Gaze and Mouse Coordination in Everyday Work

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Mouse and gaze

**Related work:**
How do trajectories of mouse and gaze vary together in time?
Lab studies

Fitt’s law

Time ($T$) varies with distance ($D$) and size ($W$)

$$T = a + b \log_2 \left(1 + \frac{D}{W}\right)$$

In the real world:

$D$ and $W$ are uncontrolled.

Targets don’t exist in isolation.
Lab: coordination in time

Smith et al. ETRA 2000

Three patterns: gaze leads mouse, gaze follows, switching between mouse and target

Bieg et al. ETRA 2010

Unknown target location: gaze “leads” by 300 ms
Known target location: mouse often leads
Lab: coordination in space

Chen et al. CHI 2001: Web browsing
Average gaze-mouse distance when moving between AOIs: 90 px, with 40\% of cases < 35 px

Huang et al. CHI 2012: Web search
Average gaze-mouse distance: 178 px and $\Delta x > \Delta y$
Mouse and gaze

**Investigation**

How do trajectories of mouse and gaze vary together in time **in the real world**?

Tasks and time boundaries not so clearly delineated!
Observational study

11 office workers
Used their own displays
Used their own applications
30 – 45 minutes

Tobii REX Laptop Edition
30 Hz, ≤ 1° acc., ≤ 1° prec.
Simultaneously record mouse and gaze
Clicks: a useful delimiter

Clear signal of action intent!

Upon click:
Take 200 × 200 px screenshot, record class of object

Button
Menu item
Document
Data extent

378 minutes
485K gaze points
3.6K clicks
Window around the click

Spatial

Spatiotemporal

Mouse  Gaze

Distance (px) vs. time (ms)
Coordination patterns

Synchronized

Distance to target

Gaze Leads

Mouse  Gaze

Gaze Follows
How often does gaze lead?

Method 1:
Which gets to **within 50 px** of target first?
→ Gaze precedes *only* 63.5% of clicks

Method 2:
Which **enters the target first**?
→ Gaze precedes 64.2%
Quantifying gaze lead temporally

Method 3:
In 1000 ms window before click,
**when does the first saccade occur?**

Median time of first saccade: 816 ms prior to click

(saccade threshold: $dx/dt > 200$ px/s)
Quantifying gaze lead spatially

Time to click
∥ mouse – gaze ∥ at $t$ ms prior to click
Early departure

Where is the gaze at click time?

In 7.7% of clicks, gaze has already left the target.

Gaze is long gone when the click occurs!
Early departure

Seems to occur in highly stereotyped actions. (e.g. Start Button, title bars, etc)

MAGIC (Zhai et al.) warps mouse cursor to gaze point after mouse actuation.

BUT

Due to early departure, can’t always depend on gaze position during mouse actuation.
Conclusions

Open-ended task recordings give nuanced views
Use clicks as convenient action intent delimiters

Eye usually leads the mouse, as expected

**But** only 64% of cases
Early departure – 7.7% of cases

Implications for interaction techniques!
Thank you!

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