THE EFFECTS OF SHAPING AND INSTRUCTION-BASED PROCEDURES ON BEHAVIORAL VARIABILITY DURING ACQUISITION AND EXTINCTION

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This study examined effects of two response acquisition procedures on topography of responding using the revealed operant technique and compared results to previous experiments on this topic. Subjects emitted 100 repetitions each of 4 response patterns on a continuous schedule of reinforcement. A 30-min extinction condition followed acquisition. One group of subjects learned the first response through a series of shaping steps designed to reduce acquisition variability. Another group of subjects was instructed in the correct response topography and was told there was no penalty for attempting other sequences. The first group of subjects produced high variability during extinction despite reduced variability in acquisition. The second group of subjects responded with moderate to high variability during extinction and little variability during acquisition. Most extinction responses for the first group were variations of the last pattern reinforced. Most extinction responses for the second group were repetitions of the last pattern reinforced.

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CHAPTER 1

INTRODUCTION

Behavioral variability may be crucial to an organism's adaptation to its environment. Variability in responding provides new behaviors that contribute to repertoire development through the process of selection by consequences (Epstein, 1985; Neuringer, 1993; Skinner, 1986). Thus, variability is an essential part of learning and development. There is a small body of empirical work studying variability in the laboratory. Neuringer (1993), studying rats responding on two levers, demonstrated that particular two-response sequences within variable four-response sequences could be increased by differentially reinforcing only sequences containing those two responses. Epstein (1985) reported that human-like problem solving can be demonstrated in pigeons when variations or blends of previously reinforced responses occur during extinction conditions. According to both Neuringer and Epstein, variation in response topography was critical for reinforcement. If the subjects had continued to emit the same previously reinforced response topographies, no new responses would have been available for reinforcement, and the original responses would have eventually extinguished. Therefore, extinction may be a source of variability in responding.

The work of Epstein and Medalie (1983) relied on extinction to produce the new blends of responses that resulted in problem solving. Epstein and Medalie trained a pigeon to peck a key and then gradually moved the key into a rectangular hole and out of the pigeon's reach so that attempts at key pecking were not successful. In the next phase, they trained the pigeon to move a rectangular box around the experimental chamber and then withheld reinforcement for moving the box. After some wing flapping and head bobbing, the pigeon moved the box so that it touched the response key and then pecked the end of the box resulting in microswitch closure and access to grain. Epstein was interested primarily in examining resurgence, the appearance of previously reinforced responding in an extinction condition, and its role in problem solving. However, more complex forms of response variation, such as the blending or sequencing of previously responses were also observed.

Nakajima and Sato (1993) reported results similar to those of Epstein and Medalie (1983). In their experiment, however, pigeons had to learn to move a box obstructing a response key rather than have the box contact the key. Some of the pigeons had been trained to move the box around the chamber in an earlier condition and some had not received this training. These authors also reported that ancillary behavior such as wing flapping, head bobbing, preening, and box pecking occurred during the response key obstruction phase. Only the pigeons that had been trained to push the box earlier solved the obstruction problem by moving the box enough to allow access to the response key. Nakajima and Sato interpreted the recurrence of the previously trained box-pushing behavior as extinction-induced resurgence.

Leitenberg, Rawson, and Mulick (1975) examined factors that may modulate resurgence. Their research included the investigation of the effects of reinforcing different response topographies (i.e., lever pressing and licking a lick tube), effects of various reinforcement schedules, maintenance of the alternative behavior for extended periods of time, and discrimination training on resurgence of previously reinforced responding. Leitenberg et al. found that high frequencies of reinforcement resulted in more resurgence, increasing the number of sessions of alternative response training reduced levels of resurgence, and resurgence was more likely during discrimination training than during procedures in which alternative responses were simply extinguished.

Other studies have examined variability during extinction without explicitly examining extinction-induced resurgence. Margulies (1961) found that extinction increased the duration of rats' lever presses over durations obtained in a previous reinforcement phase. Mechner (1958) found that successive single key response runs varied more during extinction than during training. Eckerman and Lanson (1969) found that pigeons' key pecking tended to vary in location more during intermittent reinforcement and extinction conditions than during continuous reinforcement conditions. Wong (1978) noted that rats' sand digging and water drinking increased during extinction of lever pressing.

Little research, however, has been conducted examining the variability of human responding during extinction conditions. Goh and Iwata (1994) noted increases in aggressive behavior during extinction of the self-injurious behavior of a developmentally disabled adult male. Kelly and Hake (1970) reported that teenage males were more likely to punch a pillow to stop an aversive noise when points were withheld for button pressing in a laboratory experiment. In a review of studies using extinction as a form of treatment for self-injury, Lerman, Iwata, and Wallace (1999) reported that aggression was more likely when extinction was implemented alone. None of these studies, however, explicitly manipulated factors that may have contributed to increased aggression during extinction conditions.

Morgan and Lee (1996) exposed college students' spacebar presses to a series of differential reinforcement of low rate (DRL) contingencies followed by extinction. These researchers found that interresponse time (IRT) distributions varied widely during extinction and were characterized by abrupt shifts from very long IRT values to very short IRT values. Morgan and Lee suggested that variability in IRTs was necessary for selection of new IRT distributions during the prior series of DRL contingencies and thus IRT variation in extinction was also high. They also suggested that the periodic appearance of IRTs in extinction that fell in the range of the previously-reinforced IRTs were examples of resurgent behavior.

Instructions have been shown to be a major factor affecting variability and adaptations to changes in reinforcement contingencies. Joyce and Chase (1990) demonstrated that instructions specifying how to respond functioned to restrict variability of responding so much that, at the point of change from one reinforcement schedule to another, no new responses were available to be selected by the new reinforcement contingencies. Under these conditions, responding appropriate to the old reinforcement schedule persisted and, therefore, behavior was not sensitive to the new schedule. A strategic instruction to respond variably, however, did produce schedule sensitive behavior.

Another aspect of experimenter-given instructions has been alleged to play a major role in determining sensitivity to changes in reinforcement contingencies. Hayes, Brownstein, Zettle, Rosenfarb, and Korn (1986) and Hayes (1989) have argued that experimenter-given instructions often function as plys. A ply is a rule that is followed because of consequences provided by the instruction-giver for complying with the instruction. In this analysis, insensitivity to changing reinforcement schedules occurs because persistence of the old behavior pattern is a form of pliance (rule-following under the control of a ply). The experimenter's instruction regarding how to respond is thought to function as a ply because of the similarity to other situations in which instructions were accompanied by pliance contingencies (positive or negative reinforcement provided by an instruction-giver for complying with the instruction).

This analysis suggests that a history of pliance, together with similar stimulus conditions surrounding the instruction, may be sufficient to generate pliance, even if pliance contingencies are not active in that situation. Hayes et al. (1986) suggested that sensitivity to changing reinforcement schedules was hindered by pliance, even though pliance contingencies were not directly manipulated. Hayes et al. inferred that experimenter-given instructions were similar enough to plys in the subjects' histories that they functioned as plys in the experiment.

Neff (1997) proposed that a ply embedded in the instructional context may have affected the extinction responding of subjects who received instructions regarding task acquisition. Neff compared two different methods of response acquisition on extinction performances of college students using a simplified variation of the revealed operant procedure developed by Mechner, Hyten, Field and Madden (1997). Neff (1997) trained college students to emit one of four keypress sequences. The correct sequence was determined by a correspondence between colored dots on the keyboard and the color of an on-screen stimulus. A response consisted of the press of the spacebar, pressing certain alphanumeric keys, and finally pressing the enter key. With this response definition, Neff was able to measure changes in topography that occurred within the response such as which keys were pressed and the order in which the keys were pressed allowing examination of complex patterns of responding.

In order to earn points, the subject had to begin a response with the spacebar, press the four keys that corresponded to the on-screen stimulus color from left to right, and then press the enter key. Correct responses were reinforced on a continuous schedule. During each of four acquisition phases only one pattern of alphanumeric keypresses was reinforced on a continuous schedule. Subjects had to emit 100 reinforced responses of a pattern before moving to the next acquisition phase. At the end of acquisition, subjects had emitted 100 responses of pattern 1 (P1) followed by 100 responses of pattern 2 (P2), 100 of pattern 3 (P4), and 100 of pattern 4 (P4). Following completion of the four acquisition phases, a 30-min extinction condition was presented, in which the on-screen stimulus remained the same as in the final acquisition phase. No points were available during extinction.

Two groups were used in this study, each with a different type of instructional history. The Trial-and-Error Group was only told to press the spacebar, some keys, and then the enter key. This group emitted highly variable responding during initial acquisition phases, low variability during later acquisition phases, and then emitted highly variable responding during extinction. Variability was evident in rates of responding, types of responses, the total percentages of response types, and the number of different response types. One subject, however, displayed very little variability in response topography during initial acquisition and then emitted little topographical variability during extinction.

To determine if variability during acquisition affected variability during extinction, Neff (1997) ran the Explicit Instruction Group, which received instructions specifying exactly how to respond correctly. This group was told to press the spacebar, press the keys with the dots that corresponded to the color on the screen in order from right to left, and then press the enter key. Subjects subsequently emitted almost no variability during acquisition and little variability during extinction.

