PhD course lecture 3
Comparing eye and head pointing

Howell Istance

De Montfort University

This work is supported by the COGAIN NoE
EU IST 6th framework program

Overview

- We have looked at
- Objective measures of usability (my lecture 1)
- Subjective measures of usability (my lecture 2)

- ..now we'll look at using these approaches to compare usability between an head pointer and an eye pointer

Acknowledgements

- The study described here was carried out by Richard Bates as part of the work for his PhD and was reported at ASSETS 2002

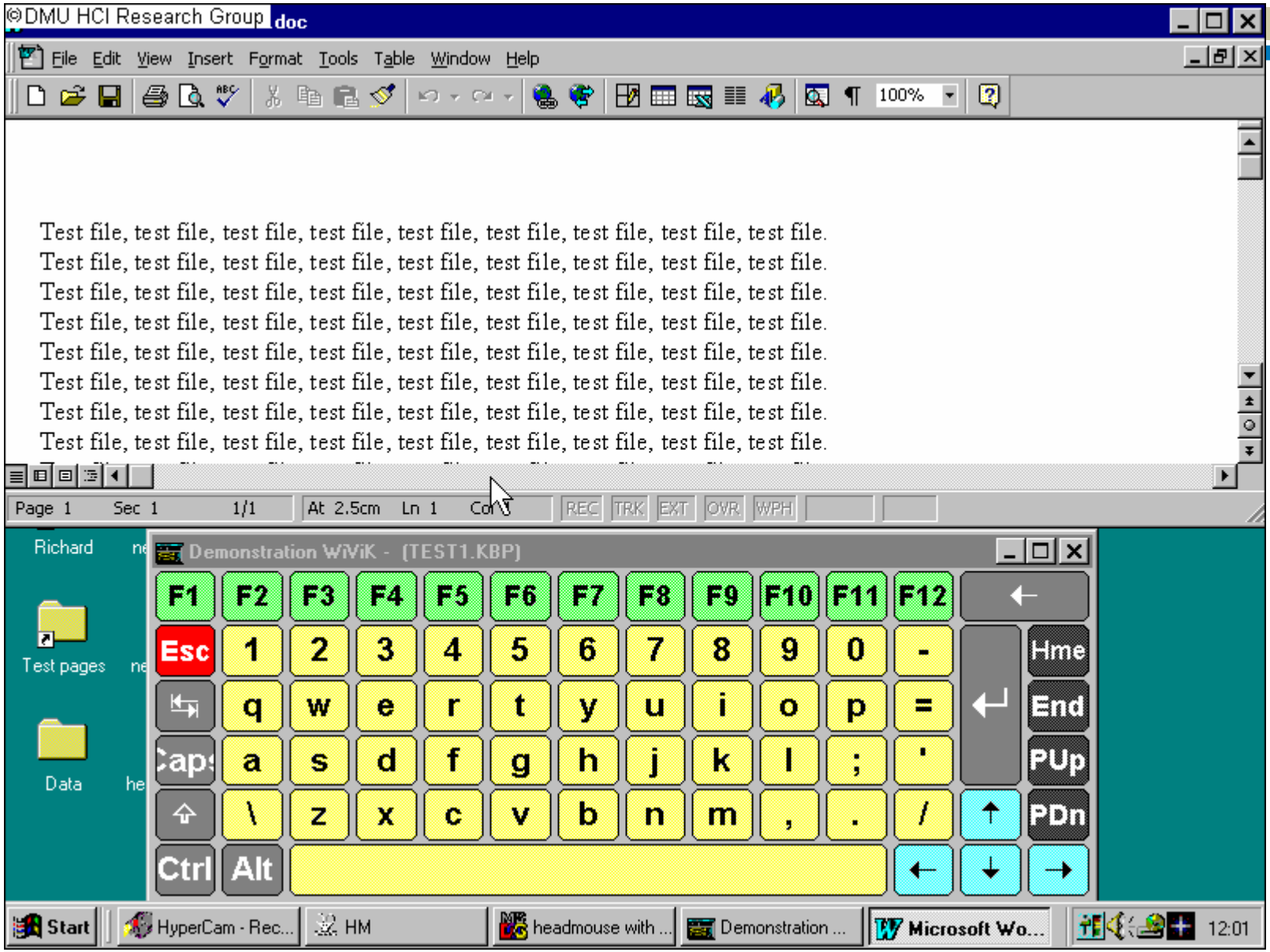
Purpose of evaluation

- How does performance with an eye mouse compare to a head mouse, as an accepted device?
- How can poor pointing performance with a eye mouse be compensated for?
- How close to a head mouse and a hand mouse can performance with an enhanced eye mouse get?

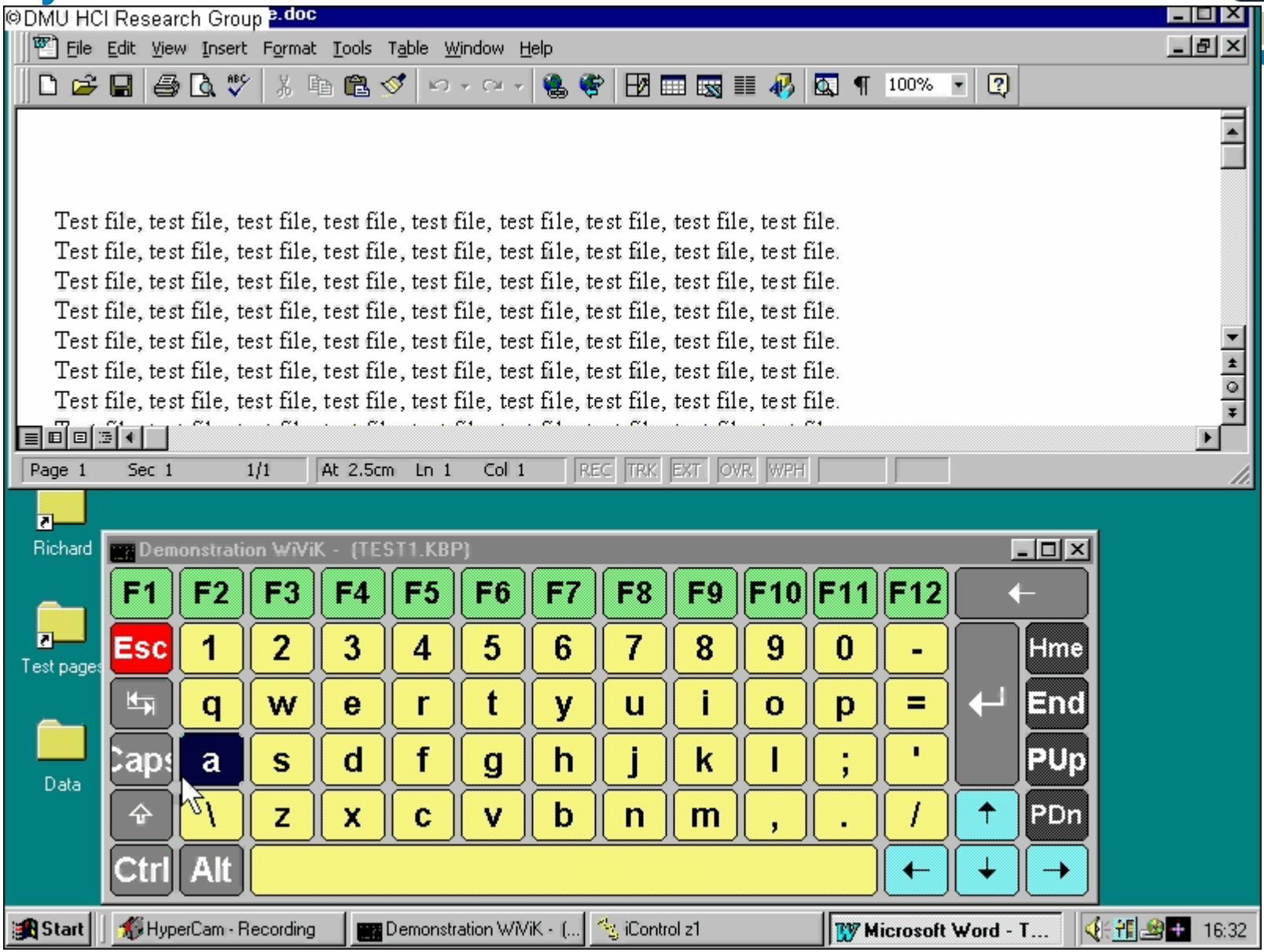
Test sample videos

- Differences between the devices:
- Video 1 - Head mouse performing test tasks
  - Slow, almost ‘damped’ motion
  - Fairly accurate
  - Positional correction easy
- Video 2 - Eye mouse performing test tasks
  - Fast movement
  - Inaccurate positioning
  - Positional correction difficult

