# Fingertip Haptics and its Application in Typing on Flat Keyboards

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# Outline

- Introduction
- Haptics R&D at Microsoft
- Keyclick feedback on flat keyboards

# Touchscreens Everywhere


Ford SYNC

Slide courtesy of Joshua Xiang, STB

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# Yet Screens do not Touch Us Back

Video courtesy of Dr. Roland Johansson, Univ. Umea, Sweden

# Haptics and High Information Capacity

Blind and deaf people have been using touch to substitute vision and/or hearing for a very long time, successfully.


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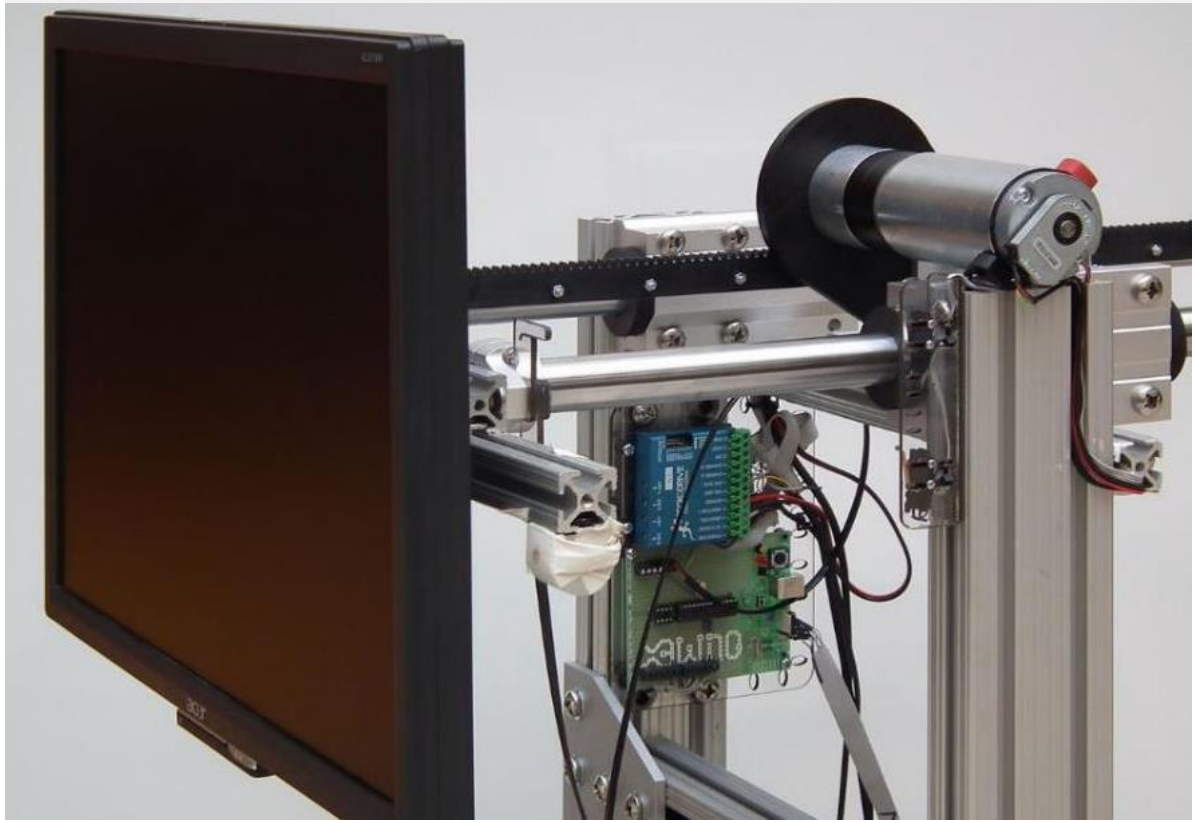
# HAPTICS R&D AT MICROSOFT

# 3D Haptic Touch

**3-D Haptic Touch**

(Mike Sinclair, Michel Pahud, Hrvoje Benko)