Neff (1997) suggested two possible reasons why the explicit instruction could have functioned to reduce variability of responding during extinction. The first suggestion was that reduced variability of responding during acquisition functioned to reduce variability of responding during extinction. This suggestion was based on the observation that one subject who responded with little topographical variability during acquisition also responded with little topographical variability during extinction. The second suggestion was that subjects' histories of aversive consequences for violating rules in similar settings may have inhibited variability (a pliance effect) even though no penalty for variability was stated in the instructions.

The former suggestion, that the amount of variability in acquisition may affect variability during extinction, is consistent with the findings of Joyce and Chase (1990). These researchers showed that the amount of variability prior to a contingency change may influence variability after that change. It is also consistent with the findings of Stokes, Mechner and Balsam (1999), even though they studied only acquisition and maintenance conditions, not extinction. Using a procedure similar to Neff (1997), Stokes et al. (1999) varied the number of steps required to acquire a response and whether the acquisition steps were shaped or instructed. They found that during early acquisition when a large step in shaping immediately followed a small shaping step, subjects were more likely to respond variably later during task maintenance phases. Stokes et al. suggested that reinforcement for response variability during early acquisition may have resulted in more response variability during later stages of acquisition and maintenance.

Neff's second account, that the Explicit Instruction Group subjects' lack of variability during extinction could have been an example of pliance, is also plausible but little empirical data can be used to evaluate this proposition because very few studies have experimentally manipulated pliance contingencies. Suggestions of pliance effects remain largely interpretations based on inferred common histories. One study that addressed the issue of the pliance contingency accompanying an instruction is Barrett, Deitz, Gaydos, and Quinn (1987). Barrett et al. found that subjects instructed to be variable responded more variably during extinction conditions if the experimenter remained in the room than those subjects who received the same instructions but with whom the experimenter did not remain in the room. The experimenter's presence presumably implied that complying with the instruction was more likely to be reinforced by the experimenter and noncompliance was likely to be punished. Barrett et al. (1987) demonstrated that the presumed pliance-inducing element of instructions can be enhanced. These experimenters, however, did not demonstrate how pliance might be reduced.

Neff (1997) suggested that future research should attempt to separate the confounding of the explicit instruction’s potential pliance-inducing aspect from the instruction's variability-reducing effect during acquisition. He suggested that one way to accomplish this would be to reduce the variability of responding during acquisition without an instruction by using a shaping procedure that minimized variability. The purpose of the current study is to investigate the two explanations proposed by Neff (1997) for the low extinction variability produced by an explicit instruction.

First, a low-variability shaping procedure, rather than instructions, was used to teach subjects to emit the criterion response and then complete the four acquisition phases reported by Neff. This condition examined the role of low acquisition variability on subsequent variability in extinction without the pliance-inducing element of an instruction. Second, the possibility that a ply was embedded in the instructional context was evaluated. Subjects were given the same instructions as the Explicit Instruction group with the addition of a statement that said that no penalty would be incurred for deviation from the instructions. This condition sought to examine whether a manipulation designed to reduce pliance would increase variability in extinction. If it did so, that would suggest that the pliance-inducing element of the instructions used in Neff's (1997) Explicit Instruction Group was a major factor in the low extinction variability obtained in that experiment. Results from these two new groups (Low Variability

Shaping Group and the "No Penalty" Group) were compared to the Trial-and-Error Group and the Explicit Instruction Group from Neff (1997).

CHAPTER 2

METHOD

Subjects

Twelve students from the University of North Texas were recruited from undergraduate introductory Behavior Analysis courses to participate in this study. Subjects earned $20.00 for their participation.

Apparatus

The apparatus and setting were the same as in Neff (1997). All sessions took place in a small room designated for use in human research experiments. Subjects were seated at a desk that held an IBM-compatible computer, a fourteen-inch color monitor, and a standard QWERTY keyboard. Small, colored, adhesive dots were placed on some of the keyboard keys. The 1357 keys of row one had blue dots. The QETU keys of row two had green dots. The ADGJ keys of row 3 had yellow dots. The ZCBM keys of row 4 had lavender dots.

General Procedures

Each subject was taken to the experiment room and asked to sit in a chair facing the computer. The experimenter then read the instructions aloud to the subject as the subject read them silently. If the subject had any questions, the experimenter repeated the relevant portion of the instructions. After questions were addressed, the experimenter left the room. A copy of the instructions remained on the table next to the keyboard.

A message on the screen read “press any key to begin”. Any keypress initiated the beginning of the session and brought a colored rectangle corresponding to one of the sets of colored dots on the keyboard onto the monitor screen. A red rectangle served as a background stimulus. After subjects initiated a response by pressing the spacebar, the red background stimulus disappeared. If the subjects pressed at least four alphanumeric keys after pressing the spacebar, a small gray rectangle appeared. Pressing the spacebar followed by the correct four-key sequence and finishing the response by pressing the enter key resulted in a four-toned chime sound and the appearance of a one-s message that read “.05”. This message indicated that the subject had earned five cents. A two-toned chime and the representation of the red background with the colored rectangle followed incorrect responses of 4 or more keys. Responses not composed of at least 4 alphanumeric keys, excluding the spacebar and the enter key, were followed by the presentation of the red background and the colored rectangle without a chime sound. Each subject was instructed to use only the index finger of his or her dominant hand throughout the experiment. Subjects earned five cents for each correct response during the acquisition phase of this experiment. Incorrect responses were never reinforced during any of the conditions.

Acquisition patterns were presented beginning with either the first row (1357) or the fourth row (ZCBM), and the order of pattern presentation moved either up or down the keyboard accordingly. If the first acquisition pattern was 1357, the rest of the patterns were presented in the order QETU, ADGJ, and ZCBM. If the first acquisition pattern was ZCBM, the rest of the patterns were presented in the order ADGJ, QETU, and 1357. Moving the order of pattern presentations systematically across subjects up or down the keyboard allowed for the evaluation of differences in responding due to the keyboard configuration.

During the acquisition condition, subjects emitted 100 correct responses of each pattern before moving to the next pattern in the experiment. For example, if a subject began with 1357 as the first acquisition pattern, that subject had to emit 100 correct 1357 responses in phase 1 before moving to the second acquisition pattern, QETU. If the subject started phase 1 at the bottom of the keyboard with ZCBM, the subject had to emit 100 correct responses of ZCBM before moving to the second pattern, ADGJ. A 10-s pause followed the completion of each acquisition phase. A total of 400 correct responses were emitted across the 4 acquisition phases.

Following completion of all 4 acquisition phases, a 30-min extinction condition began. During this condition, no responses received reinforcement. The colored rectangle stimulus associated with the fourth response pattern in acquisition remained on screen throughout this condition. A two-toned chime followed all responses containing at least 4 alphanumeric keys between the presses of the spacebar and the enter key. Responses of less than 4 keys resulted in the stimuli being represented without a chime sound. Following completion of the extinction phase, subjects were paid the $20.00 they earned during the acquisition phases.

Low Variability Shaping Group

The Low Variability Shaping Group was exposed to a series of progressively more complex keyboard configurations beginning with the simplest key configuration and ending with the complete keyboard used in the rest of the experiment. The plan was for subjects to learn to emit the complete response pattern (e.g., spacebar, 1357, enter) in steps of 1 alphanumeric key, then 2 alphanumeric keys, then 3, and then all 4 alphanumeric keys. This shaping procedure was intended to reduce response variability during acquisition in order to allow for the assessment of the effects of low variability in acquisition without confounding instructional effects. At the beginning of the shaping phase, all keys were removed from the keyboard with the exception of the spacebar, either the ‘1’ or the ‘Z’ key (depending on whether they would begin acquisition training from the top or bottom of the keyboard), and the enter key. A colored dot on that alphanumeric key corresponded to the colored rectangle presented on the computer screen. With the exception of one subject, S38, the rest of the keyboard was covered with a keyboard shield that was designed to prevent pressing of the keys. For S38, the key caps were removed from the keyboard but the keyboard shield was not on the keyboard. All subjects in the Low Variability Shaping Group received the same minimal instruction as the Trial-and-Error Group in Neff (1997). They were informed that they would have to press the spacebar to begin a response, press some keys, and then press the enter key.

Following completion of 5 reinforced responses of pressing the spacebar, making a single press on the ‘1’ key or the ‘Z’ key, and the enter key, a message on the monitor screen instructed the subject to inform the experimenter that the session was finished. The experimenter then asked the subject to wait in an adjoining room for a moment. During this time, the experimenter added a second key cap, either the ‘3’ or the ‘C’, onto the keyboard, changed keyboard shields to accommodate the new key, and restarted the program. The subject was then readmitted into the experiment room and told that the instructions were the same as the previous session. This time the subject had to press the spacebar, the ‘1’ and ‘3’ keys or the ‘Z’ and ‘C’ keys in order from left to right, and then press the enter key to complete a correct response. This response was also reinforced 5 times before a computer message instructed the subject to inform the experimenter that the session was finished.