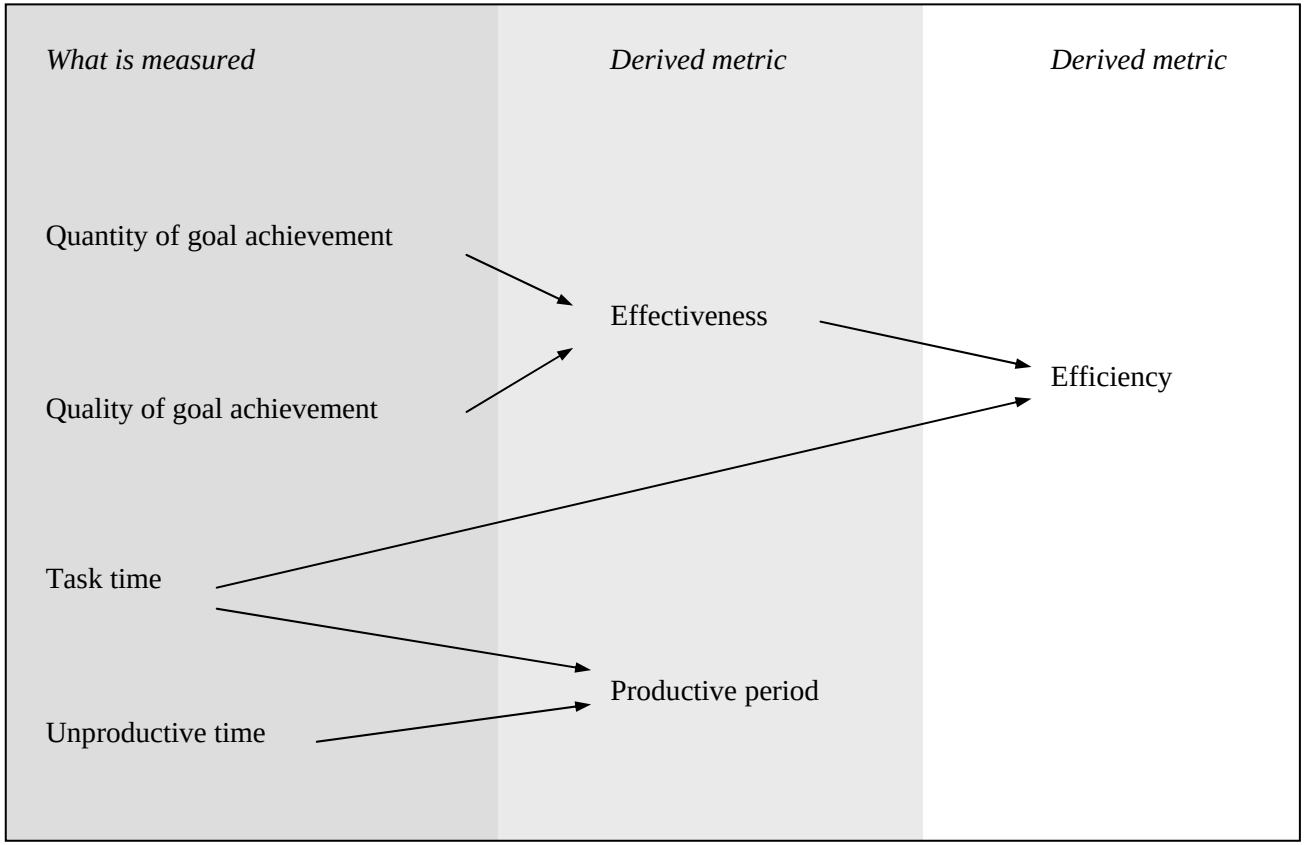
Head Mouse..


©DMU HCI Research Group
doc
File Edit View Insert Format Tools Table Window Help
100%
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Page 1 Sec 1 1/1 At 2.5cm Ln 1 Col REC TRK EXT OVR WPH
Richard
Test pages
Data
Demonstration WiViK - (TEST1.KBP)
F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11 F12
Esc 1 2 3 4 5 6 7 8 9 0 - =
q w e r t y u i o p
a s d f g h j k l ; '
\ z x c v b n m , . /
Ctrl Alt
Hme End PUp PDn
Start HyperCam - Rec... HM headmouse with ... Demonstration ... Microsoft Wo... 12:01

Eye Mouse


©DMU HCI Research Group
e.doc
File Edit View Insert Format Tools Table Window Help
100%
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Test file, test file, test file, test file, test file, test file, test file, test file, test file.
Page 1 Sec 1 1/1
At 2.5cm Ln 1 Col 1
REC TRK EXT OVR WPH
Richard
Test pages
Data
Demonstration WiViK - (TEST1.KBP)
F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11 F12
Esc 1 2 3 4 5 6 7 8 9 0 - =
q w e r t y u i o p
Caps a s d f g h j k l ; '
z x c v b n m , . /
Ctrl Alt
Hme End PUp PDn
Start
HyperCam - Recording
Demonstration WiViK - (...
iControl z1
Microsoft Word - T...
16:32

Recap on metrics



Quality

Quality = 5 – [(3 × count of incorrect commands)
+ (2 × count of misses)
+ (1 × count of control corrections)]

Incorrect command = select wrong target
Miss = click outside any target
Control correction = corrective move to pointer path

Tasks all start with 5, deemed to be failed when quality = 0

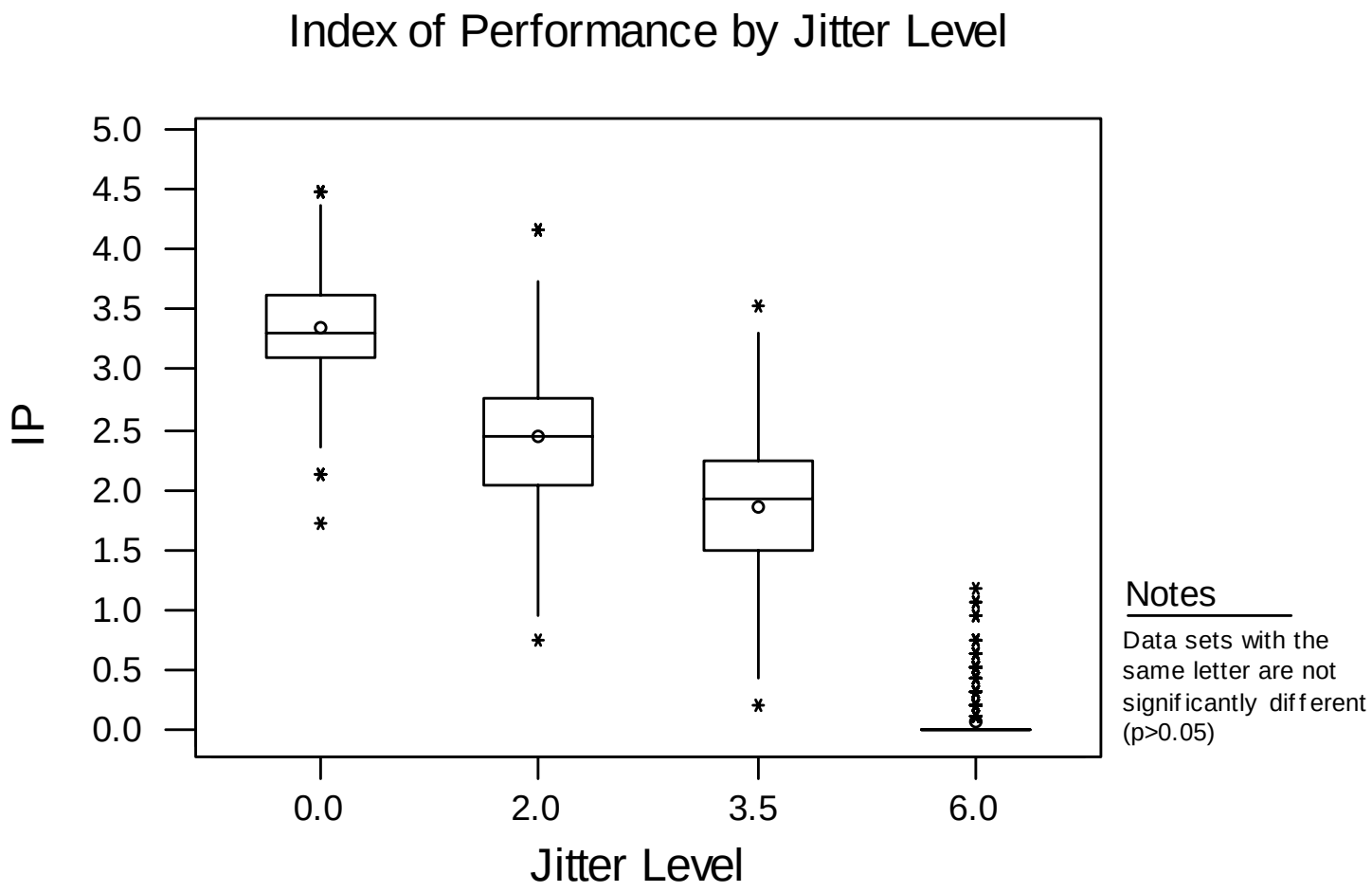
Efficiency

$$\text{Efficiency} = \frac{\text{Quality of interaction}}{\text{Time taken for interaction}} \times \frac{100}{1}\ \%$$

