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A Web-accessible tutorial for PsyScope based on classic experiments in human cognition

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PsyScope is a graphically oriented, script-based program for the control of experiments on Macintosh computers that has been made freely available to the psychology community by its developers (Cohen, MacWhinney, Flatt, & Provost, 1993) at Carnegie Mellon Univeristy. We describe a graduated tutorial that was written for new users of PsyScope (instructors or students); the text and scripts can be retrieved from a website at Hamilton College (http://cogito.hamilton.edu/tutorial/). The tutorial examples may be used as classroom demonstrations or as pedagogical aids in teaching students how to use PsyScope in their own research projects. The four examples include a Stroop test, simple and choice reaction time, and a sentence-verification task.

PsyScope is a graphically oriented, script-based Macintosh program for the control of laboratory experiments in cognitive psychology and linguistics, conceived by Jonathan Cohen and Brian MacWhinney of Carnegie Mellon University (Cohen, MacWhinney, Flatt, & Provost, 1993). There are several commercially available programs for the Macintosh that facilitate the design and conduct of experiments, such as SuperLab (Cedrus Corp., P.O. Box 27553, Phoenix, AZ 85061) and MacLaboratory (Chute, 1994). In our view, PsyScope is more flexible and powerful than these alternatives, and it has the advantage of being available at no charge. At the same time, however, most users have found PsyScope to have a higher threshold for becoming an efficient user than the alternatives. In addition to the extensive technical documentation that accompanies PsyScope, there are several published descriptions of the program. For instance, a concise introduction to PsyScope may be found in Cohen et al. (1993), and illustrations of the approach we have adopted in implementing PsyScope in undergraduate laboratory courses at Hamilton College are presented in Vaughan and Yee (1994) and Vaughan, Yee, Heisterkamp, Grey, and Mattson (1997). However, there are no published materials that are directly addressed to the new faculty or student user.

We are grateful to Brian MacWhinney and Jonathan Cohen of Carnegie Mellon University for having made PsyScope available to the psychology community, to the National Science Foundation for providing funds for the facilities used in developing these materials (through an Instrumentation and Laboratory Improvement grant to Hamilton College), to the Pew Program in Undergraduate Education (New York State cluster) for supporting the development of the tutorial materials, and to Sidney Perloe for his constructive additions to the tutorial materials. Among our students in cognitive psychology, Amy Grey, Kara Hrubi, Tiffany Mattson, and Christine Santoro made particularly valuable contributions, but all helped test and improve the materials. We appreciate the suggestions of Robert Proctor and two anonymous reviewers, which improved the manuscript. Correspondence should be addressed to J. Vaughan, Department of Psychology, Hamilton College, 198 College Hill Road, Clinton, NY 13323 (e-mail: jvaughan@hamilton.edu).

To facilitate our own teaching and the research projects of our students, we have developed tutorial materials suitable for undergraduates and instructors who are new to PsyScope. In this paper, we present a brief overview of the tutorials that may be accessed through our website.

The tutorial materials illustrate the key features of PsyScope in a graduated series of four example scripts, each based on a classic paradigm in human cognition. Instructors can adapt these examples for classroom demonstrations to illustrate psychological phenomena or for laboratory exercises to illustrate methodological techniques. After completing the tutorial examples, instructors and students will be equipped to explore PsyScope more fully and to develop their own demonstration exercises and research experiments.

THE PsyScope PROGRAM

Before describing the components of our tutorial, let us outline the fundamental components of the PsyScope program. PsyScope enables users with no computer programming experience to develop new experimental procedures using a graphic user interface (GUI). PsyScope's DESIGN window provides an overview of the architecture of an experiment in a hierarchical tree structure, which can be constructed and modified by standard Macintosh click-and-drag operations.

A PsyScope script (the file used to run an experiment) is a hierarchically arranged representation of the experiment; different levels of the hierarchy are shown in PsyScope's windows. In the DESIGN window, the highest level, the EXPERIMENT, is represented by a psi icon (Ψ). Attributes of the EXPERIMENT define the experiment name, the number of trials, and other characteristics of the experiment as a whole.

The second level of organization is the TEMPLATE level. A template defines the sequence of events that constitutes a single trial, such as the stimulus events, response-collection events, and the intertrial interval.

