

## A Computer-Based Laboratory Project for the Study of Stimulus Generalization and Peak Shift

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### Abstract

This paper describes materials designed for classroom projects on stimulus generalization and peak shift. A computer program (originally written in QuickBASIC) is used for data collection and a Microsoft Excel file with macros organizes the raw data on a spreadsheet and creates generalization gradients. The program is designed for use with human participants. The stimuli produced by the program are horizontal lines of varying length. It is possible to manipulate the variables examined in some past experiments, such as the effect of S+, S- similarity on the degree of peak shift (cf. Hanson, 1959). The user determines whether simple generalization training or discrimination training will be used, and the specific line lengths appearing in each phase of the procedure.

Keywords: laboratory project, teaching, stimulus generalization, peak shift

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One of the difficulties faced by instructors of courses on the psychology of learning is to develop laboratory projects that effectively recreate the methods used in actual research. The traditional steady-state research methodology used with pigeons or rats does not readily lend itself to classroom investigation because of the extensive timeframe involved, the difficulty in procuring the necessary equipment, and problems with finding an appropriate housing arrangement for the subjects. Zuriff (2005) recommended that instructors use laboratory exercises that recreate the “golden oldies” of past behavior-analytic research, that is, classic experiments that illustrate basic learning processes. Among the numerous advantages of this approach is that laboratory exercises of this kind can be conducted with commercially available computer simulations of animal behavior if live animals are unavailable (e.g., Graf, 1995; Venneman & Knowles, 2005).

The laboratory project described here is intended to help instructors create a laboratory project involving original data collection from live subjects. In brief, human participants are used in lieu of nonhumans. Also, the project does not require extensive investigations of single individuals; rather comparisons can be between-groups.

The topic of the laboratory project is stimulus generalization and peak shift, an area that qualifies as both a “golden oldie” (cf. Ghirlanda & Enquist, 2003; Honig & Urcuioli, 1981) and the subject of ongoing research and theory development (e.g., Blanco, Santamaría, Chamizo, & Rodrigo, 2006; Derenne, Breitstein, & Cicha, 2008; Ghirlanda & Enquist, 2007; Lynn, Cnaani, & Papaj, 2005; Martindale, 2006; McLaren & Mackintosh, 2002; Spetch, Cheng, & Clifford, 2004). In the traditional method of measuring stimulus generalization, participants first receive *generalization training* followed by a *generalization test*. During training one stimulus (S+) is presented repeatedly and responses in its presence are reinforced. During testing, a variety of related stimuli are shown and stimulus generalization is measured as responses to stimuli other than S+. The graphical depiction of response frequency to each stimulus constitutes a

*generalization gradient*. The generalization gradient is usually symmetrical in shape with the modal response or “peak” of the gradient directed to the S+.

If participants receive *discrimination training* instead, responses to the S+ are reinforced while responses to a second stimulus (S-) are not. This procedure often produces an asymmetrical generalization gradient, with the gradient displaced away from S+ and towards stimuli on the opposite end of the stimulus dimension from S-. *Peak shift* describes displacement in the modal response; if the mean response is displaced but the modal response is not, then the term *area shift* may be used (Rilling, 1977).

Research on stimulus generalization and peak shift has used both humans and nonhumans. When nonhumans are used, the reinforcer is typically food and subjects are trained with response-contingent food in the presence of one stimulus (S+) but not the other (S-). When humans are used, the “reinforcer” is typically feedback indicating that the response was correct or incorrect. The generalization test also varies. For nonhumans, responses to the test stimuli (including S+) are extinguished to prevent additional learning. For humans, meaningful feedback about response accuracy is withheld (subjects may be told that a response was recorded, but not whether the response was correct or incorrect; cf. Derenne, 2006). Despite these important differences in procedure, many of the variables investigated with humans and nonhumans have been shown to have a similar effect (e.g., Wills & Mackintosh, 1998; Thomas, 1993). Keith (2002) has also recommended peak shift as a topic of in-class laboratory investigations. Keith, however, suggested that the project should be conducted with materials that the students create. With the present project, the computer program minimizes preparation time. The Microsoft Excel file organizes the raw data and generates a generalization gradient.

