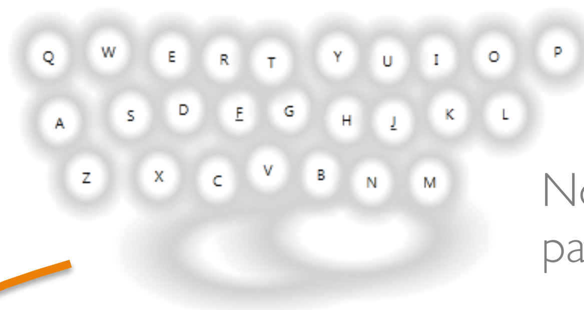
Layouts for Adaptive, Visual



Adaptive, Non-Visual (e.g., P7)

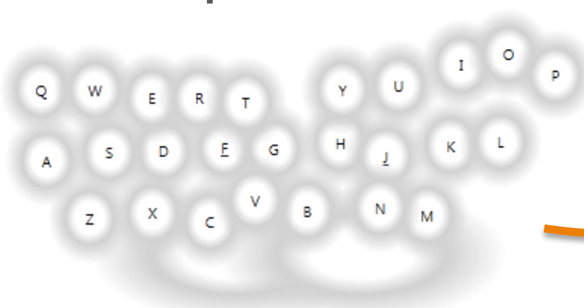
Shown to participant

Underlying adaptation



Not shown to participants

Adaptive, visual

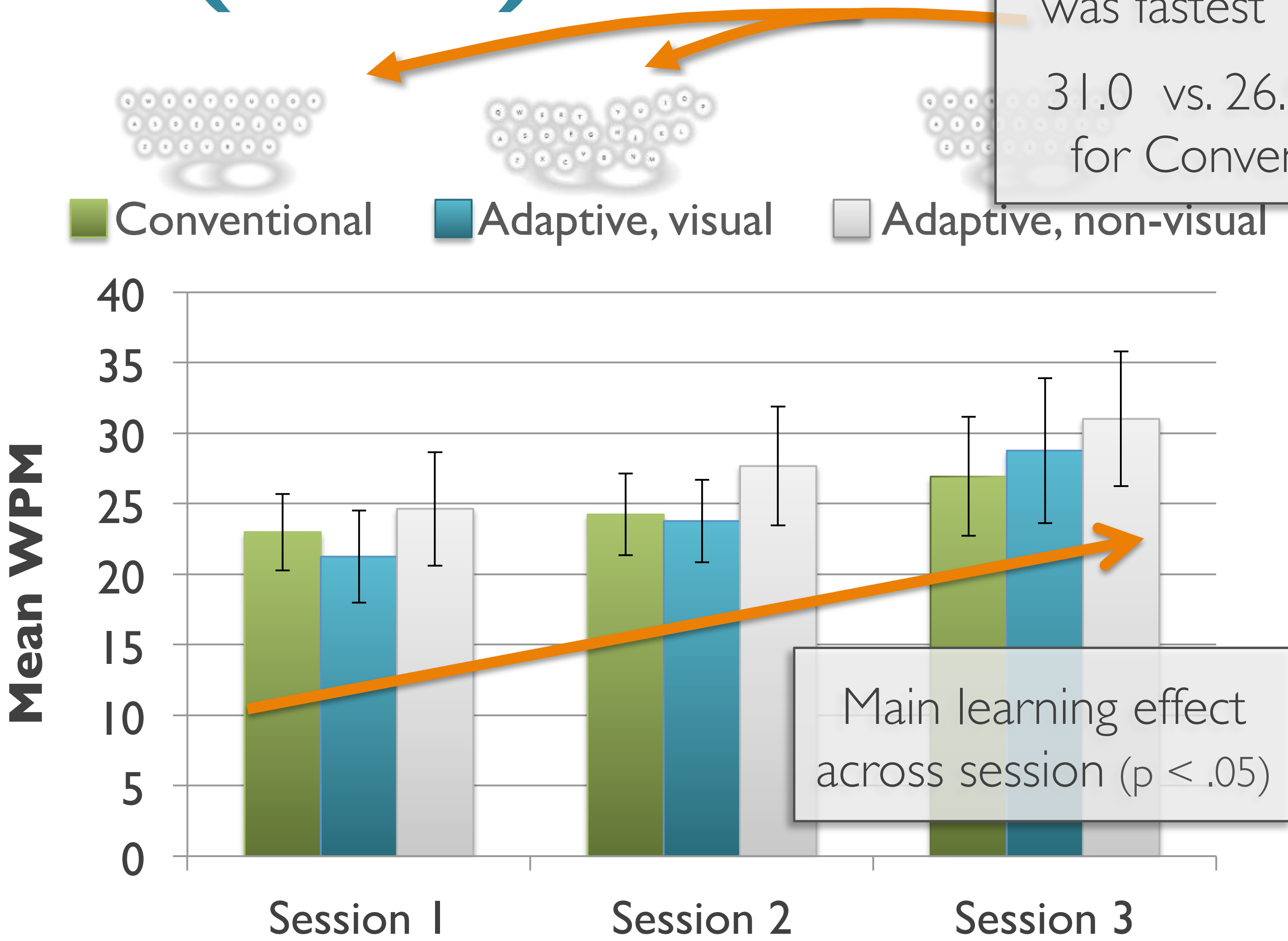


More adaptation with visual portrayal

Speed (WPM)

Adaptive, non-visual was fastest ($p < .05$)

31.0 vs. 26.9 WPM for Conventional

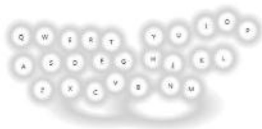


(Uncorrected error rates near 0%)