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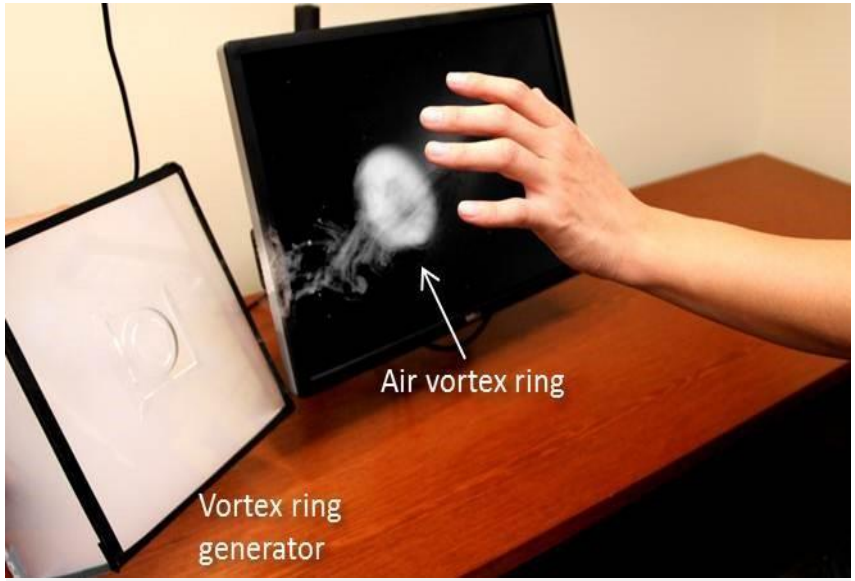
# Ungrounded & In-the-Air Haptics

**GyroTab**

(Akash Badshah, Sidhant Gupta, Daniel Morris, Shwetak Patel, Desney Tan)




**AirWave**

(Sidhant Gupta, Shwetak Patel, Dan Morris, Desney Tan)

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# Looking for the “Killer App”


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# Looking for the "Killer App" (*cont.*)


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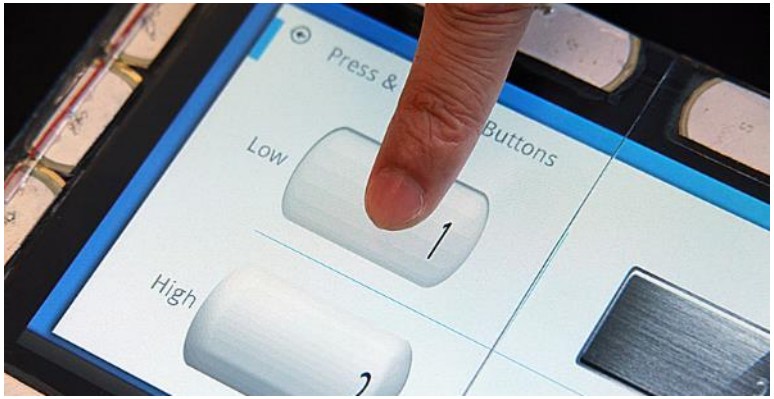
# Fingertip Haptics

**Feeling Objects on Touchscreens**

**Click-like Feedback on Touchscreens**




**"*SlickFeel*: Sliding and Clicking Haptic Feedback on a Touchscreen," Xiaowei Dai, Jiawei Gu, Xiang Cao, J. Edward Colgate, and Hong Z. Tan, *UIST 2012*.**

- Examples of “flat” keyboards
- Tactile feedback facilitates typing on flat keyboards
  - Fukumoto *et al*., CHI’01
  - Poupyrev *et al.*, UIST’02
  - Brewster *et al.*, CHI’07
  - Hoggan *et al.*, CHI’08
  - Lee *et al*., CHI’09
- What’s left to study?
  - Keyclick feedback for ten-finger touch typing
  - Haptic feedback that feels like key clicks

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# KEY-CLICK FEEDBACK ON FLAT KEYBOARDS (two studies)

# Q1. When Does Global Haptic Feedback Feel Local?


**"A masking study of key-click feedback signals on a virtual keyboard," Jin Ryong Kim, Xiaowei Dai, Xiang Cao, Carl Picciotto, Desney Tan, and Hong Z. Tan, *EuroHaptics 2012*.**