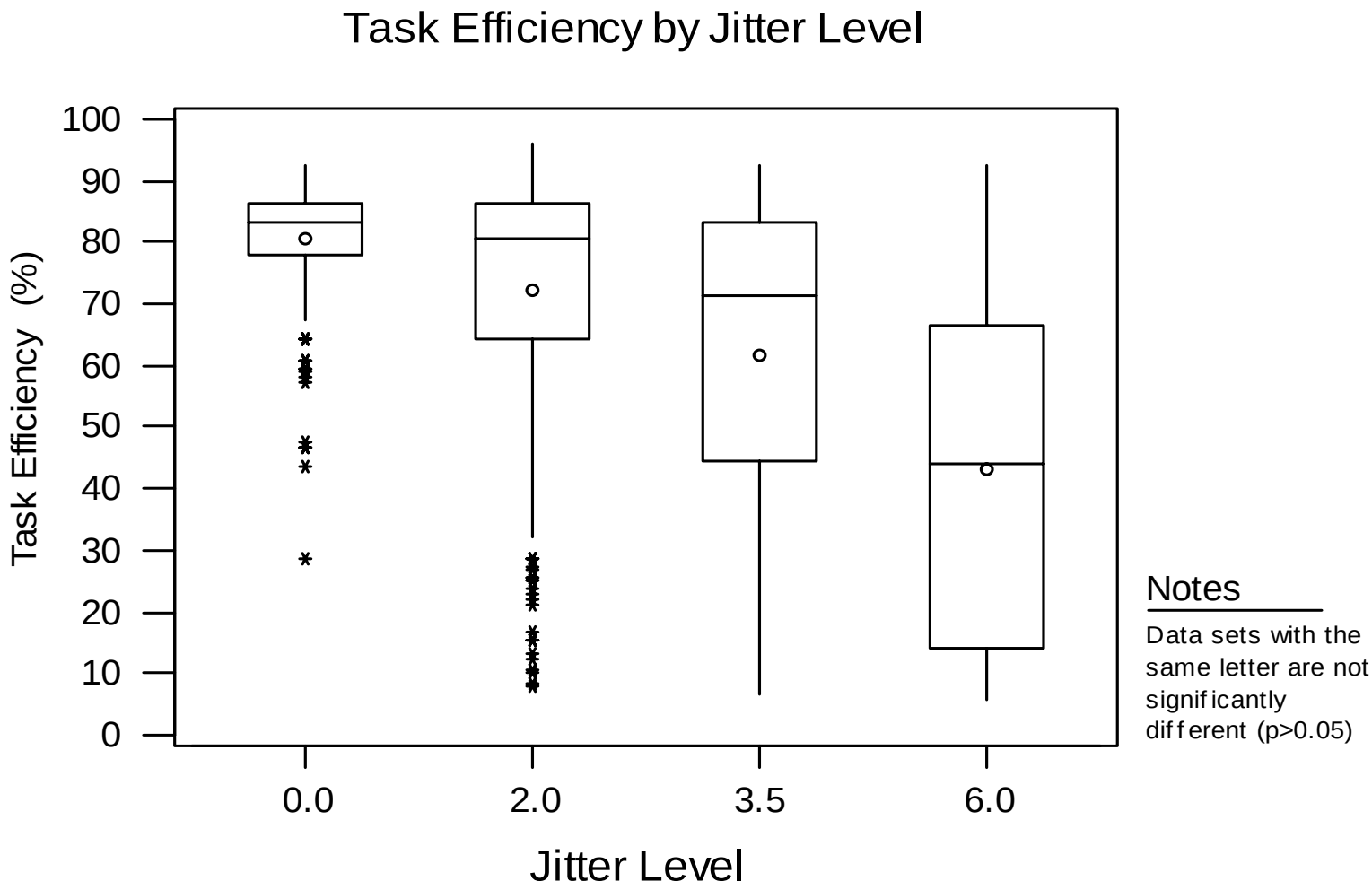
Validating the metrics

- Extremely important to see whether the metrics are sensitive to factors relevant to eye and head pointing performance
- (We can't just assume they are…)
- Use the **same jitter test** for the test tasks to compare devices
- Compare with the simple target acquisition task carried out for scale testing (lecture 2)

Calculate Fitts IP from previous data



Using ‘real-world’ tasks



Factors for subjective assessment

Workload Factors

- Physical effort
- Mental effort
- Time pressure
- Frustration
- Performance

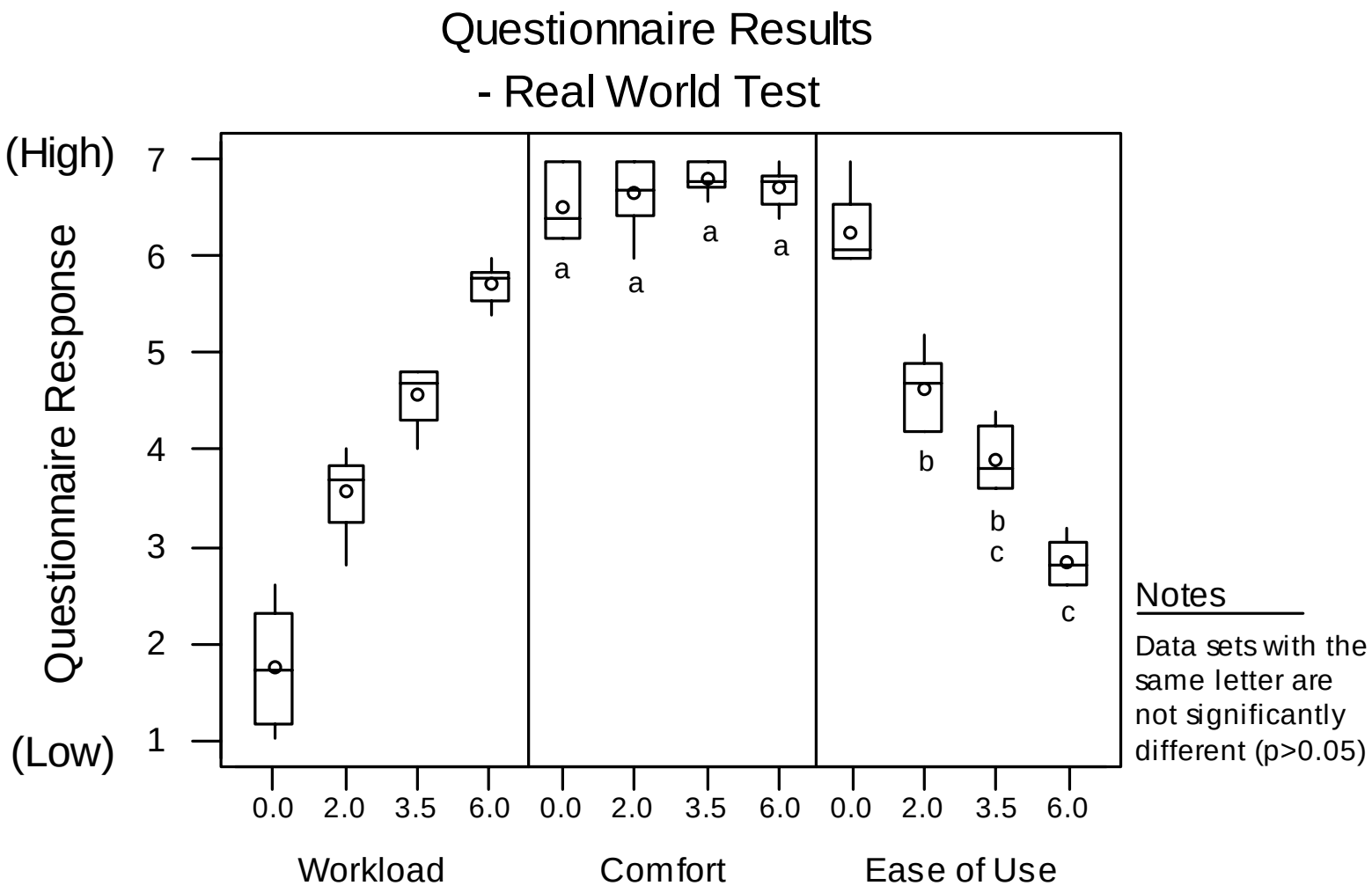
Comfort Factors

- Headache
- Eye discomfort
- Facial discomfort
- Mouth discomfort
- Neck discomfort