This sequence was repeated adding 1 key at a time until the subject emitted 5 reinforced repetitions of the complete phase 1 acquisition pattern. After the subject left the room following this final shaping step, the experimenter replaced the keyboard used in the shaping procedure with a different keyboard that had all of the key caps connected and all of the colored dots already in place. This time, when the experiment restarted, subjects began at the beginning of phase 1. They had to emit 100 reinforced repetitions of P1 before moving to the next acquisition phase. If subjects emitted more than 10 errors during the shaping procedure, their participation in the experiment was terminated at the end of the shaping phase.

“No Penalty” Group

The “No Penalty” Group received instructions similar to the Explicit Instruction Group in Neff (1997). These instructions specified that the subject had to press the alphanumeric keys with dots that matched the colored rectangle on screen in a left to right manner to earn money (see Appendix A). The only difference in the instructions between the “No Penalty” Group and the Explicit Instruction Group was that the statement “There is no penalty of any kind for attempting other sequences at any point during this experiment” was added following the instruction specifying the correct key sequence.

The “no penalty” statement was designed to reduce variability-restricting pliance likely to be generated by the topography-specifying instruction. The wording of the “no penalty” statement was chosen to permit variability without directly encouraging it. The statement was designed to let subjects know that there were no prohibitions against response variability. These subjects did not go through a shaping phase prior to the beginning of the acquisition condition. Instead, the first phase of acquisition began after the experimenter and the subject finished reading the instructions.

CHAPTER 3

RESULTS

Detailed analyses of response topographies were conducted by grouping responses into categories and summarizing performances in acquisition and extinction conditions. These categories attempted to retain the information obtained about individual responses while providing useful information about differences in responding during each condition. Data will be presented in the following order: a detailed analysis of response types across categories during acquisition and extinction conditions, and two graphical summaries of variability during extinction (see Appendix B for figures). In order for a series of keypresses to be scored as a response, the sequence had to begin with the spacebar, some alphanumeric keys had to be pressed, and then the enter key had to be pressed to end the response. Keystroke sequences not involving the press of the spacebar or the enter key were not scored as responses.

Individual Response Type Variability Charts

Figures 1-4 present one form of response topography classification first reported by Neff (1997). Alphanumeric keypresses within a response have been divided into response type categories and classified according to pattern element contribution (indicating to which of the four reinforced response patterns they are most related). Columns of the chart are formed by pattern element contribution, with P1 standing for the response pattern first reinforced in acquisition, P2 as the second, and so on. Rows are divided into eight response type categories and one “other/word” category. These categories have been placed in order of most similar to the reinforced acquisition patterns, beginning at the top with “pure” patterns, to least similar to the reinforced acquisition patterns, the “other/word” category at the bottom of the chart. A large number of responses at the top of the chart indicates responding closely related topographically to the reinforced acquisition patterns. A large number of responses at the bottom of the chart indicates responding less directly related to the acquisition patterns.

Eight of the possible 9 response type categories have been distributed according to the acquisition pattern to which each response is related. Responses in the last category, “other/word”, were not distributed across the 4 acquisition patterns because no clear pattern element contribution could be established. The left side of the chart presents data from the first acquisition phase (in which P1 was reinforced 100 times), and the right side of the chart presents data from the entire extinction condition. The same analysis was conducted for acquisition phases 2, 3, and 4 but the data are not presented because all groups responded similarly with almost no variability during these phases. Data from acquisition phases 2, 3, and 4 will be shown in later graphs.

“Pure” response types, at the top of the chart, were exact replications of 1 of the 4 patterns reinforced during the acquisition condition. A "backpat" response was the reproduction of 1 of the 4 acquisition patterns in reverse order. A "mixpat" response reproduced 1 of the 4 acquisition patterns in a jumbled sequence. Mixpat responses could include any order of the reinforced pattern alphanumeric keystrokes other than the reinforced sequence or its backward version as long as all alphanumeric keystrokes belonged to the same acquisition pattern. For a subject who learned the alphanumeric key patterns starting with the bottom pattern (ZCBM), a pure P1 would be ZCBM, a backpat 1 would be MBCZ, and a mixpat 1 might be BCZM.

The "mostpat" response type is the next category below mixpat. To be scored as a mostpat, at least 51% of the alphanumeric keystrokes had to be from one of the acquisition patterns while the remaining alphanumeric keystrokes could be from another acquisition pattern or any other keystroke. For instance, the response ZXCBM would be scored as a mostpat 1 because the ‘X’ was not part of the reinforced key sequence. Responses with a single alphanumeric keystroke from one of the acquisition patterns such as ‘Z’ as well as responses that contained only part of a pattern such as ‘ZCB’ were also scored as mostpat responses.

Continuing down the response type column and away from pure pattern responses, a response was scored in the "single repeat" category if a single key from one of the reinforced patterns was pressed repeatedly. An example of a single repeat response might be ZZZZ or QQQQ. The response had to contain multiple presses on a single key and the key pressed had to be part of one of the reinforced patterns.

A "half/half" response was scored if 50% of the keystrokes were from one acquisition pattern while the other 50% were from another acquisition pattern. When a half/half response was scored, .5 of the response was allocated to each of the patterns. As an example, the response C1Z5 would be scored as half P1/half P4 and .5 would be placed in the P1 and P4 half/half bins.

A vertical pattern was scored when the response included one and only one keystroke from each row of the keyboard. Pattern element contribution was scored according to the row or pattern in which the first key was pressed. The response ZAQ1, for a subject whose first acquisition pattern was on the bottom row, would be scored as a vertical P1. If the same subject responded RF4V a vertical P3 would be scored.

Preference in scoring was given to the pattern or row on which the vertical response started because subjects indicated that the first key pressed was the most important key (Neff, 1997). Vertical pattern responses did not necessarily consist of previously reinforced keystrokes; a response was still scored a vertical P1 if it began in the P1 row of keys (e.g., XSW2) because it originated with a keystroke in the same row as keys belonging to the P1 response.

Similarly, the "mostrow" category did not require keypresses that were part of the acquisition patterns. Indeed, at least 50% of the response had to be from keys not part of the acquisition patterns. A mostrow would be scored if the response was SFHK because none of those keystrokes were part of the acquisition patterns. A second example of a mostrow response is ASDFH because at least 50% of this response was formed by keypresses unreinforced in acquisition.

Responses that could not be classified as belonging to one of the above categories including names, initials, or words were placed in the other/word category. Responses in this category were not placed into row or pattern columns because no clear pattern element contribution could be established.

Below the chart is a count of the number of responses emitted in that phase or condition together with a variability measure. A simple metric for summarizing how variable behavior was during a phase or condition was derived from the number of response type bins occupied by at least one occurrence, divided by the total possible bins (33) and expressed as a percentage. This variability percentage measures how variable behavior was in terms of how many different response types were emitted. One occurrence of a response type is counted as heavily as 500 occurrences in that response type bin, so this metric cannot summarize the full scope of variability shown in the chart.

An example of the use of this chart may help to clarify this classification system. Figure 1 presents the data of S28 of the Low Variability Shaping Group. Data from the shaping phase are not included because all subjects shown here completed shaping with less than 10 incorrect responses. Following the shaping phase, this subject began the standard acquisition phase with the 1357 pattern. During phase 1 acquisition, this subject's first response was the alphanumeric key '1'. This response was categorized as a mostpat 1. Later this subject also responded with alphanumeric keystrokes of `1357, 12357, and 357 for a total of 4 mostpat 1 responses. Three vertical P1 responses, 5TGB, 3EDC, 1QAZ were emitted as well as 1 vertical P4. Also, S28 responded with QETU, a pure P2 response, ADGJ, a pure P3 response, and ZCBM, a pure P4 response, one time each. This subject completed the necessary 100 responses for moving to acquisition phase 2 resulting in 111 total responses during acquisition phase 1. A total of 7 of the possible 33 bins were filled for a response type variability of 21% during phase1 acquisition.

S28's extinction condition data shows examples of other response type categories. This subject responded with the alphanumeric key sequence of UTEQ twice, a backpat 4 response, and 8 mixpat 4 responses such as BMCZ and CBMZ. The 4 single repeat 1 responses were 1111, 3333, 5555, and 7777. Examples of half/half responses were QEBM (half 2/half 4), ZDCA (half 4/half 3), and DEDE (half 3/half 2). S28 also emitted 21 “other/word” responses such as JU7 and 5EWDC.

The low variability shaping procedure was not successful in eliminating all variability during phase 1 acquisition. Most subjects emitted at least a few responses that were classified in bins other than the pure P1 bin. These variable responses typically included pure P2, P3, or P4 as well as variations of P1 such as vertical P1 and mostpat 1 responses. Response acquisition variability during phase 1 for the Low Variability Shaping Group ranged from 3% to 27%. This variability occurred despite completing the required pattern 5 times in the shaping phase before beginning acquisition phase 1.

During extinction, subjects in the Low Variability Shaping Group emitted primarily P4-related responses. Subjects also emitted responses categorized in other bins, however. Variability percentages for this group ranged from 49% to 79%.

Unlike the Low Variability Shaping Group, subjects in the “No Penalty” Group emitted little or no response variability during acquisition (see Figures 3 and 4). Variability percentages during P1 acquisition ranged of 3% to 6%.