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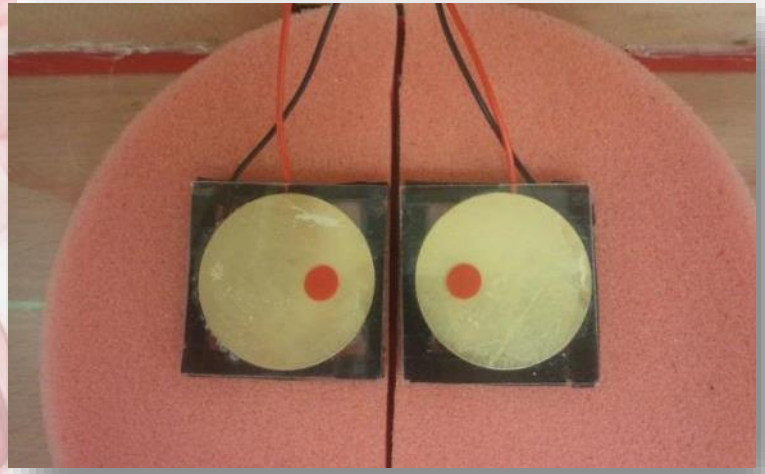
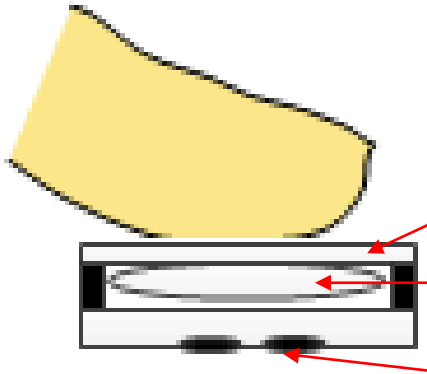
# Experimental Apparatus



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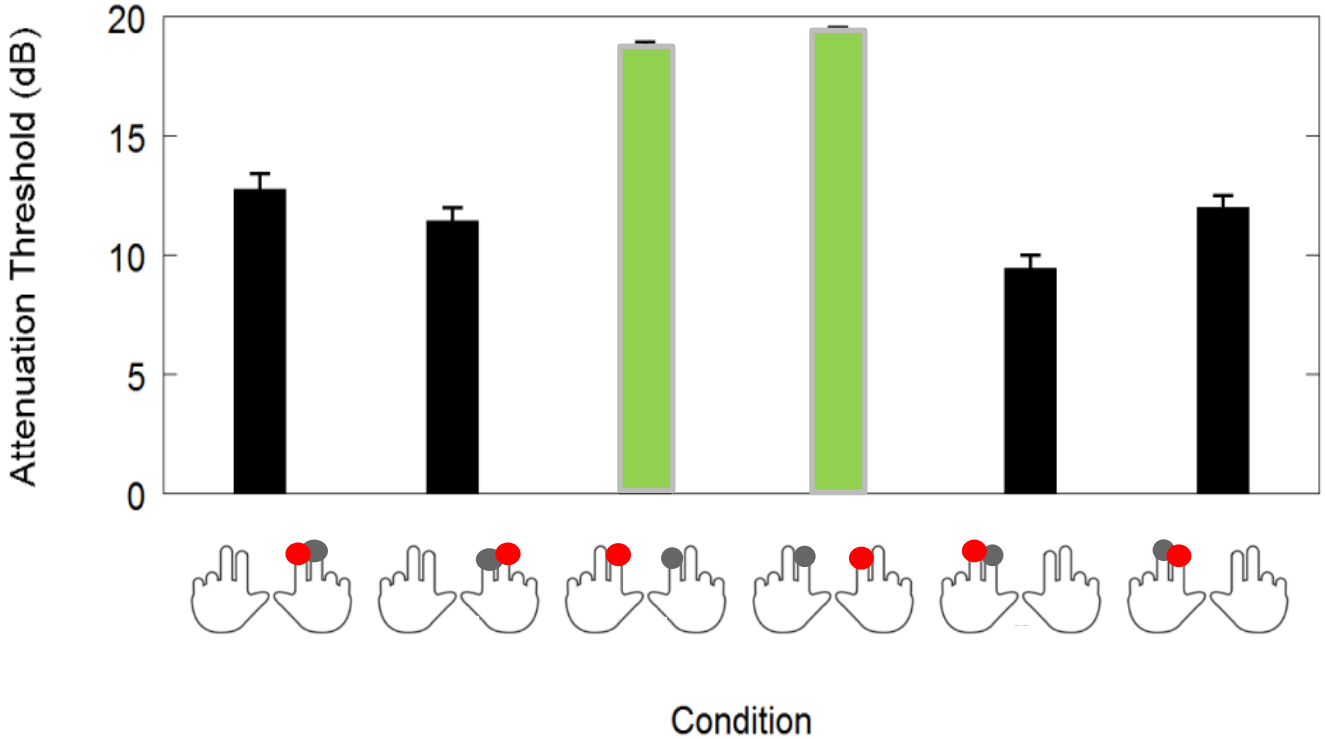
Average = 19.5dB

Average = 11.5dB




Active Finger  Passive Finger

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# Q2. Does Keyclick Feedback Improve Typing?