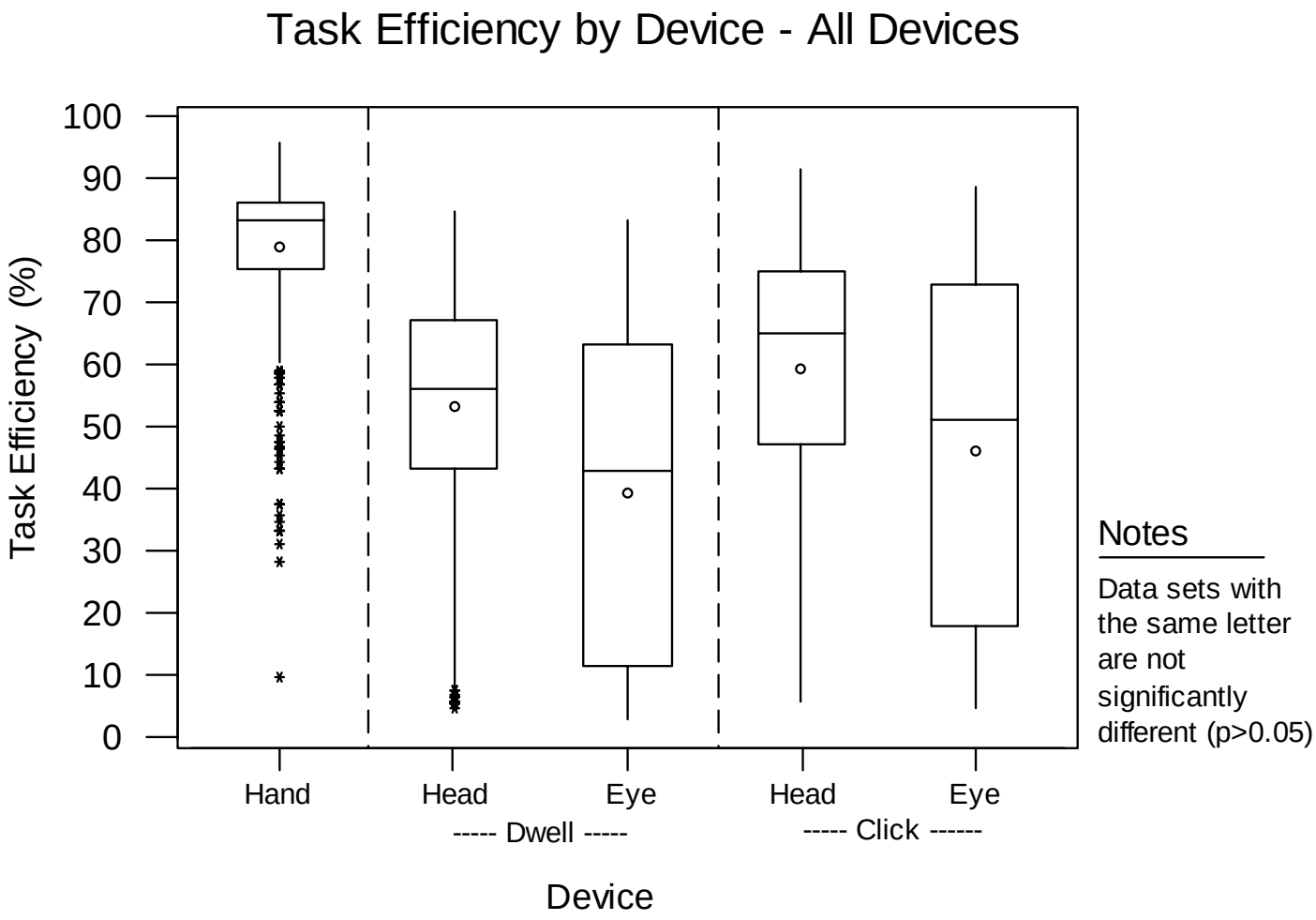
Ease of use factors

- Accuracy of pointing
- Speed of pointing
- Accuracy of selection
- Speed of selection
- Ease of system control

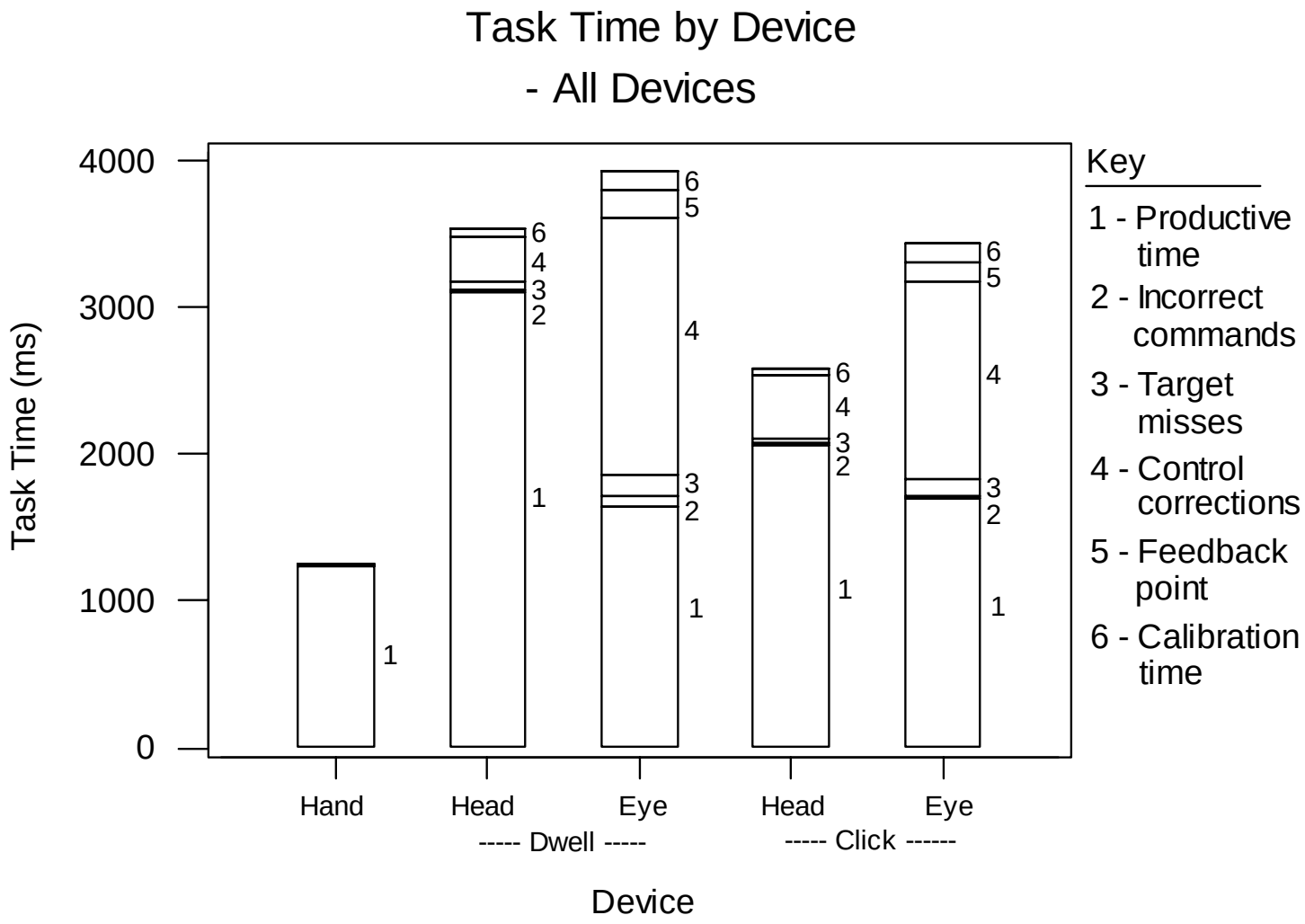
Questionnaire response by jitter level..