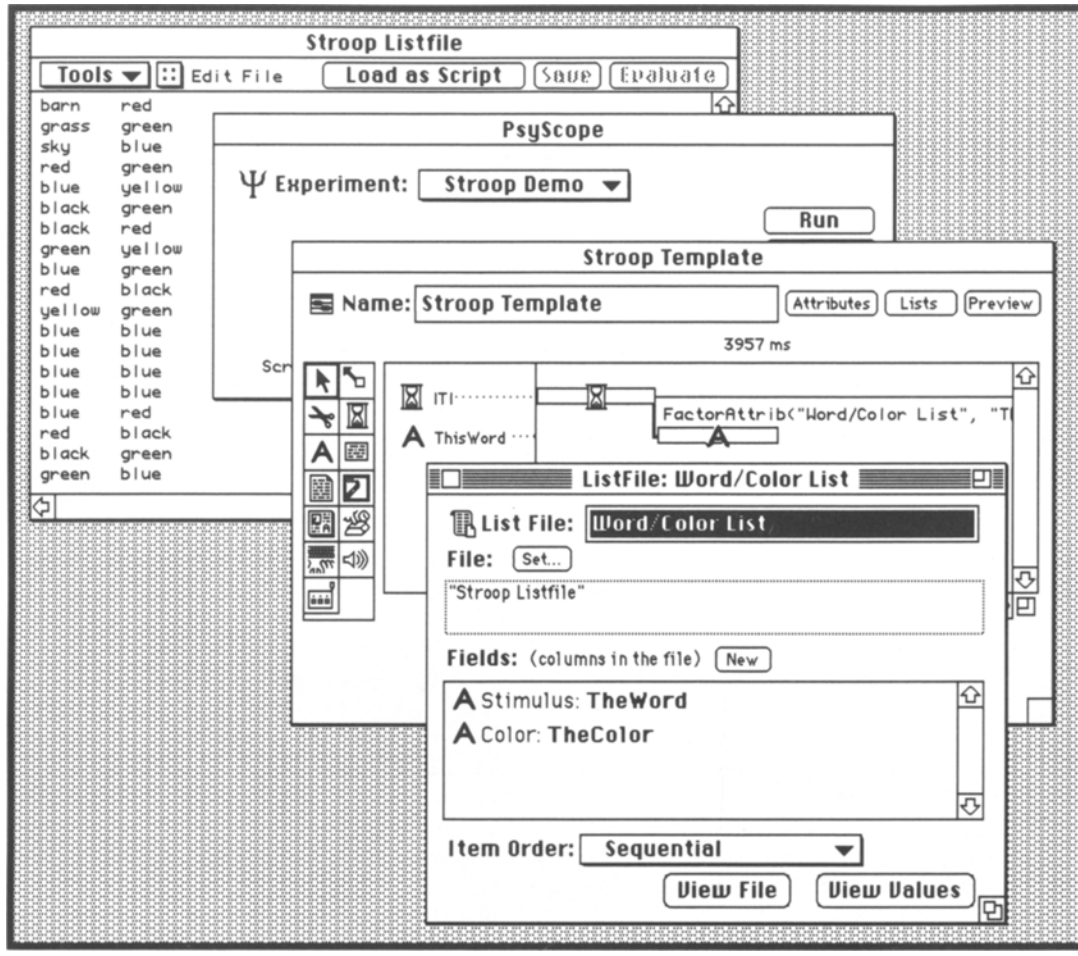

Figure 1. From back to front, the Stroop Listfile window (which contains the sequence of stimuli to be presented and their colors), PsyScope's Console window, the Stroop Template window (which defines the sequence of events in each trial), and the ListFile window that defines how the columns of the Stroop ListFile file are to be interpreted.

The detailed characteristics of the events in a template are defined in the ATTRIBUTE level. Attributes, such as pictures, text, character fonts and colors, and event durations, may be constant or may vary from trial to trial.

Finally, the stimuli to be presented can be defined in generic TEXT files that are linked to the script. These may be created and modified in any text editor. The lists specify the pictures, text, and other variable attributes used in the experiment.