- We compared typing performance with
  - Physical keyboard with full feedback
  - Visual letter feedback only
  - Visual + auditory beep feedback
  - Visual + *localized* keyclick feedback
  - Visual + *global* keyclick feedback
- Performance metrics
  - Typing speed (words per minute)
  - Keystroke per character (KSPC)
  - Error rates (corrected, uncorrected, total)

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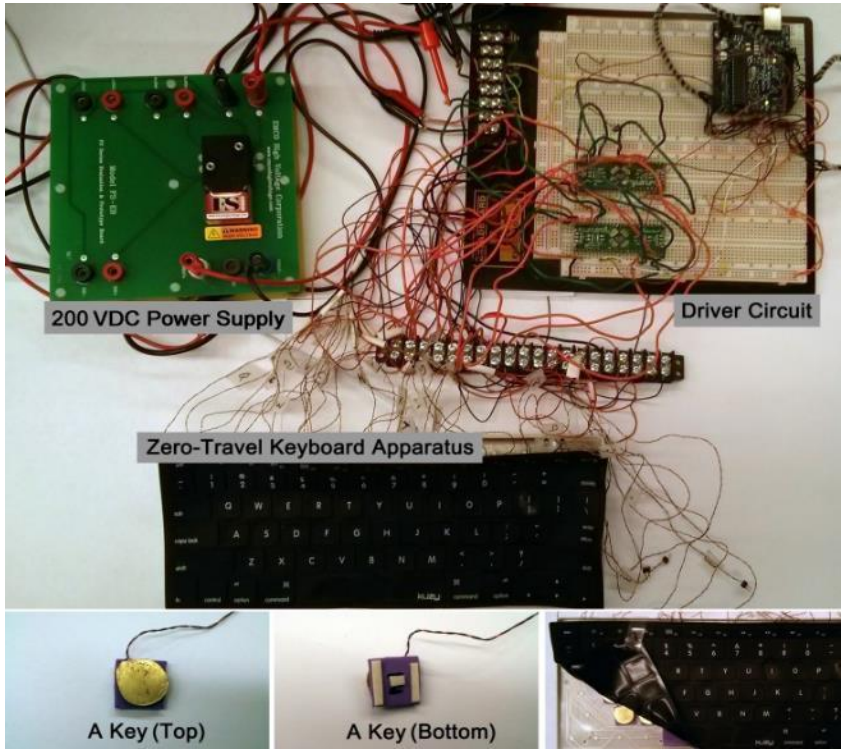
**"A study of touch typing performance with keyclick feedback," Jin Ryong Kim and Hong Z. Tan, *Haptics Symposium 2014*.**