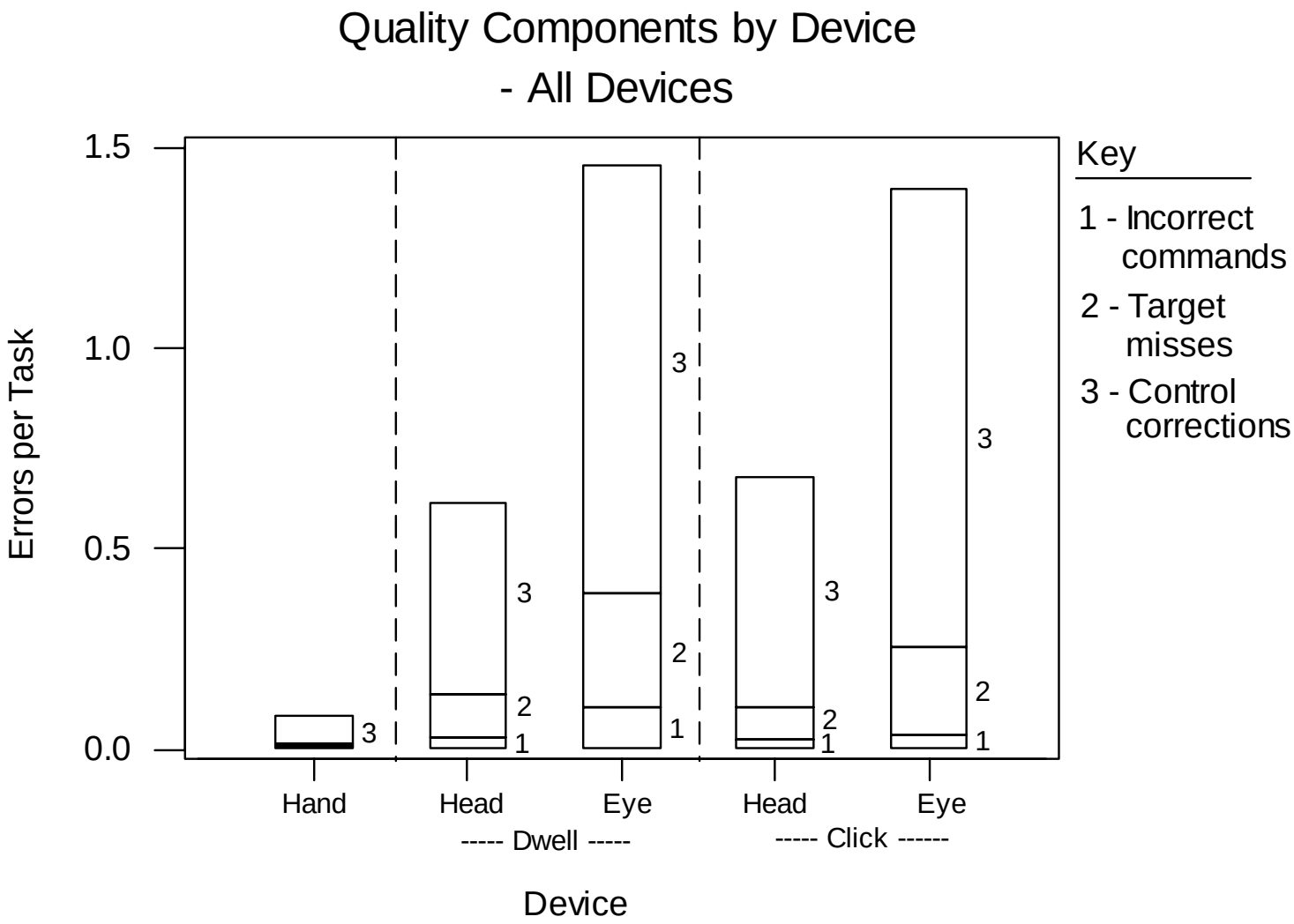
Comparing devices by selection method



Impact analysis of time components

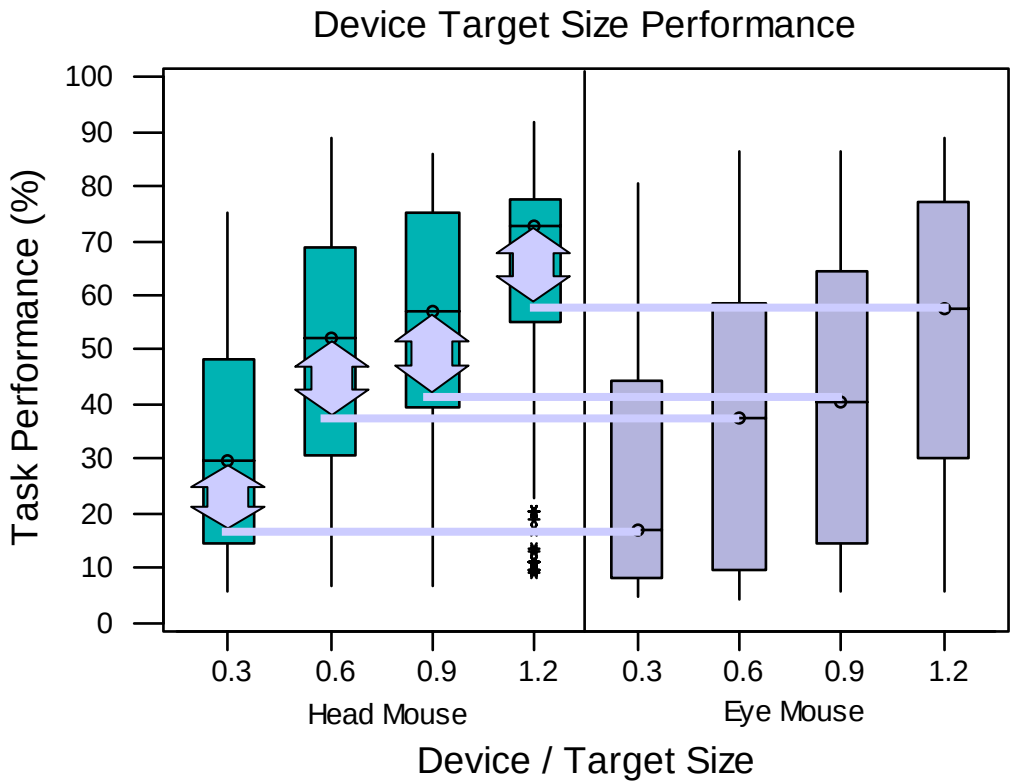


Impact analysis of quality components



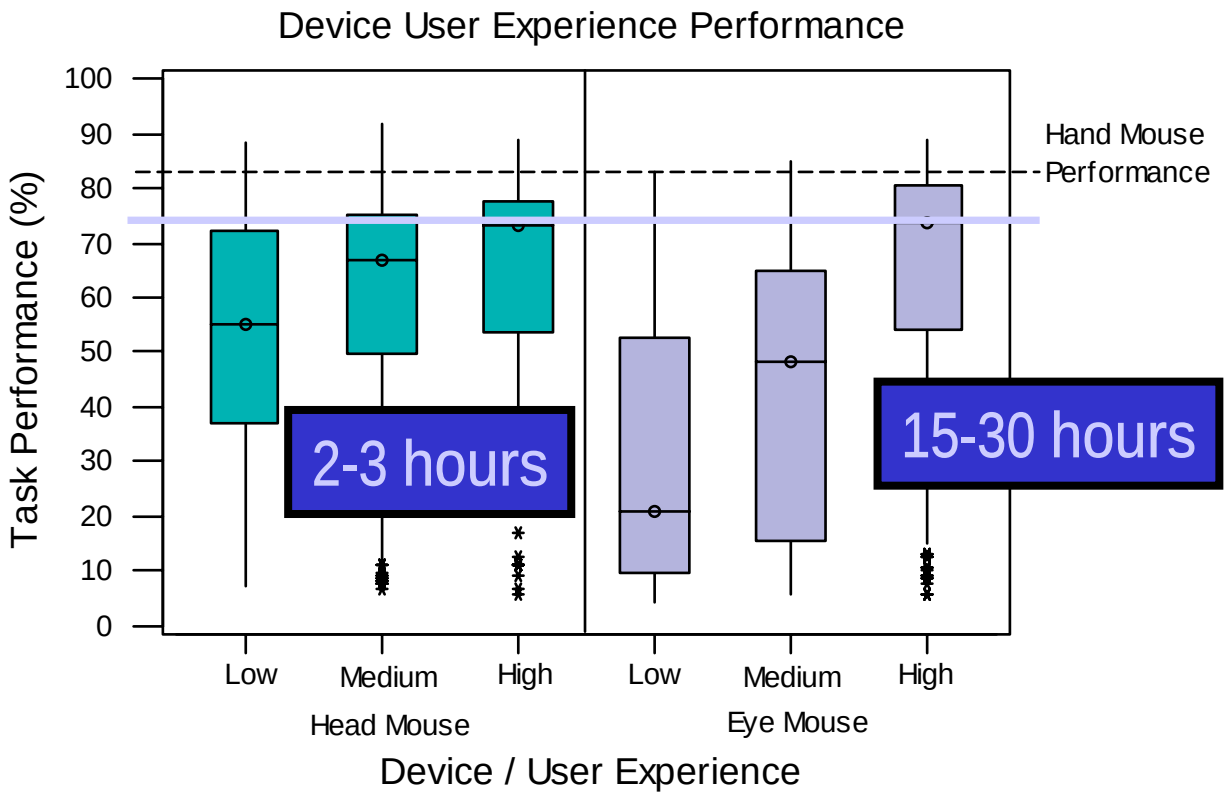
Test results - target size

- Increasing performance with increasing target size (!)
- Difference between devices is approximately constant
- Suggest if targets made larger for eye mouse then device may equal head mouse...?

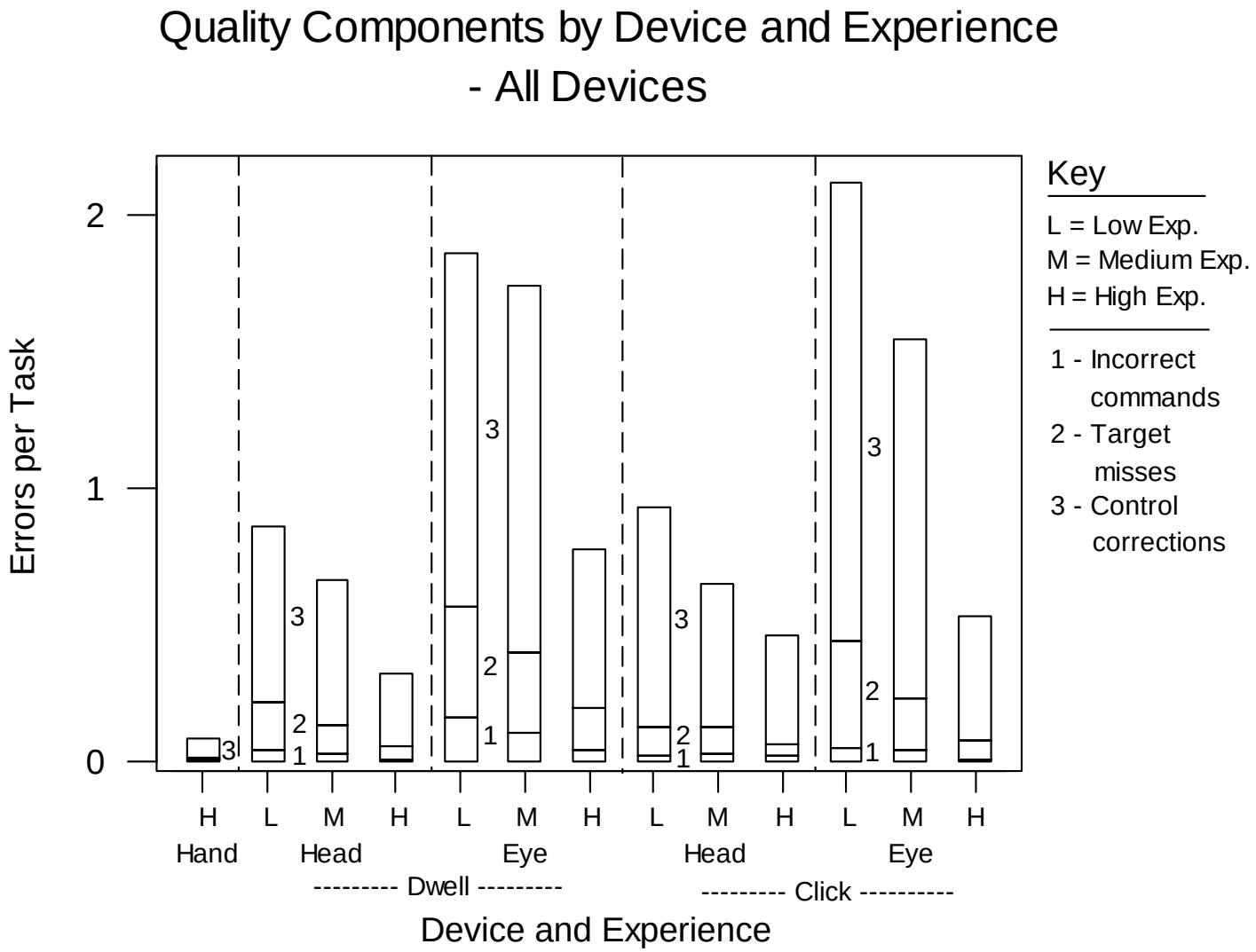


