Doing Cognitive Science by Hand: A Tutorial on Computer Mouse-Tracking

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Background

Recently, the measurement of computer-mouse trajectories en route to choices on the screen has served as a window into the real-time dynamics of a wide range of cognitive processes. This mouse-tracking methodology is able to provide a sensitive, temporally fine-grained measure by which participants' tentative commitments to various choice alternatives can be tracked semi-continuously over hundreds of milliseconds. Similar in spirit to the goals of eye-tracking methods, mouse-tracking may provide access to the micro-structure of perceptual, cognitive, and social decisions. Though both methodologies have their strengths, one advantage of mouse-tracking is that it relies on continuous streams of hand motion rather than discrete saccades, and it does so with nominal cost—needing nothing more than a computer and mouse. These qualities led Magnuson (2005, p. 9996) to comment that "the continuous data provided by the mouse-tracking technique [has] the potential to address not only specialized theoretical debates but also some of the biggest questions facing cognitive science."

The mouse-tracking methodology has been applied across a range of topics in cognitive science in recent years. Through tracking hand movement, novel findings about the real-time dynamics of cognition have been made with respect to spoken-word recognition (Spivey, Grosjean, & Knoblich, 2005), semantic categorization (Dale, Kehoe, & Spivey, 2007), sentence processing (Dale & Duran, in press; Farmer, Cargill, Hindy, Dale, & Spivey, 2007), evaluative thinking (Wojnowicz, Ferguson, Dale, & Spivey, 2009), person perception (Freeman & Ambady, 2009; Freeman, Ambady, Rule, & Johnson, 2008; Freeman, Pauker, Apfelbaum, & Ambady, 2010), audiovisual integration (Freeman & Ambady, 2011b), learning (Dale, Roche, Snyder, & McCall, 2008), decision making (McKinstry, Dale, & Spivey, 2008), deception (Duran, Dale, & McNamara, 2010), time perception (Miles, Betka, Pendry, & Macrae, 2010), and many others. This research cuts across domains and pushes a unified methodological message that manual action provides a powerful window into cognitive processes (Freeman, Dale, & Farmer, 2011).

Mouse-tracking research also has theoretical significance, and it is often used to make critical distinctions between competing theoretical accounts. For example, mouse-tracking data have already been central to the development of broad theories of mental processing (Spivey, 2007), and researchers often use such data to select one theoretical model over another, e.g., dynamic versus symbolic models (Farmer, Anderson, & Spivey, 2007; Freeman & Ambady, 2011a; Freeman et al., 2008).

For example, in one study, participants categorized faces' sex by moving the mouse from the bottom-center of the screen to a MALE or FEMALE response, located in the top-left and top-right corners (Figure 1; Freeman & Ambady, 2011b). When simultaneously processing a sex-atypical voice, participants' mouse movements were continuously attracted to the opposite sex-category response before arriving at response consistent with the face's sex. This opened up the real-time face–voice integration process and showed how ongoing processing results from the two modalities are dynamically integrated over time.

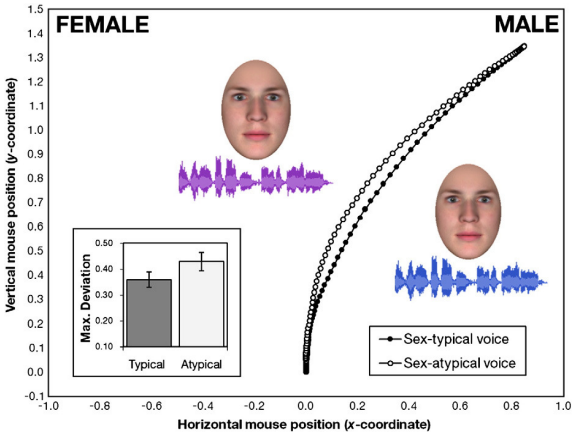

Figure 1. Mouse-tracking reveals continuous integration of face and voice processing (Freeman & Ambady, 2011b).

Objective and Overview

The purpose of this tutorial is to introduce the recording, measurement, analysis, and interpretation of mouse-trajectory data to cognitive scientists. As noted above, the method is relevant to a wide range of interests: perceptual judgment, categorization, psycholinguistics, social cognition, and many others. Through an overview of the freely available MouseTracker software package (http://mousetracker.jbfreeman.net), we will discuss how to design and run mouse-tracking studies, compute measures, and analyze data extracted from mouse trajectories. MouseTracker is a comprehensive and user-friendly stimulus presentation and data analysis package with a full graphical-user interface (Freeman & Ambady, 2010). Attendees will gain hands-on experience with measuring and analyzing trajectory data using MouseTracker, and also using R. By the end of the tutorial, the attendee should have a conceptual understanding of the methodology and its theoretical implications, be familiar with procedures, tools, and software to design and run mouse-tracking studies, and be equipped to analyze and interpret mouse-trajectory data. The tutorial is suitable for any cognitive scientist interested in exploring the real-time dynamics of cognition.

Widespread Interest in Mouse-Tracking

Since the first mouse-tracking study (Spivey et al., 2005), many mouse-tracking studies have been published, are in press, or under review. Now that user-friendly software (MouseTracker) specifically designed for running and analyzing mouse-tracking experiments is freely available, researchers need only a computer and mouse to use the methodology, making its availability on par with more common measures, such as response time. The tutorial will train cognitive scientists in exploiting this burgeoning mouse-tracking methodology.

Schedule

Conceptual and Theoretical Overview	30 min.
Designing and Running Studies using MouseTracker and Excel	45 min.
Measuring and Analyzing Mouse-Trajectory Data using MouseTracker, Excel, and R	90 min.
Conclusions	15 min.

Further Materials

Participants will receive a flash drive containing copies of software, scripts, lecture slides, and supporting papers. The latest version of the MouseTracker software and further links will be available from:

http://mousetracker.jbfreeman.net/tutorial

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