During extinction, the “No Penalty” Group subjects emitted responses primarily P4-related, but with a much higher proportion of pure P4 responses than that seen in the Low Variability Shaping Group. The “No Penalty” Group subjects emitted some responses classified in the other categories as well, but typically did not fill as many bins as the Low Variability Shaping Group. The range of variability percentages in extinction for the "No Penalty" Group was 6% to 58%, and 4/6 subjects had variability measures between 40 and 60%, overlapping with the lower end of the range of variability measures of the Low Variability Shaping Group.

Differences in response type variability percentages in all 4 acquisition phases and the extinction condition are summarized by the Response Type Variability Graph (Figures 5 and 6). Figure 5 shows the percentage of the 33 possible response bins filled by each subject during the entire acquisition condition and the extinction condition for the Low Variability Shaping Group and the “No Penalty” Group. The same information for the two reference groups of Neff (1997), the Trial-and-Error Group and the Explicit Instruction Group, is shown in Figure 6 to enable comparison among the 4 groups. Figures 5 and 6 present the percentage of response type variability along the y-axis. Each acquisition phase and the extinction condition are presented along the x-axis.

The top half of Figure 5 presents the percentage of response type variability for the Low Variability Shaping Group. During P1 acquisition, response type variability ranged from 3% to 27%. During phase 2, phase 3, and phase 4 very little response variability occurred. During the subsequent extinction condition, however, response type variability ranged from 48% to 79%.

Despite the variability observed in acquisition phase 1 for the Low Variability Shaping Group, 4 of the 6 subjects emitted less variability during acquisition phase 1 than did 4 of the 6 subjects in Neff’s Trial-and-Error Group. However, the Low Variability Shaping Group was still more variable than Neff’s Explicit Instruction Group during P1 acquisition. During extinction, subjects in both the Low Variability Shaping Group and the Trial-and-Error Group emitted high amounts of response type variability. Subjects in

Neff's Explicit Instruction Group continued to respond with little response type variability during extinction.

Highly stable response topographies during the response acquisition condition characterized performance by the “No Penalty” Group. Variability percentages ranged only from 3% to 6%, similar to that produced by Neff's Explicit Instruction Group during acquisition. Despite response type stability throughout the acquisition condition, "No Penalty" subjects emitted variable response topographies during extinction, ranging from 6% to 58% of bins filled. Four of the 6 subjects’ variability percentages in extinction were greater than the variability percentages of 5 of the 6 subjects in Neff's Explicit Instruction Group. Variability percentages of the "No Penalty" subjects during extinction overlapped with the ranges of extinction variability seen in Neff's Trial-and-Error Group and the Low Variability Shaping Group, but fell in the lower end of those ranges.

Pattern Element Contribution Bar Graphs

Figures 7-10 present a second method of examining subjects’ responding in extinction, independent of the classification system used with the Response Type Variability Charts. Data are classified according to pattern element contribution and 4 response categories for the extinction condition. Pattern Element Contribution graphs arrange each of the 4 acquisition patterns plus an ‘other’ category along the x-axis and percentage of total extinction responses along the y-axis. Varied colors within the stacked bar graphs depict the 4 response categories. Figures 7, 8, 9, and 10 show Pattern Element Contribution Graphs for the Low Variability Shaping Group, the “No Penalty” Group, the Trial-and-Error Group, and the Explicit Instruction Group, respectively.

Each response was assigned to 1 of the 4 acquisition patterns according to the percentage of alphanumeric keystrokes within the response. If 51% of the alphanumeric keystrokes of a response were from a single acquisition pattern or from the same row of keys as that pattern that response was classified as having its elements contributed by that pattern. For example, if a subject's first acquisition pattern was 1357, QET13 would be classified as having P2 element contribution because more than 51% of the alphanumeric keystrokes are from P2. This classification was designed to attribute the response to the pattern or row that seemed to be controlling the majority of the response topography. When subjects emitted vertical pattern responses, those that had a single alphanumeric keypress on each of the 4 rows, the pattern from the row on which the first alphanumeric key press occurred was credited with the pattern element contribution. An example would be AQ1Z, assuming the first pattern learned was 1357, the pattern element contribution would be P3. The P3 designation would be assigned because the first alphanumeric key press was on the third row. If half of the alphanumeric key presses of a response were from one acquisition pattern or row and the other half of the alphanumeric key presses of the same response were from another acquisition pattern or row, each of the two patterns were attributed .5 of the response. Again assuming that 1357 was the first pattern learned, the response EDTG would be scored as .5 P3 and .5 P2. This half/half classification was used because neither of the patterns could be considered to exert more control over the topography of the response than the other. If a response could not be attributed a pattern contribution or the alphanumeric key presses formed words or the subject's initials, the response was assigned to the "other/word" category.

Within the pattern element contribution classification, responses were assigned to 1 of 4 categories. These categories were pure, blend of reinforced key strokes (BR), blends of reinforced and unreinforced keystrokes (BRU), and unreinforced keystrokes (U). Responses in extinction that were repetitions of 1 of the 4 responses reinforced during the acquisition condition were categorized as a pure pattern and denoted by the color red. For instance, if the first pattern that the subject learned during acquisition was 1357, then during extinction any responses that were 1357 exactly were placed in the pure P1 category. A response consisting of a blend of keystrokes from any of the 16 keystrokes comprising the 4 reinforced patterns was placed in the BR category and depicted by dark blue. Responses with reinforced and unreinforced keystroke components, for instance ZSXCM, were scored in the BRU category and are represented by light blue. Responses consisting entirely of keystrokes unreinforced as part of the acquisition condition were placed in the 'U' category and represented by green. An example of the latter would be SFHK. The categories BR, BRU, and U represent progressively dissimilar topographies from those of the pure patterns reinforced during acquisition.

As seen in the Response Type Variability Charts, responding for subjects in the Low Variability Shaping Group was dominated by P4 contribution alphanumeric keypresses for all subjects except S30, with smaller contributions from P1, P2, P3 classifications, and the 'other' category. Within the dominant P4 contributions, subjects tended to emit primarily responses that fell in the BR category. That is, subjects emitted responses that were mainly variations of the P4 keystroke sequence. Two subjects, S30 and S31 also emitted large percentages of ‘U’ category responses. The responses of these subjects were characterized by high-rate pressing of the alphanumeric keys nearest the enter key and followed a general drift of alphanumeric key pressing across the keyboard as the session progressed until alphanumeric keypressing was clustered in a zone falling efficiently between the spacebar and the enter key. Keypresses in this proximity to the enter key yielded classifications as U responses with row 3 or row 4 contribution.

With the exception of the 2 subjects who engaged in high percentages of U responding, the percentages of pattern element contribution are very similar to Neff’s Trial-and-Error Group (Figure 9). For this group, responding was characterized largely by P4 element contribution with the highest percentage of responses categorized as BR.

Responding for the “No Penalty” Group (Figure 8) closely resembles that of Neff’s Explicit Instruction Group (Figure10). For both the Explicit Instruction Group and the “No Penalty” Group almost all responding consisted of pure P4 responses. Subjects in the "No Penalty" Group produced more variability during extinction conditions than did subjects in Neff's Explicit Instruction Group, but these differences are difficult to identify in these stacked bar graphs. That is because a small number of occurrences of several different response types generated very low percentages, and this kind of variability becomes almost invisible (see the data of S40 and S41 for an example). Large amounts of ‘U’ category responses by S35 are similar in topography to those of S30 and S31 of the Low Variability Shaping Group.

CHAPTER 4

DISCUSSION

The Low Variability Shaping Group produced low acquisition variability, lower than the majority of Trial-and-Error Group subjects but not as low as Explicit Instruction Group subjects. Unlike the Trial-and-Error Group subjects, Low Variability Shaping Group subjects had already learned the correct response topography in the shaping condition prior to the beginning of the standard acquisition condition, so any variability occurring in the acquisition phases would seem to have been exploratory in nature. This exploration during acquisition suggests that the low acquisition variability of the Explicit Instruction Group subjects was not due simply to the instruction's effect of informing the subject how to emit a correct response. Both the Explicit Instruction Group subjects and Low Variability Shaping Group subjects knew how to emit a correct response at the beginning of acquisition, yet Low Variability Shaping Group subjects produced slightly higher amounts of variability. Instead, the difference in performance of the 2 groups suggests that some aspect of the explicit instruction given to the Explicit Instruction Group inhibited some variability even in acquisition.

In extinction, the Low Variability Shaping Group produced high levels of variability, more similar to responding of Trial-and-Error Group subjects than Explicit Instruction Group subjects. Variability consisted mostly of BR's of P4 and some BR's of P1, P2, and P3, much like variability in the Trial-and-Error Group. Thus, in the absence of an instruction, higher percentages of variability occurred in extinction even though acquisition variability was fairly low. It does not seem, then, that low variability during acquisition is sufficient to restrict variability during extinction. This finding supports the suggestion that some aspect of the instructions restricted the response variability of Neff's Explicit Instruction Group.

The "no penalty" instruction did have an effect different from the instruction given to the Explicit Instruction Group. The "No Penalty" Group produced low acquisition variability, identical to the Explicit Instruction Group. This finding is consistent with the contention of Stokes et al. (1999) that topography of responding is less variable when instructions about responses are completely specified. However, the "No Penalty" Group produced much more variability in extinction than the Explicit Instruction Group, as measured by percentages of response type. This increased variability adds support to the argument that the amount of variability in acquisition does not predict the amount of variability in extinction. Second, it suggests that the pliance-inducing element of the explicit instruction in Neff (1997) served to inhibit at least some variability in extinction. The "no penalty" statement was intended to reduce the pliance-inducing element, and the effects obtained are consistent with such an explanation.