Test results - user experience

- Increasing performance with increasing user experience
- Experienced eye mouse users can reach head mouse performance
- Learning time much greater for eye mouse
- Suggests training users



Impact analysis by experience



Test summary...

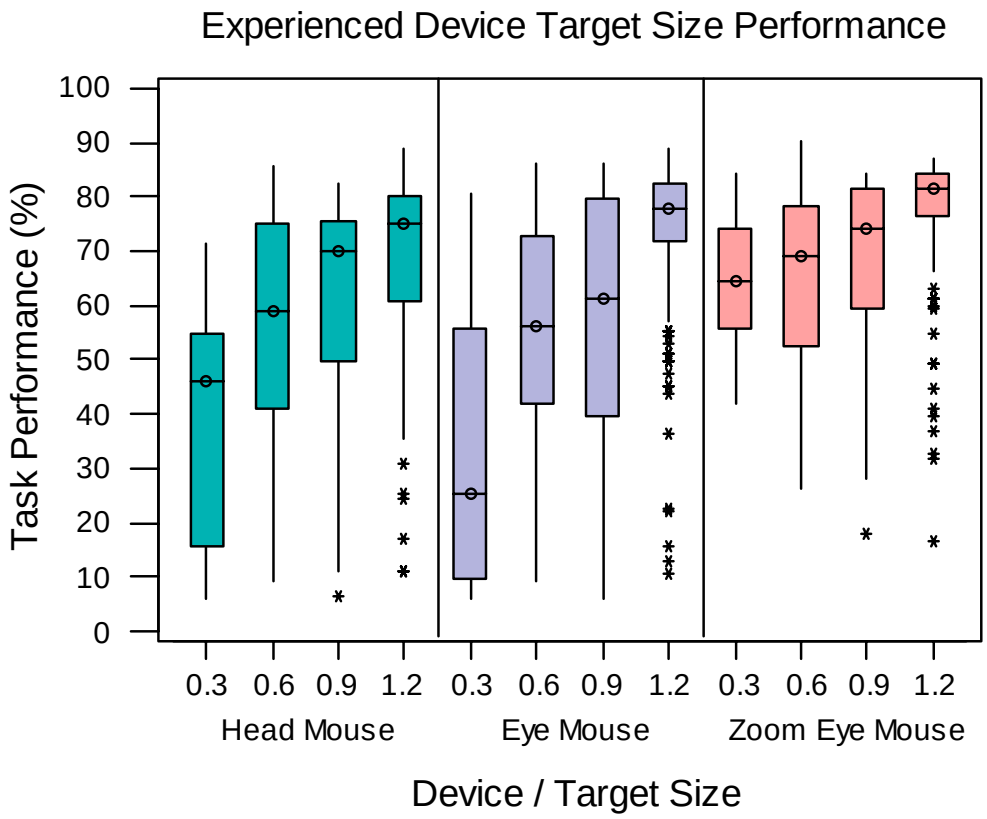
- The nature of the tasks was not important
- Target size was important
- User experience was important

- *So can we :*
- Make sure users are trained and experienced?
- Make target sizes larger?