THE PsyScope TUTORIAL

Our tutorial (http://cogito.hamilton.edu/tutorial/) has been designed to facilitate exploration and experimentation with several aspects of the PsyScope program on a Macintosh computer. The first tutorial example gives a broad overview of PsyScope to introduce its organization and capabilities, using the Stroop test as a concrete example. The second example demonstrates how to implement a simple reaction time experiment. The third and fourth examples demonstrate some more advanced features of PsyScope using a choice reaction time and a sentence-verification paradigm. After having worked through these four examples, users should be able to implement many standard paradigms, to create other classroom demonstrations, or to implement their own research paradigm.

Example 1: The Stroop Demonstration

The Stroop demonstration (http://cogito.hamilton.edu/tutorial/stroop.html) illustrates the classic Stroop color naming effect (Stroop, 1935/1992). This effect is that an incongruent color word interferes with naming the color in which the word is printed. A recent comprehensive review of research and theoretical interpretations of Stroop and Stroop-related phenomena is presented by MacLeod (1991).

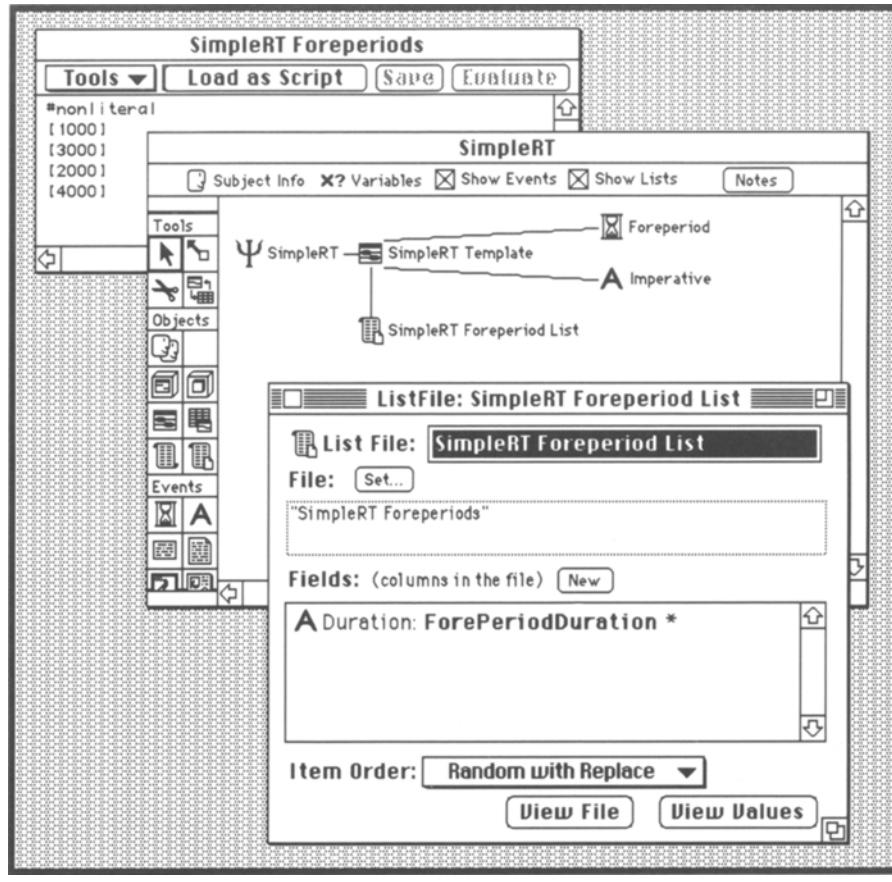

Figure 2. From back to front, the SimpleRT Foreperiods window (which contains the sequence of foreperiod durations to be presented), the SimpleRT design window (which defines the attributes of the experiment), and the ListFile window that defines how the numbers in the SimpleRT Foreperiods file are to be interpreted.

The Stroop example of our tutorial presents a series of color words on the screen for a brief time, each in a different color of letters. The program does not record responses. However, when classroom participants are instructed to say the letter color of each word aloud as quickly as possible, the interference between the color word and the letter color is obvious.

The Stroop demonstration uses the following features of PsyScope: an EXTERNAL STIMULUS TEXT FILE (called "Stroop Listfile") that contains the list of words to be presented and their corresponding colors; and a TEMPLATE window (called Stroop Template) in which the sequence of events (stimuli) on each trial is specified (see Figure 1). The window labeled "Listfile: Word/Color List" is the PsyScope object that locates and interprets the external stimulus text file.