One could argue that the "no penalty" statement directly prompted more variability in extinction, rather than disinhibiting variability through reducing pliance. But a simple prompting explanation would not be able to explain why variability did not increase in the acquisition phases that immediately followed the instructions. One would also have to explain why the effects of the prompt were delayed until the extinction condition. The alternative explanation suggests that variability was strongly inhibited by the instructional context; however, the “no penalty” statement disinhibited variability after the extinction condition increased motivation to respond variably.

The “No Penalty” Group subjects’ Pattern Element Contribution bar graphs showed that the vast majority of extinction responses were pure P4, more like the Explicit Instruction Group than the Trial-and-Error Group or Low Variability Shaping Group. This P4 extinction responding suggests that specific experimenter-given instructions produce performances that can be distinguished from non-instructed performance based on the nature of the variability rather than the amount of variability.

In a recent experiment studying instructions and extinction effects, Dixon and Hayes (1998) came to a similar but not identical conclusion. Different groups received specific, general, or minimal instructions regarding how to behave in a multiple schedule task that required variable topographies in one component and stereotypic topographies in the other schedule component. In a subsequent extinction condition, those subjects given specific instructions (specifying how to behave differentially in the presence of colored stimuli associated with different multiple schedule components) during acquisition produced more of the originally “correct” discriminated responses than did subjects given general or minimal instructions. Their interpretation of these results stressed that specific instructions given at the beginning of an experiment enhance extinction-induced resurgence to the older of several forms of behavior.

In the present experiment, if one considers pure P4 responses in extinction as resurgent behavior, the findings are similar to those of Dixon and Hayes (1998). However, the fact that subjects in both instructed groups of the present experiment rarely emitted the older forms of resurgent behavior (P1, P2, and P3) suggests a revision of the conclusions of Dixon and Hayes. A specific instruction may not simply enhance resurgence of the oldest of several forms of behavior; if so, P1 responses would have been dominant in extinction. Rather, it seems to suggest that a specific instruction enhances control by what was specified in that instruction even in subsequent extinction conditions. In Dixon and Hayes (1998), the specific instruction specified that behavior should come under the stimulus control of the colored discriminative stimuli associated with each schedule component. If behavior occurred in extinction that was consistent with the original stimulus control present in the first reinforcement condition, Dixon and Hayes classified it as resurgence of the oldest form of behavior. In the present experiment, the instruction common to both the Explicit Instruction Group and the "No Penalty" Group specified that keypresses should occur on keys matching the color of the on-screen stimulus in a left-to-right manner. Because the colored on-screen stimulus in extinction was the stimulus associated with reinforced P4 responses, P4 responding in extinction indicated that subjects were behaving in accordance with the stimulus control specified in the instruction given at the beginning of reinforced acquisition.

Although the "no penalty" statement made subjects more likely to emit some response topographies other than pure P4 responses (enough to produce a quantitative difference in the amount of extinction variability), it did not completely override the strong stimulus control specified in the basic instruction. Perhaps the "no penalty" statement was simply too weak to override powerful pliance-inducing elements of the explicit instruction and its context. Many of the conditions that might reasonably be thought to amplify pliance (see Hayes, Zettle, & Rosenfarb, 1989) remained present for subjects in both of the instruction groups. The situation and task were unfamiliar to the subject, the experimenters were authority figures in this context, and subjects knew their behavior was being recorded and examined by the experimenters. In addition, specific and detailed instructions may be more likely to have been associated with pliance contingencies historically for two reasons: (a) specifying behavior to that degree suggests that compliance with the instruction is important to the instruction-giver, implying a greater likelihood of vigilance and instructor-mediated consequences, and (b) it would be easier for an instruction-giver to detect whether an instruction-recipient is complying with or deviating from a highly specified response form. If this analysis is correct, the “no penalty” statement addressed only the possibility that compliance was important to the instruction-giver. The other factors that may contribute to pliance such as unfamiliarity of the task, experimenters as authority figures, and ease of detection of deviation from the instruction were not addressed. In this light, it is remarkable that the "no penalty" statement had any effect at all on extinction variability. Perhaps a stronger form of “no penalty” statement, or one specifying allowable deviations from the instructed stimulus control, would enable more extinction variability than the form used in the present experiment.

Pliance-inducing elements were not the only factors promoting rule-following for the instructed subjects. Rule-following during acquisition was reinforced by the programmed point deliveries. This means that complying with the instructions was also a form of “tracking”. Tracking is rule-following reinforced by the naturally-occurring outcomes of behavior, as opposed to consequences provided by an instruction-giver for compliance (Zettle & Hayes, 1982). Continuing to follow the instructions during extinction by emitting P4 responses may therefore be a joint function of pliance plus tracking. The "no penalty" statement is unlikely to have affected the influence of the history of tracking because the "no penalty" statement did address the correspondence between the instruction and obtaining points. The present findings suggest that the nature of acquisition conditions, rather than simply the amount of acquisition variability, is crucial in determining variability in a subsequent extinction phase.

This conclusion is consistent with the general conclusion of Stokes et al. (1999) that acquisition procedures affect variability in acquisition and subsequent phases. The current results extend that account to conditions in which extinction is the subsequent phase. However, whereas Stokes et al. explained their effects in terms of a relationship between greater variability early in acquisition and variability in later acquisition and a subsequent reinforcement condition, initial variability levels in acquisition did not predict variability levels later in acquisition or during the terminal extinction condition in the present experiment.

Stokes et al. (1999) used a revealed operant methodology related to the methodology of the present experiment; however, important differences exist between the procedures and the measures of variability used in the two experiments. The first and most obvious difference is that the present experiment exposed subjects to an extinction condition, whereas subjects in Stokes et al. were exposed only to reinforcement conditions. Second, the response definition in Stokes et al. was different than that used in the present experiment. A reinforceable response was composed of at least 10 alphanumeric keystrokes from a particular zone on the keyboard; thus, the number and kind of keystrokes in a reinforced response could vary. This response definition was considerably broader than the one used in the present experiment and probably resulted in more variability occurring throughout the entire reinforced acquisition period. Third, the primary measures of variability focused on the number of keystrokes within a response and how different the keystrokes of any response were from the preceding response (measured by an uncertainty statistic). These differences make comparisons between measures of variability in their study and the present study difficult. Differences in procedures and results suggest that there is much room for further research in the area of examining the behavioral variability of humans.

The findings of the present experiment together with those of Neff (1997), support several tentative conclusions regarding the nature and determinants of variability during extinction. Acquisition conditions strongly influence the nature and amount of variability in a subsequent extinction phase. Extinction variability can be reduced in a laboratory context by a pre-experimental instruction specifying the topography and stimulus control of a reinforceable responses. Extinction variability can be enhanced somewhat by an instructional element designed to reduce pliance. Extinction variability is maximal relative to instructed response acquisition when subjects acquire the response through trial-and-error learning or shaping following minimal pre-experimental instruction.

Instructions have been shown to be a major factor affecting variability and adaptations to changes in reinforcement contingencies. Joyce and Chase (1990) demonstrated that instructions specifying how to respond functioned to restrict variability of responding so much that, at the point of change from one reinforcement schedule to another, no new responses were available to be selected by the new reinforcement contingencies. Under these conditions, responding appropriate to the old reinforcement schedule persisted and, therefore, behavior was not sensitive to the new schedule. A strategic instruction to respond variably, however, did produce schedule sensitive behavior.

APPENDIX A

INSTRUCTIONS

During this study, you will be alone in this room. Your task is to try to earn money by pressing sequences of keys on the keyboard. Start each sequence by pressing the space bar and end each sequence by pressing the enter key. If a colored square in the middle of the screen matches one of the colors on the keyboard, press the matching colored keys in the order of left to right. For example if the square is green, press spacebar, Q E T U, enter.

There is no penalty of any kind for attempting other sequences at any point during this experiment.

When you press a sequence of keys that earns money, a number will flash on the screen indicating the amount of money you earned for that sequence. For example, if $0.05 flash on the screen, it means that you earned a nickel. Each time you see the $0.05 flash, you've earned a nickel.

Use only the index (pointer) finger of your dominant hand throughout the experiment. Continue to use the same hand and finger for the entire experiment. Remember to start each new sequence by pressing the spacebar and to end each sequence by pressing the enter key. Try to see how much money you can get. Good Luck!

Steps to follow to earn money

Step 1: **Press Spacebar**

Step 2: **Press the colored keys that match the screen from left to right**

Step 3: **Press the enter key to complete the sequence and earn money**

APPENDIX B

Figure 1. Response Type Variability Chart. Presents response type variability during Phase 1 and the extinction condition for S28, S29, S30 of the Low Variability Shaping Group. Response type is presented in the rows and the acquisition phase of which the response is a member is presented in the columns. 'Other' responses are presented separately from acquisition phase contribution.