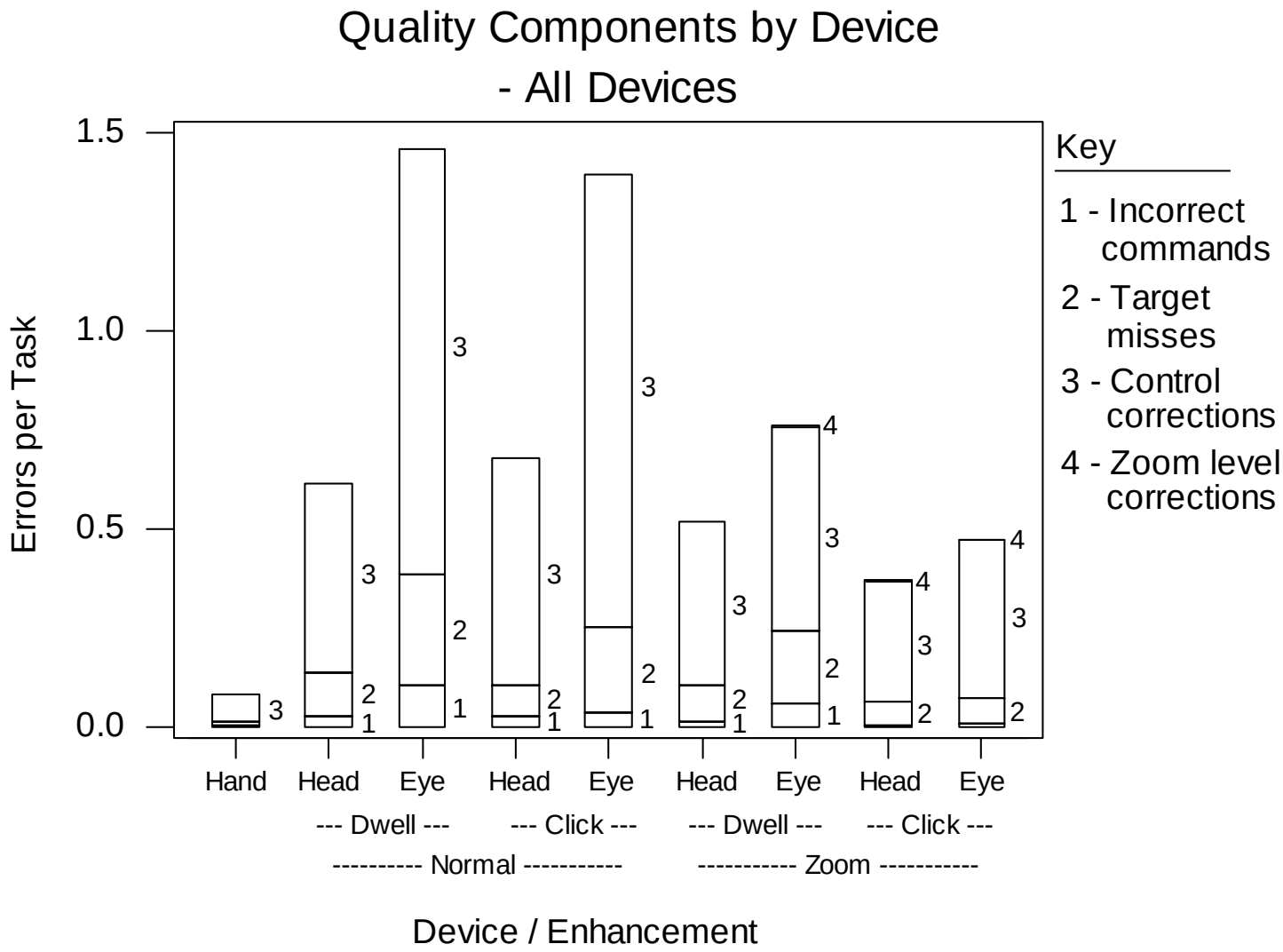
- A second experiment...

Target size, experience and zoom

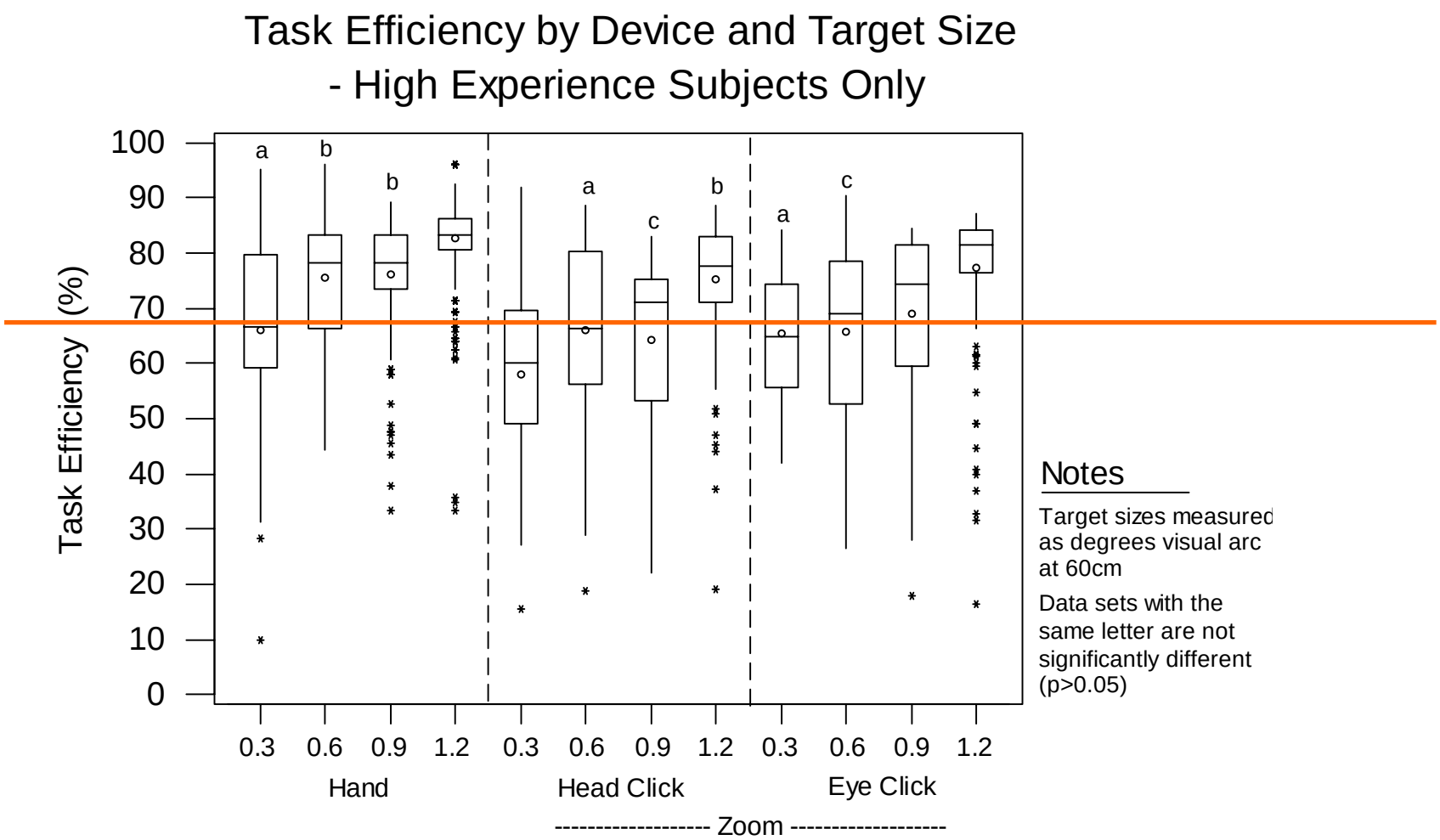
- Only experienced user head and eye mouse data
- Eye mouse very good on largest target, still poor on smaller targets
- Added eye mouse with ‘zoom screen’ to increase target sizes



