Stimulus-Response Tests: An Applied Demonstration

Demonstration paper

Carolyn C. Matheus
Department of Computing Technology
Marist College
Poughkeepsie, New York, USA
Carolyn.Matheus@Marist.edu

Justin Svegliato
Department of Computing Technology
Marist College
Poughkeepsie, New York, USA
Justin.Svegliato1@Marist.edu

Abstract*—Stimulus-Response (S-R) tests capture automatic reactions to stimuli, providing a unique way to acquire information about unconscious perception. S-R tests are applicable in multiple disciplines, including experimental biology, neuro-informatics, and social and behavioral sciences. In many computer-based S-R tests, users sort stimuli (e.g., images or text) into different categories using designated keys on the keyboard. Response times can be recorded in different intervals (e.g., milliseconds). The error rate and speed in completing tasks provide a foundation for measuring underlying variables. The current research will demonstrate a prototype of a S-R research tool applied to the field of social and behavioral sciences, including the demonstration of: a computer-based S-R test and code; scripting for automatically generating and assigning user identifications, tracking and assigning users to different conditional groups, and automatically forwarding users to external websites; and procedures for collecting and exporting data.

I. Introduction

Stimulus-Response (S-R) tests provide a unique way to obtain information about unconscious perception because S-R tests capture implicit (i.e., automatic) reactions to stimuli without cognitive forethought. Research has demonstrated that S-R tests can be applied across multiple disciplines, including social and behavioral sciences (e.g., to implicitly assess stereotypes about gender and race) [1, 2], experimental biology [3, 4], and neuro-informatics (e.g., for virtual reality experiments) [5, 6]. Extended applications may also include political science (e.g., for assessing preferences for different political candidates), web design (e.g., for assessing placement of text and images on websites), and electrophysiology [3]. In social and behavioral sciences, S-R tests have been used for psychological experiments in which users make judgments about stimuli (e.g., images or text) they are presented with on a computer monitor. In such experiments, participants complete a series of timed tasks in which they sort stimuli into different categories using designated keys on the keyboard, and response times are recorded in different intervals (e.g., milliseconds). The speed and error rate in completing the tasks can be used to measure underlying variables. The current research will demonstrate a prototype of computer-based S-R research tool. The current prototype is the first step toward the overall goal of creating a user-friendly, open-source S-R software package that can be used to address research questions across interdisciplinary domains.

The structure of computer-based S-R instruments provides a platform for expanding the nature of the variables that can be examined, and web-based applications provide an avenue for expanding the demographic of potential users. However, current computer-based S-R programs and instruments, such as the Implicit Association Test [1] and VisionEgg [3], lack usability and accessibility. For example, some instruments can only be run locally because they are not browser-based, are only customizable in XML, lack a configurable interface, do not provide options for automatic user-identification and tracking, and lack verification of the methodology used for precisely recording time intervals. In addition, a challenging aspect of S-R tests is developing the extensive code needed to run the computer-based presentation of stimuli, which can be difficult for inexperienced programmers [7]. If an interface existed for the code to be easily adapted by researchers, and if the code was widely available for dissemination to the open-source community, then S-R tests could be used relatively easily and distributed to researchers in new domains who may not have programming knowledge.

II. Demonstration of S-R Test

A computer-based S-R prototype designed to examine gender-based stereotypes of occupations will be demonstrated, which is a research topic of interest in the field social and behavioral science. This demonstration will include: an overview and demonstration of a computer-based S-R test based on the Implicit Association Test [1]; an explanation and demonstration of how an S-R test can be adapted for

different research variables, including a demonstration of the extensive code needed for creating a S-R test; an explanation of how user identifications can be automatically generated and assigned to participants, and how participants can be automatically tracked and assigned to different conditional groups; how participants can be automatically forwarded to external websites; and how data are collected and exported for analysis.

The primary author will act as the user in this demonstration. The user will sort stimuli words into categories. Some categories are presented as congruent with common stereotypical thought-processes (e.g., women are nurturing; men are powerful); some categories are presented as stereotypically incongruent (e.g., women are powerful; men are nurturing). In the first step of this S-R test, the user is presented with the word "Female" on the top left side of the computer screen and "Male" on the top right. A stimulus word then appears in the lower center of the screen and the participant is instructed to press "F" to categorize the word as "Female" or "J" to categorize the word as "Male". Example words include gender-typed names such as "Mary" and "John". In the second step, the user is presented with gender-typed occupations and asked to sort them as masculine or feminine. Example occupations include elementary school teacher and engineer. In the next step, words are presented in stereotypically congruent pairs (engineer + male; elementary school teacher + female), followed by stereotypically incongruent pairs (engineer + female; elementary school teacher + male). Stimuli (i.e., words) associated with gender or occupation then appear on the bottom center of the computer screen for the user to sort into their respective categories.

The speed at which the user sorts the words, as well as the error rate, can be used to calculate a *d-score*, which represents the difference in time it takes to sort words into stereotypically-congruent versus stereotypically-incongruent categories [8]. It is expected that the user will find tasks easier to perform when they are stereotypically congruent with existing thought processes about gender and occupations (e.g., women are more nurturing than men and may be better suited for an occupation such as elementary school teacher). When people perform tasks compatible with their existing cognitive associations (e.g., matching the concept of women with kindness and men with power) they perform the task efficiently. On the other hand, when people are asked to reverse associations (e.g., matching the concepts of women with power and men with kindness) they slow down and make more errors [9]. Thus, the degree of difficulty—which theoretically represents the extent of implicit stereotypical thinking—should be evidenced by response time and error rate in the different tasks. *D-scores* can be used as a dependent variable in subsequent data analyses.

Current S-R tools lack usability for lay researchers who are not versed in programming. The long-term goals of the current research project are to develop, test, and disseminate an open-source package for web-based S-R tests that can be broadly tailored and applied to difference research domains. Specifically, long-term goals of this project are to: a) Develop a user-friendly, web-based S-R design interface that can be easily adapted by researchers across domains, that allows for distribution, execution, and collection of data, and can be administered via the Web to diverse samples in any geographical location with Internet access; b) Develop open-source, platform-independent S-R software that can be implemented on any device, including a PC, tablet, Mac, or iPad, using any operating system, including Linux, OSX, and Windows; c) Pilot and disseminate the S-R software to the open-source community; and d) Evaluate data mining techniques for extracting and examining the data collected by S-R tests. The current proposal includes the first steps taken toward this goal by demonstrating a web-based open-source S-R test with extended capabilities (e.g., automatically generating user identifications and tracking participants). The importance of developing web-based S-R software that can be easily adapted by researchers in different disciplines is emphasized.

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