# Localized Keyclick Feedback using Piezoelectric Actuators

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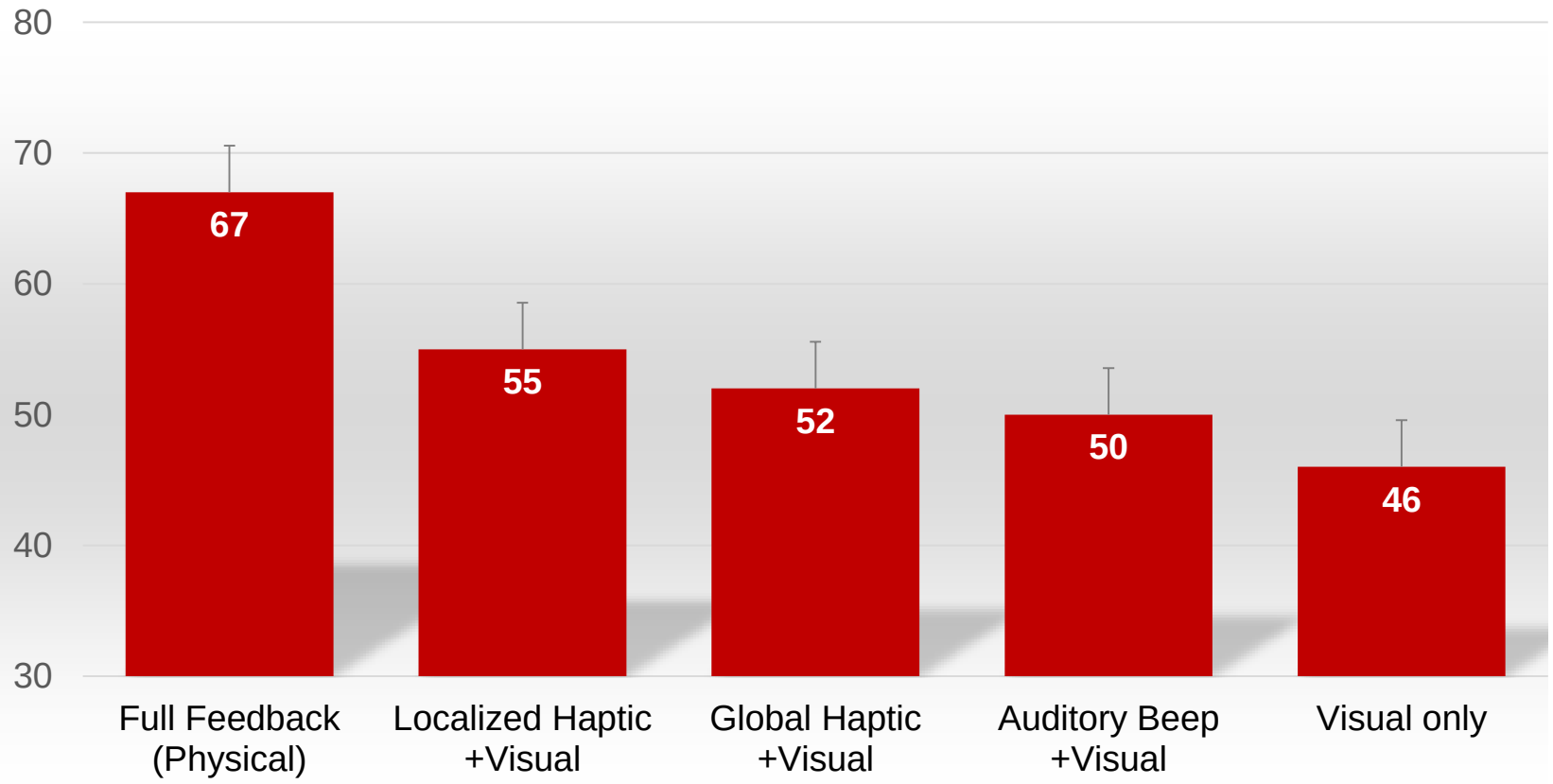
# Results: Words per Minute