Impact of zoom on quality components

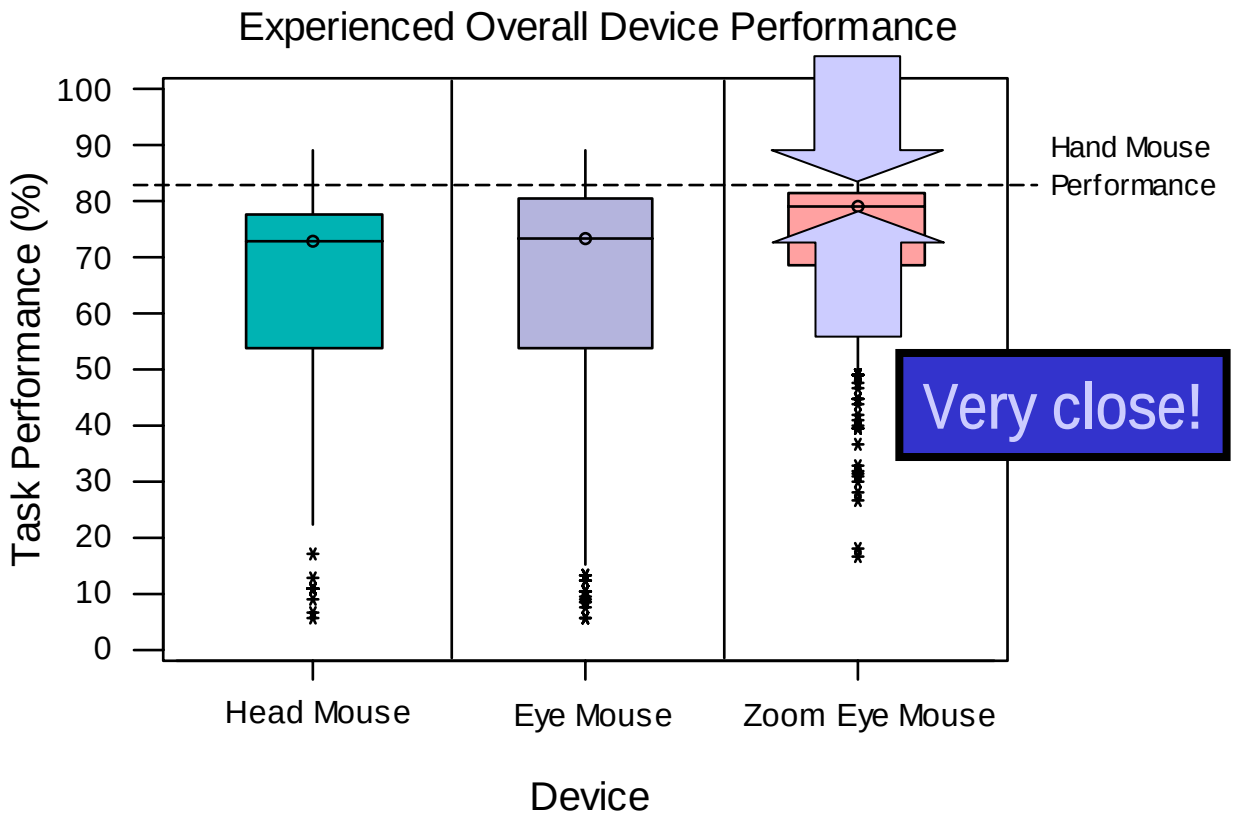


Comparing head and eye zoom



How good can an eye mouse get?

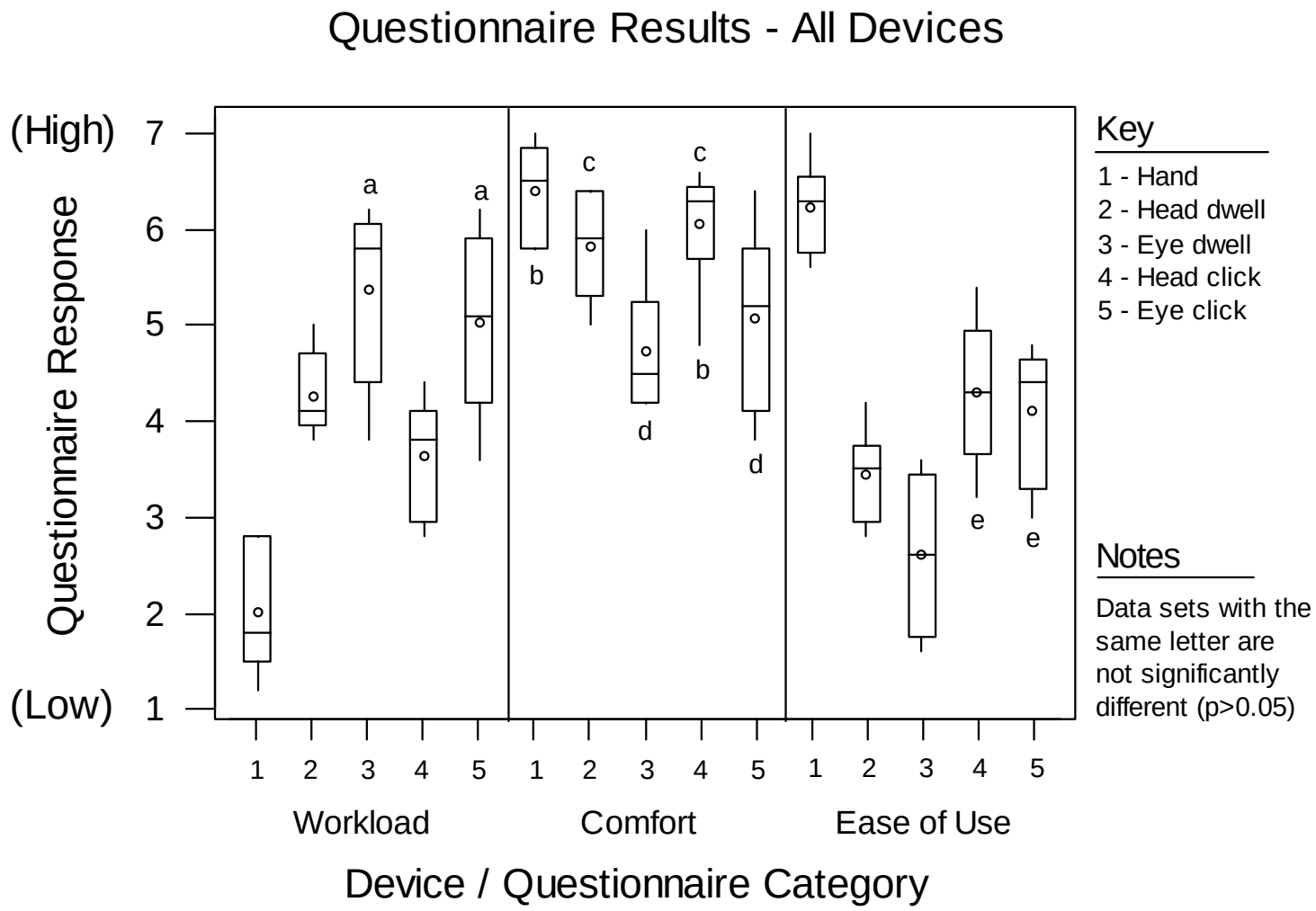
- Need experienced users
- Need ‘zoom’ facility
- ‘Better’ than head mouse
- Very close to hand mouse baseline
- A viable and usable computer input device...



Conclusions – objective measures

- Task efficiency provides a sensitive metric for comparing devices and modifications to devices
- The components of task efficiency reveal how much improvement in performance can be expected from making enhancements to devices
- Nevertheless, assessing time and quality components from trial logs can be time consuming

Questionnaire results by device (no zoom)



Effect of zoom on overall satisfaction

Cost / benefit of enhancement and subjective device satisfaction				
Device	*Satisfaction per device (1-7 rating)*		*Change due to zoom enhancement*	
	Standard devices	*Enhanced devices*	*(1-7 rating)*	*(%)*
Hand	6.20	-	-	-
Head Dwell	4.36	4.70	+0.34	+8%
Eye Dwell	2.93	3.47	+0.54	+18%
Head Click	4.73	4.83	+0.10	+2%
Eye Click	3.90	4.50	+0.60	+15%

Subjective assessment

- Usefulness of the subjective data was influenced by the small number of subjects and the small number of assessments made
- Measures are sensitive to differences in selection method (dwell or click)
- Measures show the impact of making device enhancements

Conclusions

- Adopting the engineering approach to studying pointing device usability provides a solid basis on which to propose device enhancements and predict the impact on performance these will have.
- There is a cost in terms of analysis time associated with this approach
- There is plenty of scope for automating some of the data analysis (and reducing this cost) by defining ideal prototypical tasks