Shaping S28	ACQUISITION Phase 1				EXTINCTION			
	P1	P2	P3	P4	P1	P2	P3	P4
pure	100	1	1	1	4	6	3	9
backpat								2
mixpat								8
mostpat	4				15	20	33	68
sgl. rpt.					4	4	1	11
half/half					7	9	13.5	18.5
vertical	3			1	10		2	77
mostrow					1	1	1	6
other/word		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	21

ACQUISITION: 111 responses EXTINCTION: 355 responses
VARIABILITY: 7/33 = 21% VARIABILITY: 26/33 = 79%

Shaping S29	ACQUISITION Phase 1				EXTINCTION			
	P1	P2	P3	P4	P1	P2	P3	P4
pure	100	2	1		5	4	6	100
backpat					1	1	1	27
mixpat								7
mostpat					8	3	1	54
sgl. rpt.								5
half/half								
vertical					3			8
mostrow					4	3	1	6
other/word	1	XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	11

ACQUISITION: 104 responses EXTINCTION: 259 responses
VARIABILITY: 4/33 = 12% VARIABILITY: 21/33 = 64%

Shaping S30	ACQUISITION Phase 1				EXTINCTION			
	P1	P2	P3	P4	P1	P2	P3	P4
pure	100	1		1	1	3	5	9
backpat								
mixpat								
mostpat	1				7	8	19	15
sgl. rpt.					1		2	16
half/half								
vertical					28			7
mostrow					3	13	520	85
other/word		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	22

ACQUISITION: 103 responses EXTINCTION: 764 responses
VARIABILITY: 4/33 = 12% VARIABILITY: 18/33 = 55%

Figure 2. Response Type Variability Chart. Presents response type variability during Phase 1 and the extinction condition for S31, S32, S33, of the Low Variability Shaping Group. Response type is presented in the rows and the acquisition phase of which the response is a member is presented in the columns. ‘Other’ responses are presented separately from acquisition phase contribution.

Shaping S31	ACQUISITION Phase 1				EXTINCTION			
	P1	P2	P3	P4	P1	P2	P3	P4
pure	100				1	1	2	5
backpat								3
mixpat								
mostpat					17	13	22	254
sgl. rpt.								
half/half						.5		.5
vertical					1			
mostrow					2	8	126	244
other/word		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	180

ACQUISITION: 100 responses EXTINCTION: 880 responses
VARIABILITY: 1/33 = 3% VARIABILITY: 17/33 = 52%

Shaping S32	ACQUISITION Phase 1				EXTINCTION			
	P1	P2	P3	P4	P1	P2	P3	P4
pure	100	1	1	1	3	3	3	8
backpat					2	2	2	7
mixpat								7
mostpat	5				7	12	12	34
sgl. rpt.								4
half/half	.5			.5	2.5	1.5	6	7
vertical	1			1	22			14
mostrow					1			9
other/word		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	33

ACQUISITION: 111 responses EXTINCTION: 202 responses
VARIABILITY: 9/33 = 27% VARIABILITY: 23/33 = 69%

Shaping S33	ACQUISITION Phase 1				EXTINCTION			
	P1	P2	P3	P4	P1	P2	P3	P4
pure	100	1			2	1	1	44
backpat					1			29
mixpat								35
mostpat	1							179
sgl. rpt.								12
half/half					.5	.5	.5	.5
vertical					2			1
mostrow								4
other/word		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	

ACQUISITION: 100 responses EXTINCTION: 313 responses
VARIABILITY: 3/33 = 9% VARIABILITY: 16/33 = 48%

Figure 3. Response Type Variability Chart. Presents response type variability during Phase 1 and the extinction condition for S34, S35, and S36 of the “No Penalty” Group. Response type is presented in the rows and the acquisition phase of which the response is a member is presented in the columns. ‘Other’ responses are presented separately from acquisition phase contribution.

No Penalty S34	ACQUISITION Phase 1				EXTINCTION			
	P1	P2	P3	P4	P1	P2	P3	P4
pure	100							738
backpat								
mixpat								
mostpat	6							167
sgl. rpt.								
half/half								
vertical								
mostrow								
other/word		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	

ACQUISITION: 106 responses
VARIABILITY: 2/33 = 6%

EXTINCTION: 905 responses
VARIABILITY: 2/33 = 6%

No Penalty S35	ACQUISITION Phase 1				EXTINCTION			
	P1	P2	P3	P4	P1	P2	P3	P4
pure	100				1	1		468
backpat							1	2
mixpat								1
mostpat								77
sgl. rpt.								3
half/half								
vertical					4			1
mostrow					1		364	9
other/word		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	14

ACQUISITION: 100 responses
VARIABILITY: 1/33 = 3%

EXTINCTION: 947 responses
VARIABILITY: 14/33 = 42%

No Penalty S36	ACQUISITION Phase 1				EXTINCTION			
	P1	P2	P3	P4	P1	P2	P3	P4
pure	100							490
backpat								1
mixpat								2
mostpat								3
sgl. rpt.								
half/half								
vertical								
mostrow								
other/word		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	

ACQUISITION: 100 responses
VARIABILITY: 1/33 = 3%

EXTINCTION: 496 responses
VARIABILITY: 4/33 = 12%

Figure 4. Response Type Variability Chart. Presents response type variability during Phase 1 and the extinction condition for S38, S40, and S41 of the “No Penalty” Group. Response type is presented in the rows and the acquisition phase of which the response is a member is presented in the columns. ‘Other’ responses are presented separately from acquisition phase contribution.

No Penalty S38	ACQUISITION Phase 1				EXTINCTION			
	P1	P2	P3	P4	P1	P2	P3	P4
pure	100							328
backpat								10
mixpat								3
mostpat	2				12	4	3	60
sgl. rpt.					23		2	4
half/half					.5			.5
vertical								
mostrow					1	25	3	5
other/word		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	1

ACQUISITION: 102 responses
VARIABILITY: 2/33 = 6%

EXTINCTION: 485 responses
VARIABILITY: 17/33 = 52%

No Penalty S40	ACQUISITION Phase 1				EXTINCTION			
	P1	P2	P3	P4	P1	P2	P3	P4
pure	100				1		2	397
backpat						1		3
mixpat								8
mostpat	3					2	1	116
sgl. rpt.								
half/half					1		.5	1.5
vertical					1			1
mostrow								1
other/word		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	

ACQUISITION: 103 responses
VARIABILITY: 2/33 = 6%

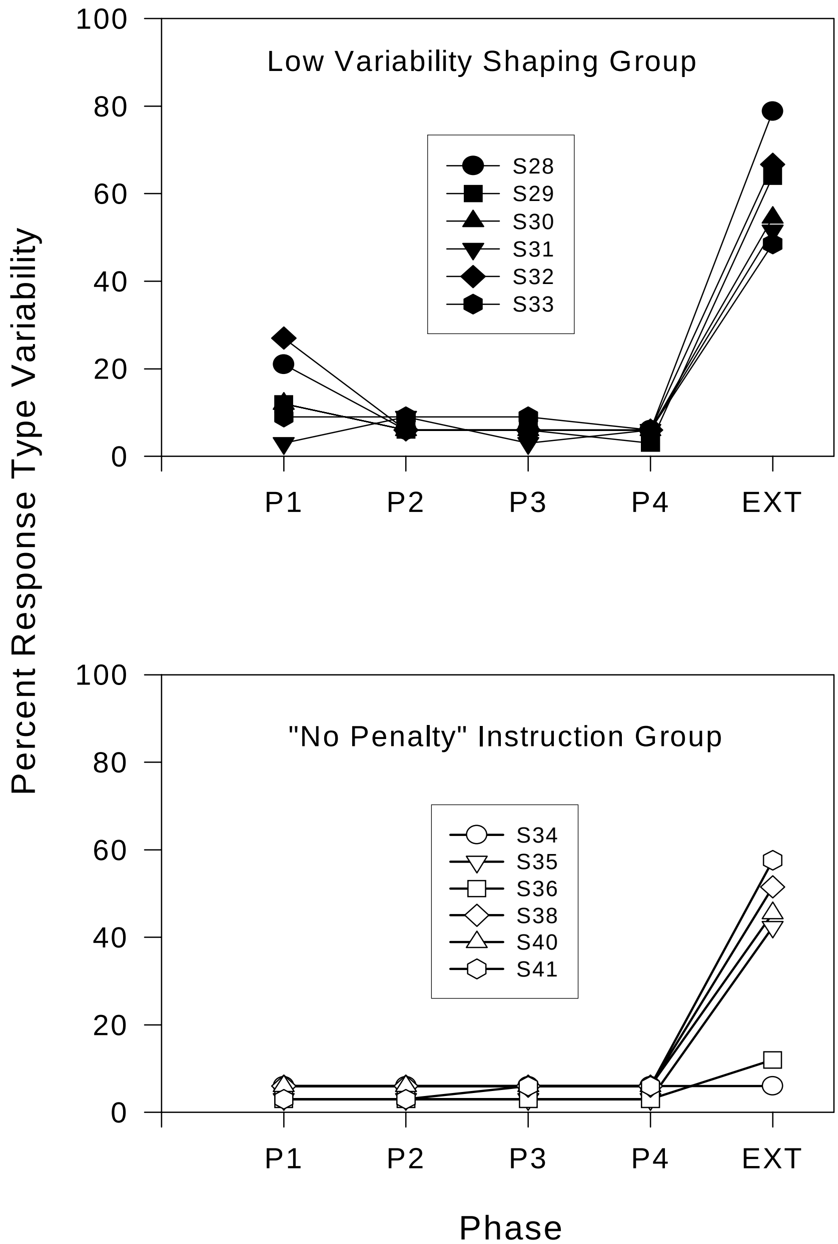
EXTINCTION: 537 responses
VARIABILITY: 15/33 = 45%