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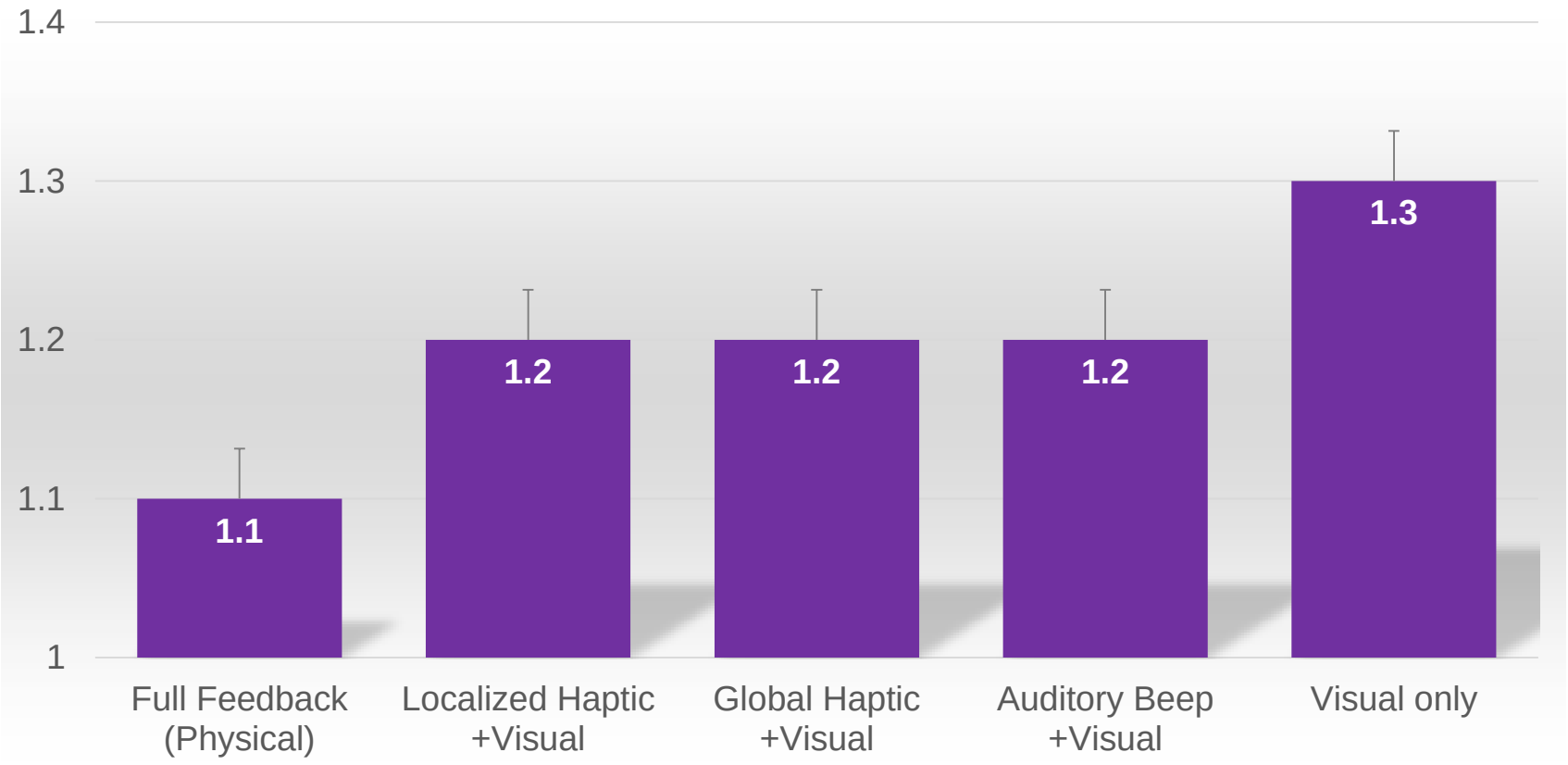
# Results: Keystroke Per Character