## USING THE PROGRAM

### *The Computer Files*

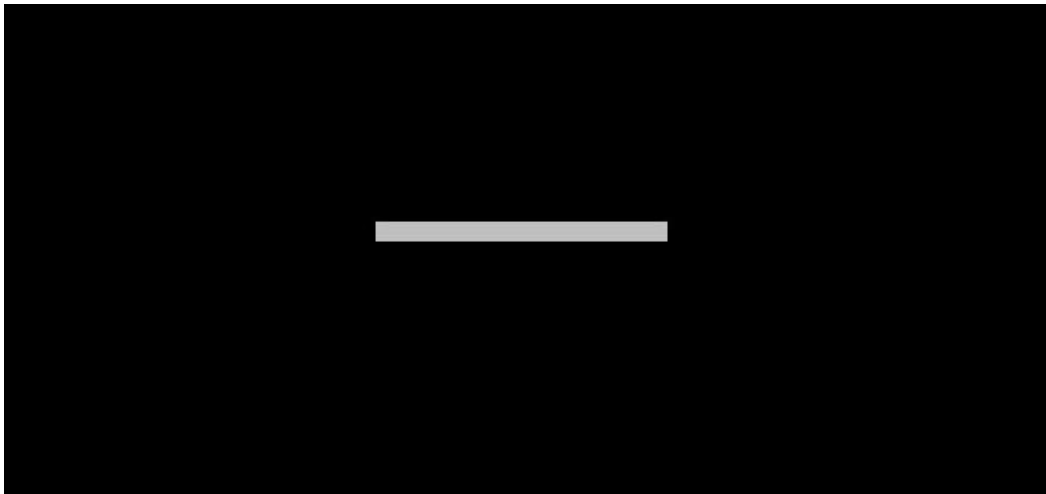
The computer files can be downloaded singly, or as a .ZIP file (Peak Shift.zip) at the following URL: <http://www.und.nodak.edu/instruct/aderenne/Peak Shift.zip>. The files include PSHIFT.exe, which is the program used in data collection, and Peak Shift.xls, which is used to organize and analyze the data.

The data collection program was created using QuickBASIC 4.5. The data collection file does not require substantial use of memory or advanced graphic abilities. However, additional software (not herein described) may be needed to operate this program with some operating systems. The program works best with Windows XP and other, older Microsoft Windows operating systems. With some operating systems, the size of the program’s display can be adjusted. To access options, the user can either right-click on the file’s icon or right-click on the title bar after the program is opened and then select Properties.

The Excel file was created using Microsoft 9.0, and uses the macro feature for the purpose of organizing the raw data. The raw data cannot be processed unless the user first enables the macros feature.

*Nature of the Stimuli*

The stimuli are lines that vary in length, a stimulus dimension that is well suited for research on stimulus generalization and peak shift (cf. Derenne, 2006; Fields, Reeve, Adams, Brown, & Verhave, 1997; O'Donnell, Crosbie, Williams, & Saunders, 2000; Pokrzywinski, 1970). Specifically, the stimuli consist of elongated white rectangles, which appear against a black background. The position of the lines varies randomly from one trial to the next, but at no point do the lines touch the edge of the screen. The exact length of the lines depends on the type of monitor that is used and how that monitor has been configured. Therefore, the program describes the lines in terms of the number of characters (specifically, ASCII character 219, or | ) comprising the line rather than absolute length. The lengths of the lines are selected by the user.



*Figure 1.* Screen shot of the default S+.

*The Data Collection Program*

The data collection program (PSHIFT.exe) includes a General Setup, Training Setup, and a Testing Setup screen, that the user must pass through before data collection begins. The General Setup screen allows the user to provide a file name for the raw data file that is saved at the end of the data collection session, to indicate whether generalization training or discrimination training will be used, and to choose the intertrial interval during training and testing. The Training Setup screen allows the user to choose the length of S+ and S- (if applicable) and the conditions under which the participant will be advanced from training to the generalization test. The Testing Setup screen allows the user to choose the total number of testing trials and the specific line lengths that will appear during the test.