Example 2: Measuring Simple Reaction Time

The SimpleRT example (http://cogito.hamilton.edu/tutorial/simplert.html) measures the time required to make a manual response to the onset of a visual stimulus. Simple reaction time tasks provide measures of encoding or detection processes and thus can be used to assess processing efficiency at a rudimentary level of behavior (see Donders, 1868/1969, and Posner, 1978, for an explanation of different classes of reaction time tasks).

In the SimpleRT example, a stimulus word (*Now!*) is presented on every trial, and the participant's task is to press the mouse button as soon as the stimulus is detected. In order to prevent the subject from just responding in anticipation of the signal without actually reacting to the onset of the stimulus, a variable foreperiod precedes each trial before the stimulus word is presented. Reaction times are measured and saved in a data file.

The SimpleRT tutorial provides instruction on how to develop an experiment script from scratch. Thus, in addition to the template window and the external stimulus text file that was introduced in the Stroop demonstration, this example provides instructions on the following PsyScope features: the DESIGN window, where the overall architecture of the experiment is laid out; the STIMULUS and EVENT ATTRIBUTES features, where the duration

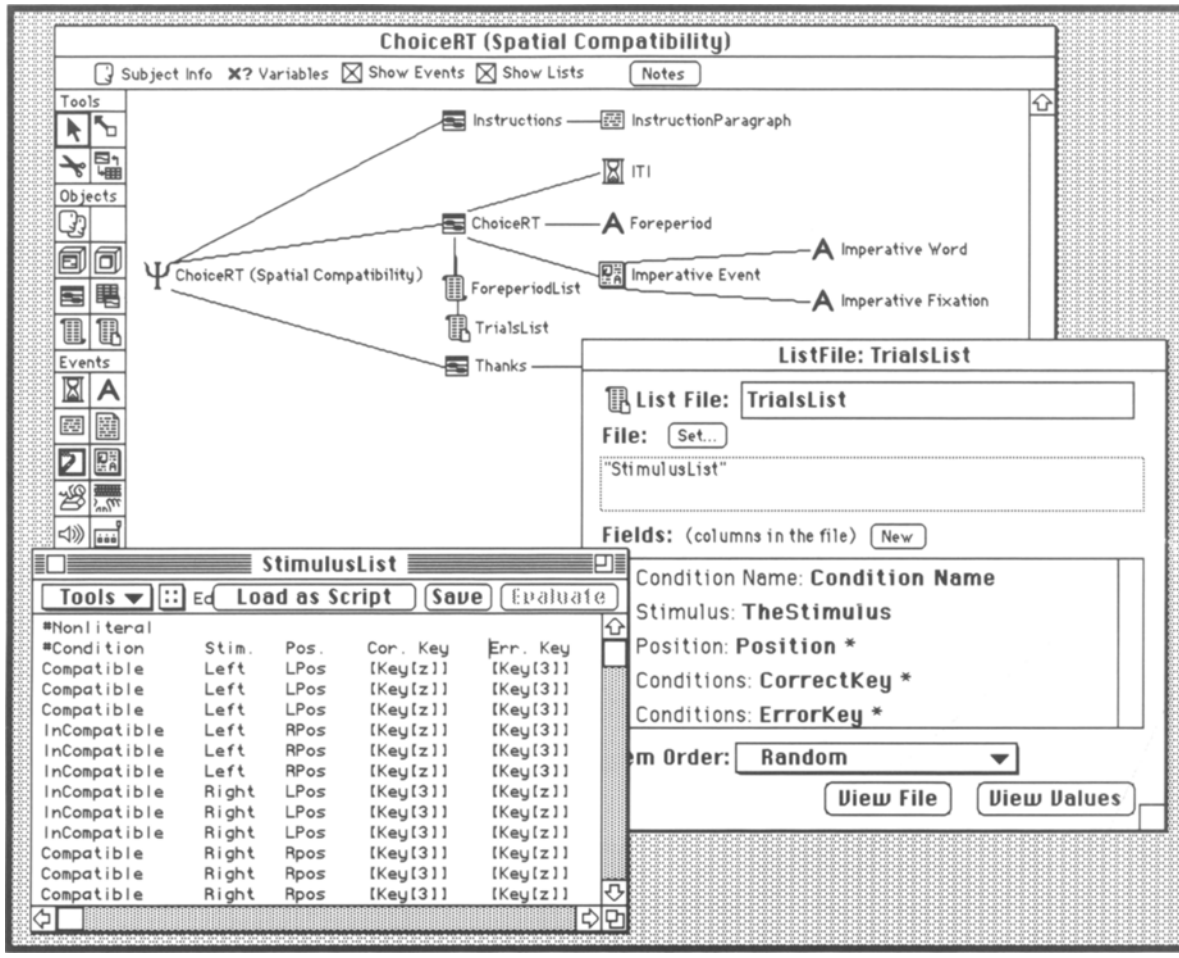

Figure 3. From back to front, the ChoiceRT design window, the ListFile window that defines how the columns of the StimulusList file are to be interpreted, and the StimulusList window (which contains the list of conditions, stimuli, positions, and correct or incorrect keys for each trial).

of events can be set and response times measured; and the SUBJECT INFO feature, where data files are automatically named and created. Additional suggestions for modifying this script are provided in the tutorial manual.