No Penalty S41	ACQUISITION Phase 1				EXTINCTION			
	P1	P2	P3	P4	P1	P2	P3	P4
pure	100				3	3	3	296
backpat					2	2	2	7
mixpat								17
mostpat					1			26
sgl. rpt.								9
half/half					1	1	4	4
vertical					9			6
mostrow								1
other/word		XXXX	XXXX	XXXX	XXXX	XXXX	XXXX	

ACQUISITION: 100 responses
VARIABILITY: 1/33 = 3%

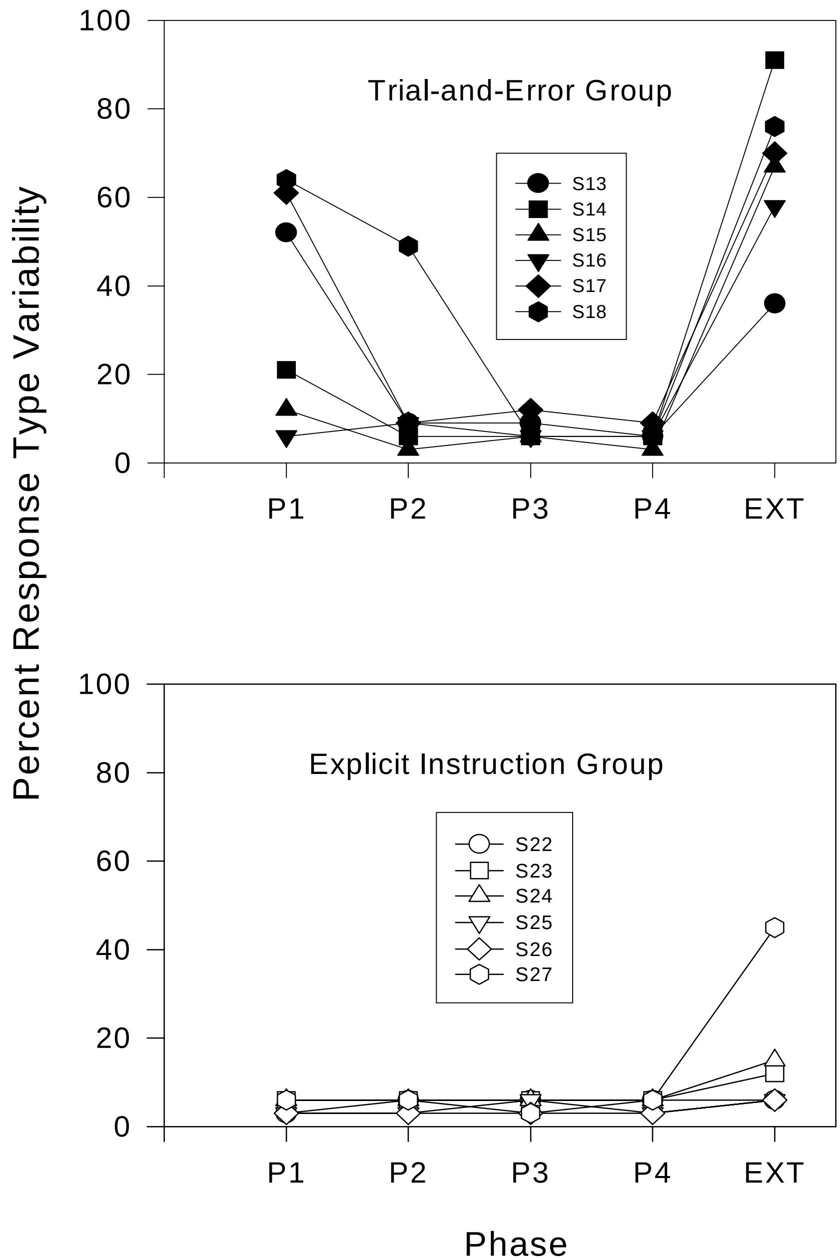
EXTINCTION: 397 responses
VARIABILITY: 19/33 = 58%

Figure 5. Response Type Variability Graphs. Presents percentage of bins filled on the Response Type Variability Charts. The top graph presents data from the Low Variability Shaping Group, and the bottom graph presents data from the “No Penalty” Group. Acquisition phases 1-4 and the extinction condition are on the x-axis and percentage of response type bins filled are on the y-axis.



Low Variability Shaping Group
S28
S29
S30
S31
S32
S33
"No Penalty" Instruction Group
S34
S35
S36
S38
S40
S41
Percent Response Type Variability
0
20
40
60
80
100
P1
P2
P3
P4
EXT
Phase

Figure 6. Response Type Variability Graphs from Neff (1997). Presents percentage of bins filled on the Response Type Variability Charts. The top graph presents data from Trial-and-Error Group, and the bottom graph presents data from the Explicit Instructions Group. Acquisition phases 1-4 and the extinction condition are on the x-axis and percentage of response type bins filled are on the y-axis.



Percent Response Type Variability
Trial-and-Error Group
S13
S14
S15
S16
S17
S18
Explicit Instruction Group
S22
S23
S24
S25
S26
S27
100
80
60
40
20
0
P1
P2
P3
P4
EXT
Phase

Figure 7. Pattern Element Contribution Graphs. Presents percentage of pattern element contribution for the Low Variability Shaping Group. Categories are ‘pure’, blend of reinforced (BR), blend of reinforced and unreinforced (BRU), and unreinforced (U) are presented according to the phase of which each response could be considered a member. Phases are on the x-axis along with the other/word category. Percentage of overall extinction responses are along the y-axis. Other/word responses were not divided into pattern element contribution and are presented separately.

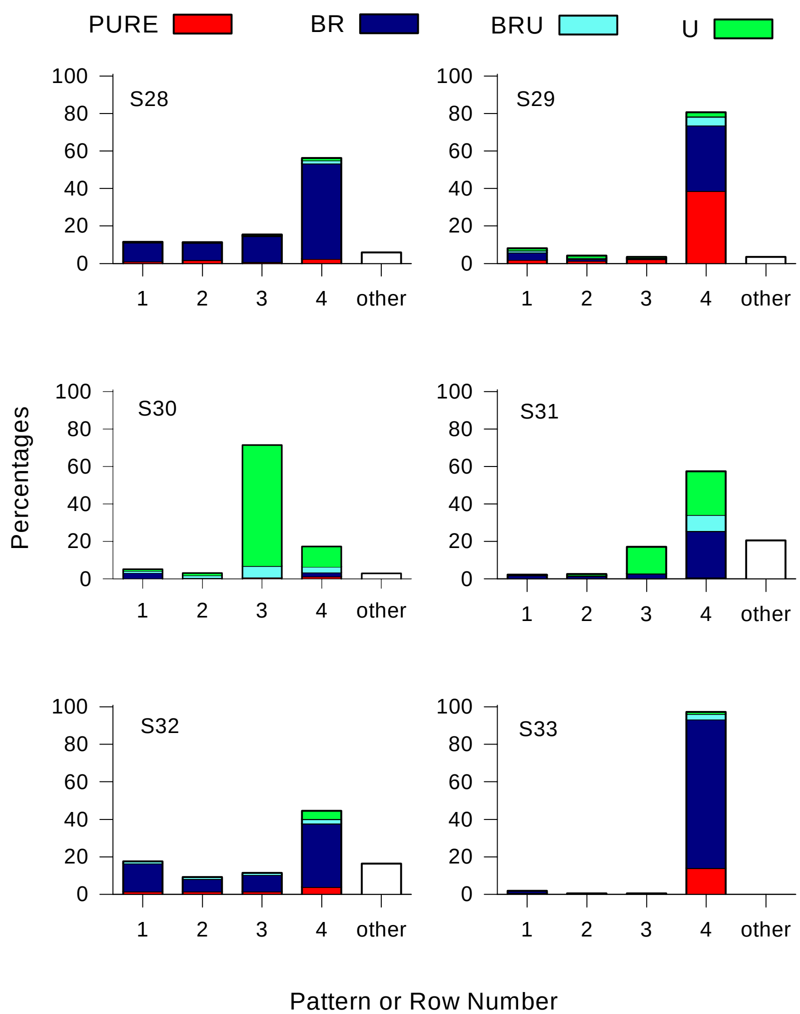

PURE
BR
BRU
U
S28
S29
S30
S31
S32
S33
100
80
60
40
20
0
1
2
3
4
other
Percentages
Pattern or Row Number

Figure 8. Pattern Element Contribution Graphs. Presents percentage of pattern element contribution for the “No Penalty” Group. Categories are ‘pure’, blend of reinforced (BR), blend of reinforced and unreinforced (BRU), and unreinforced (U) are presented according to the phase of which each response could be considered a member. Phases are on the x-axis along with the other/word category. Percentage of overall extinction responses are along the y-axis. Other/word responses were not divided into pattern element contribution and are presented separately.