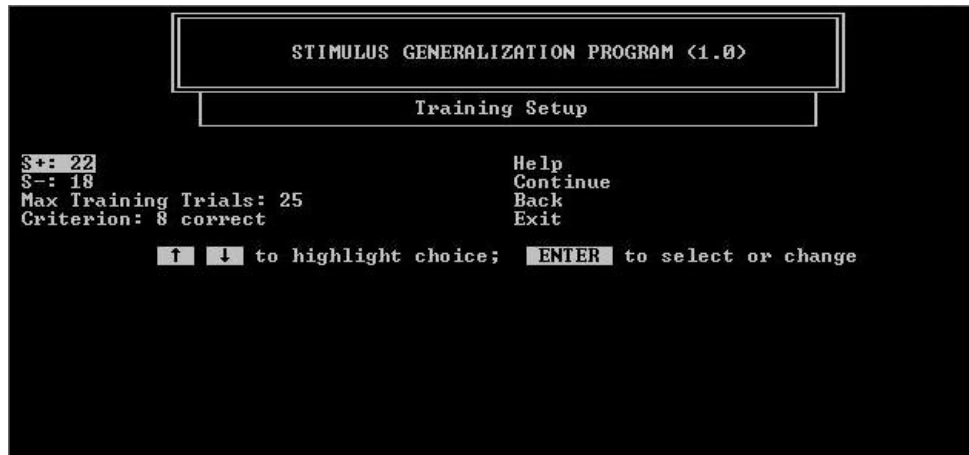


Figure 2. Screen shot of the Training Setup menu.

Once the user has set up the program, a screen will appear with brief instructions for the participant. At this point, the user should turn the computer over to the participant. The instructions are relatively brief and the user may choose to provide additional information for participants. The participant initiates the session by pressing a key. Responses during training and testing follow a go/no-go procedure (i.e., participants are instructed to respond to S+ by pressing the spacebar and to refrain from responding to S-).

During discrimination training, S+ and S- are presented in a semi-random sequence. When the maximum of 40 training trials is selected, the specific order is as follows: S+, S-, S+, S+, S-, S-, S-, S-, S-, S+, S+, S-, S-, S+, S+, S-, S+, S+, S-, S+, S-, S-, S-, S+, S-, S+, S+, S-, S-, S+, S+, S-, S-, S+, S+, S+, S-, S-. The selection of fewer training trials for the participant produces only a part of this sequence. During the generalization test, the presentation of test lines is organized into a series of cycles, in which each line appears once (in a truly random sequence), before the next cycle begins.

Under the default settings, data collection takes approximately 30 minutes. At the end of the session, a message appears thanking the participant. A key press at this point generates a separate data file that saves the participants' responses and closes the data collection program. The data file is saved to the folder or directory containing the data collection program.

### *The Data Analysis Program*

The data are analyzed using Peak Shift.xls. This Microsoft Excel file contains macros that are used to open a saved data file and sort the data into a spreadsheet. The macros feature in Excel first must be enabled. The user can store data for up to six conditions, labeled Condition 1 through Condition 6. The data for each condition are organized in a separate spreadsheet, and data for up to 20 participants can be added to a given condition's spreadsheet. The user determines which conditions in the data collection procedures he or she is using will correspond with which conditions in the Excel file.

To add data to the Excel file, the user must select the Menu spreadsheet, and then click on the button for the appropriate condition. A window will appear that allows the user to select and open the data file. The user should search for all files, not just Excel files, when locating the data file. After the file is opened, the data are organized in the condition's spreadsheet, and at the same time a graph of the generalization gradient is created (or, if already in place, updated).

### *Selecting the Stimuli*

Users of the computer program should be aware that peak shift may not be obtained unless S+ and S- are relatively similar to each other (cf. Derrne, 2006); conversely, if the two stimuli are too similar, participants will be unable to discriminate them. The user may wish to vary S+, S- similarity as a systematic replication of Hanson's (1959) original experiment on peak shift. Another possibility is that the user may wish to examine how variations in the organization of the generalization test affect responding. Research has shown, for example, that if S+ is not located centrally within the range of test stimuli, responding may shift away from S+ and towards middling stimulus values (e.g., Helson & Avant, 1967; Newlin, Rodgers, Dickson, Strub, & Thomas, 1978; Thomas, Strub, & Dickson, 1974). The so-called frequency effect (Hébert, Bullock, Levitt, Woodward, & McGuirk, 1974; Thomas, Lusky, & Morrison, 1992), and range effect (Spetch et al., 2004; Thomas, Mood, Morisson, & Wiertelak, 1991) can also be examined.

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## Author Note

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