Figure 2 shows the STIMULUS TEXT FILE (SimpleRT Foreperiods), DESIGN window (SimpleRT), and the EXTERNAL LISTFILE windows (ListFile: ForePeriod List) that are used in this example.

Example 3: Measuring Choice Reaction Time

The ChoiceRT example (http://cogito.hamilton.edu/tutorial/choicert.html) implements a more complex reaction time paradigm: a choice reaction time experiment. In a choice reaction time task, any of two or more events that require different responses may occur on each trial. The participant must select the response that is appropriate for the stimulus presented. The ChoiceRT example demonstrates the effect of another kind of interference on performance, analogous to that of the Stroop task. Automatic processing of the positional information (whether the target word is presented on the left- or right-hand side of the screen) interferes with the manual response to a target word (*Left* or *Right*) that indicates with which hand the subject is to respond. Thus, if the word *Left* appears, on either the left side or the right side of the computer screen, the correct response is to use the left hand to press the left key. Incompatibility between the spatial location of a stimulus and the side of the appropriate response increases response times (Fitts & Seeger, 1953; Welford, 1968). The phenomenon in this example is similar to that of the Stroop demonstration in that irrelevant features of a stimulus event (i.e., the written color word in the Stroop demonstration, and the stimulus position in the ChoiceRT demonstration) are automatically processed and disrupt the flow of information processing. A recent review and assessment of irrelevant location effects on manual responses is provided by Lu and Proctor (1995).

In addition to the features introduced in earlier examples, the ChoiceRT script uses the following features of PsyScope: the DESIGN window, in which multiple trial TEMPLATES are utilized to display a set of instructions and a note of thanks to willing volunteers; both INTERNAL and