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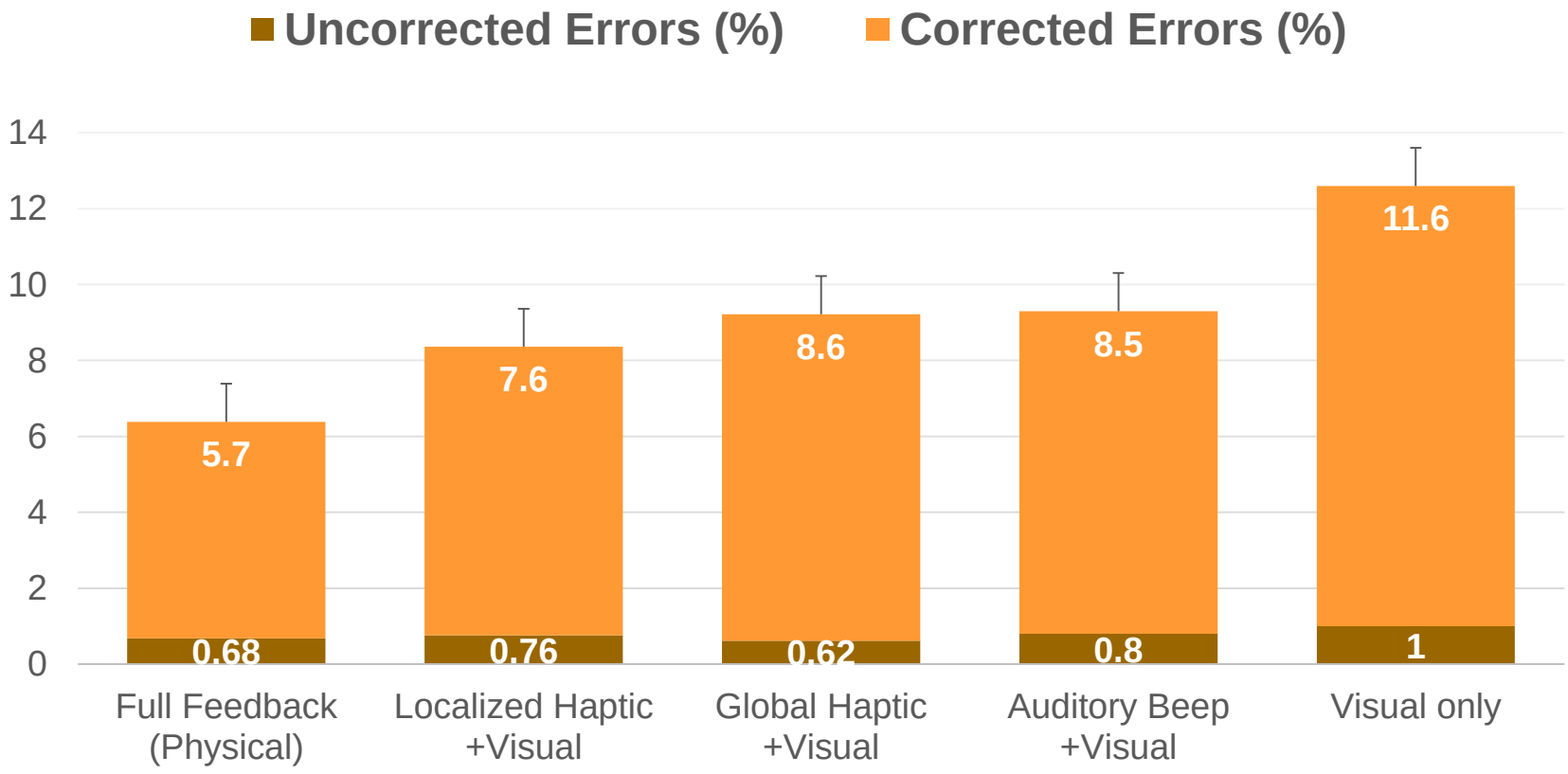
# Results: Error Rate (%)

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# CONCLUDING REMARKS

Localized keyclick haptic feedback can be achieved through sufficient mechanical de-coupling and the masking effect

Physical keyboard produces the highest typing speed, lowest keystroke per character, and lowest error rates

The addition of haptic keyclick feedback (localized or gloval) and auditory beep feedback to visual feedback significantly improves typing speed, efficiency and error rates

Localized keyclick feedback leads to higher typing speed and lower error rates as compared to global keyclick feedback and auditory beep feedback

*What is the performance/cost tradeoff for employing localized vs. global keyclick feedback in a flat keyboard?*

# Collaborators

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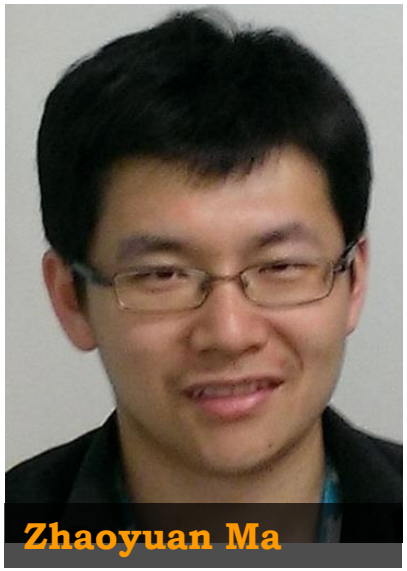
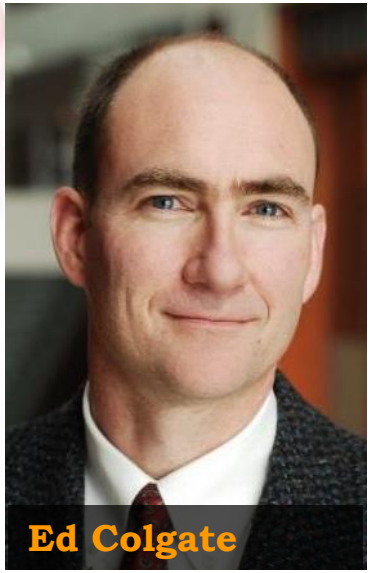
Jesse Kim


Zhaoyuan Ma


Xiaowei Dai


Jiawei Gu


Ed Colgate


Carl Picciotto


Desney Tan


Xiang Cao