Error bars: 95% confidence intervals

Comments at End of Session 3

Adaptive, Visual

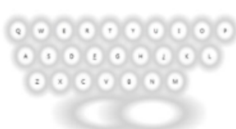


8/12 participants remarked negatively on the visual adaptation

"I felt I was constantly looking at my hands." (P8)

"[Adaptive, visual] seemed easiest this time—as long as I didn't look and see the odd spacing." (P9 after session 3)

Adaptive, Non-Visual



Most participants preferred this keyboard but generally had trouble defining how it was different from Conventional

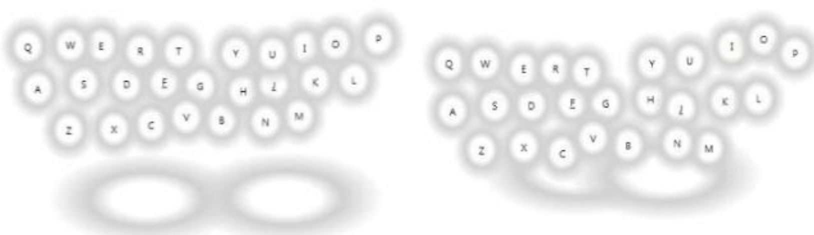
Summary

1 Adapt underlying model, but not visually…

Improved typing speed over the conventional and visually adaptive keyboards

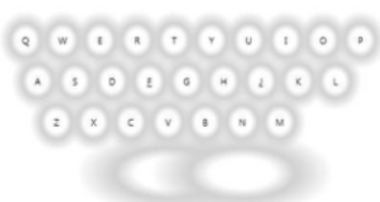
Subjectively offered good performance but **participants couldn't tell why**

2 …versus adapt model & visual



Seemed to require **more visual attention**, but perceived to be comfortable and natural to use

3 Conventional keyboard (not adaptive)



A personalized key-press classification model improves ten-finger touchscreen typing performance

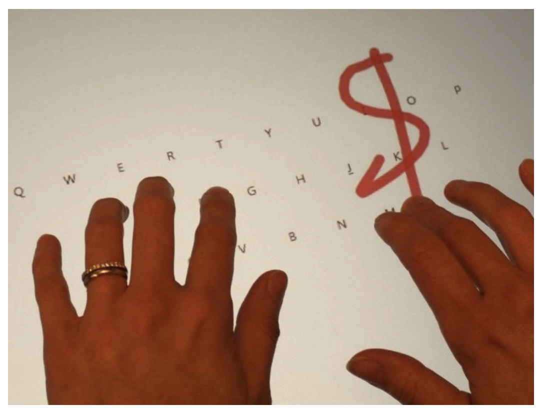
How this personalization is visualized has a significant impact

What's next?

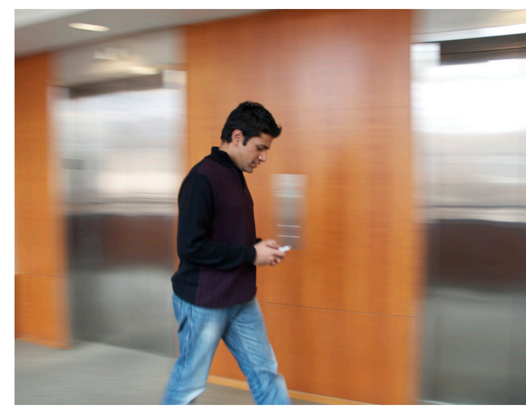
Further classifier exploration

Combining with language models

Gestures & mobile sensors

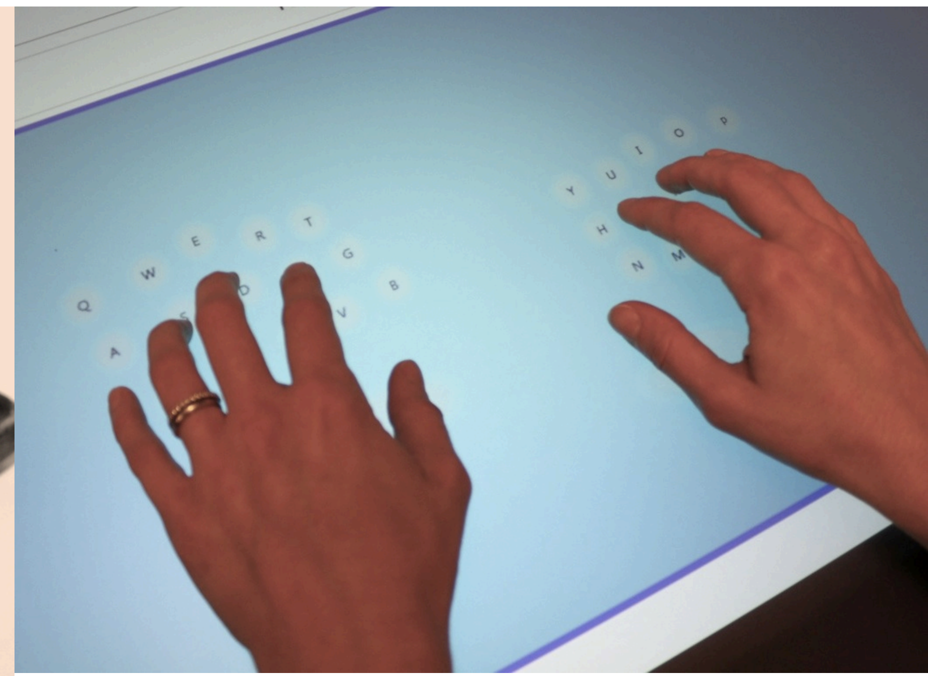


[CHI 2012:
Findlater, Lee, Wobbrock]



[CHI 2012:
Goel, Findlater, Wobbrock]

What can typing be like if we're not constrained by a physical keyboard?



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