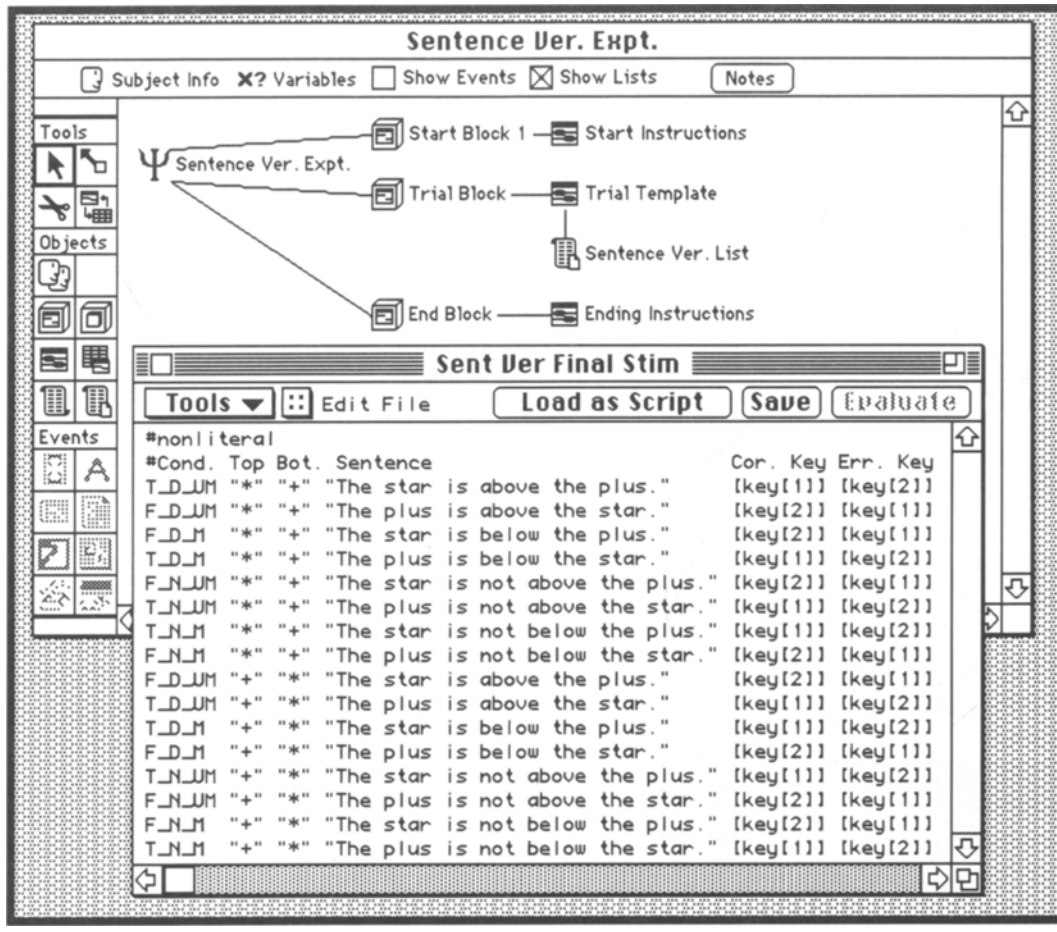

Figure 4. From back to front, the Sentence Ver. Expt. design window, and the Sent Ver Final Stim window (which contains the list of conditions, locations, stimuli, and correct or incorrect keys for each trial).

EXTERNAL LIST FILES, to independently vary duration and positional characteristics of a trial; and the PASTEBOARD event, which allows composite presentations of graphics and text. In addition, this example illustrates how to use the stimulus attributes to vary the screen location of stimuli and the events attributes to score responses. Finally, response durations and accuracy measures are saved in a data file for each participant.

Figure 3 presents the DESIGN, the STIMULUS TEXT FILE, and the EXTERNAL LISTFILE windows that are used in this example.

Example 4: Sentence Verification

The Sentence Verification example (http://cogito.hamilton.edu/tutorial/sentver.html) implements the Clark and Chase (1972) sentence verification experiment. In this task, participants report whether a sentence is an accurate description of a simple picture. The experiment measures the effects of sentence complexity on decision times. Some sentences are in simple declarative form (e.g., "The plus is above the star"), whereas others use transformations (e.g., "The star is not below the plus"). The key variations in sentence structure concern the use of negation ("The plus is above the star" vs. "The plus is not above the star") and the use of marked adverbs. "The plus is above the star" is an example of an unmarked form, whereas "The plus is below the star" is an example of a marked form. Each of these variations is fully crossed with the other in the example. Typical results reveal slower processing times for sentences containing a negation or a marked adverb than for simple declarative sentences. The negation effect, furthermore, interacts with the truth value of the sentence. That is, responses are faster when evaluating a negative sentence that falsely describes the picture. Subsequent research has shown interesting individual differences in sentence verification responses depending on a person's tendency to rely on spatial or propositional representations (see Mathews, Hunt, & MacLeod, 1980). The present example could easily be adapted to explore this idea by offsetting the onset times of the picture and sentence elements of the trials.

The Sentence Verification script illustrates how to use many of the same PsyScope features used in earlier examples to develop a study with a more complex design.

In particular, this example varies three independent variables and presents multiple text events simultaneously, using a PASTEBOARD event. Figure 4 shows the DESIGN and STIMULUS TEXT FILE windows from the Sentence Verification script. The implementation of this experiment is described in more detail in Vaughan and Yee (1994).

Accessing the Web-Based Tutorial

The expanded, Web-based PsyScope tutorial provides a step-by-step guide for constructing and running the four experiments just described. The Web version of the four tutorials may be accessed from the author's website (http://cogito. hamilton.edu/tutorial/).

Users will also need to download the PsyScope program from the developers' website, at Carnegie Mellon University (http://psyscope.psy. cmu.edu/).

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