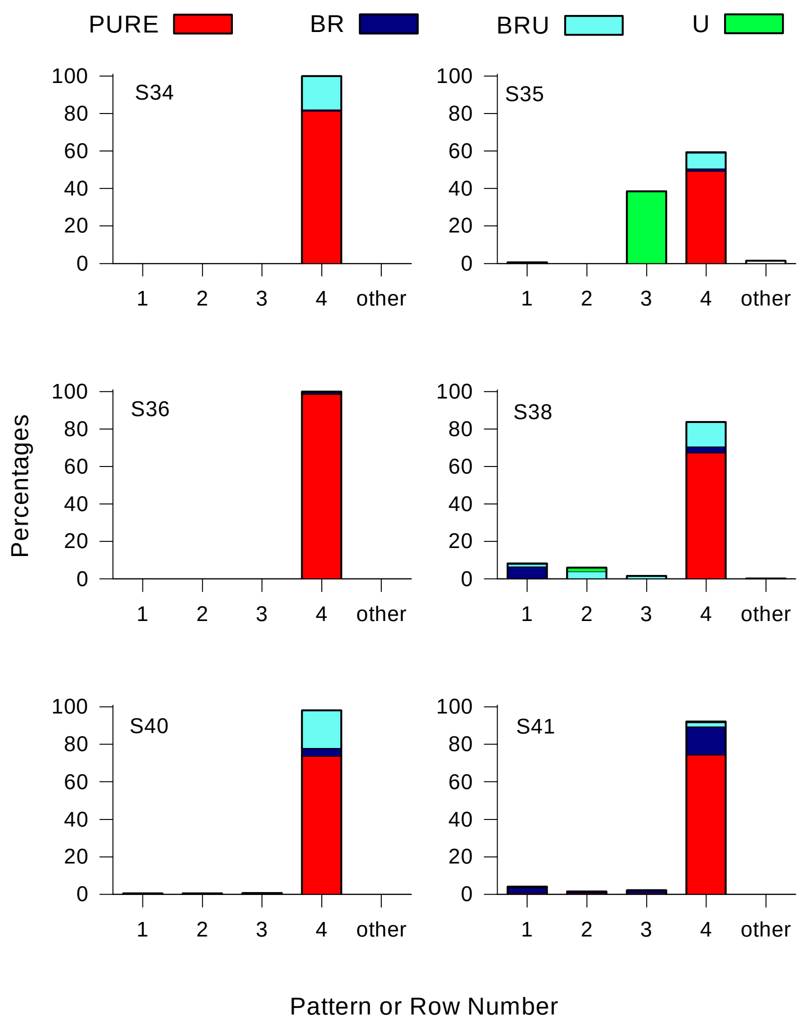

PURE
BR
BRU
U
S34
S35
S36
S38
S40
S41
100
80
60
40
20
0
1
2
3
4
other
Percentages
Pattern or Row Number

Figure 9. Pattern Element Contribution Graphs presented in Neff (1997). Presents percentage of pattern element contribution for the Trial-and-Error Group. Categories are 'pure', blend of reinforced (BR), blend of reinforced and unreinforced (BRU), and unreinforced (U) are presented according to the phase of which each response could be considered a member. Phases are on the x-axis along with the other/word category. Percentage of overall extinction responses are along the y-axis. Other/word responses were not divided into pattern element contribution and are presented separately.

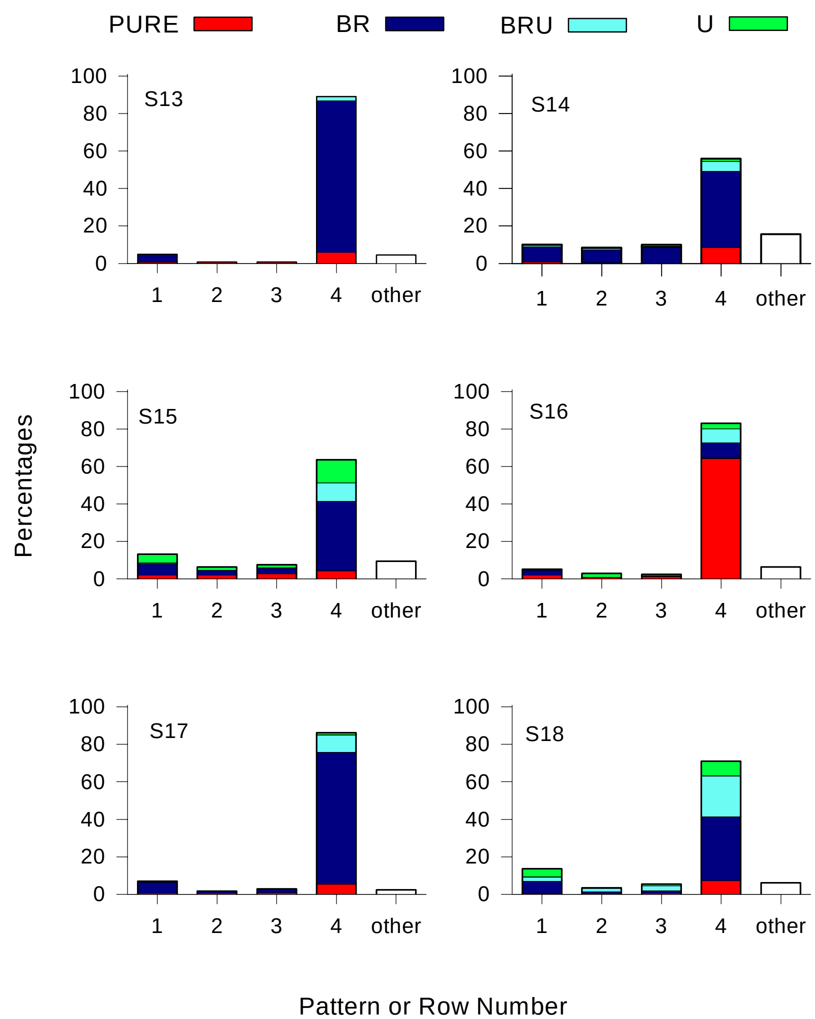
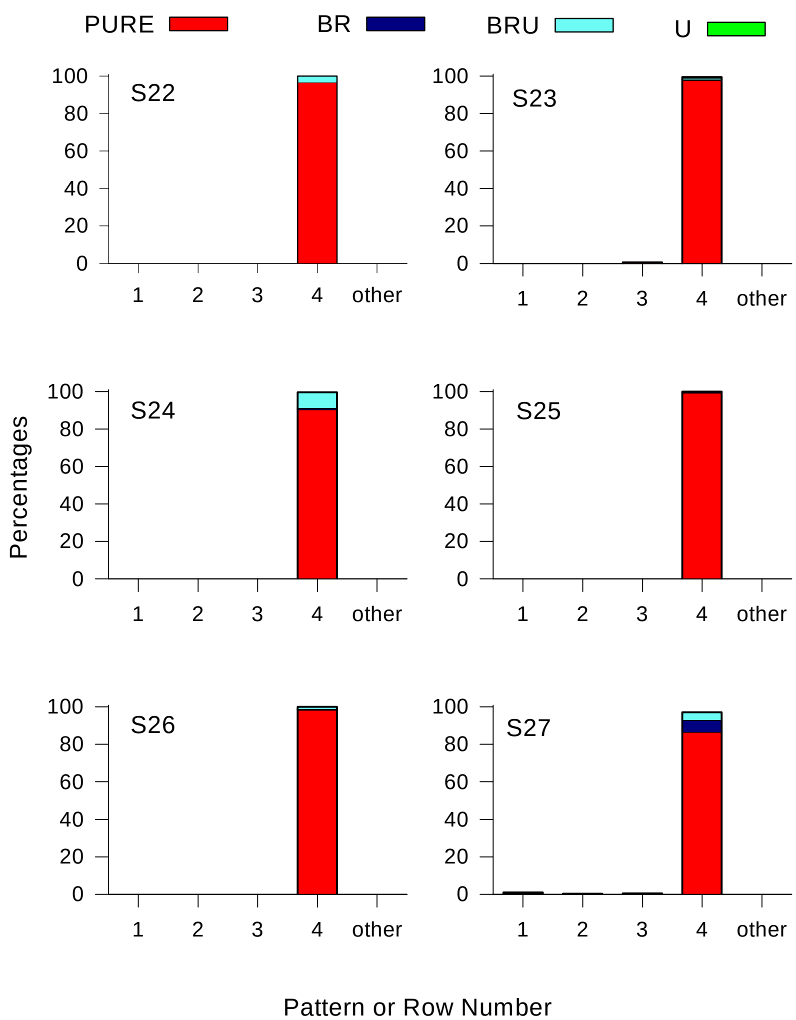

PURE
BR
BRU
U
S13
S14
S15
S16
S17
S18
100
80
60
40
20
0
1
2
3
4
other
Percentages
Pattern or Row Number

Figure 10. Pattern Element Contribution Graphs presented in Neff (1997). Presents percentage of pattern element contribution for the Explicit Instructions Group. Categories are ‘pure’, blend of reinforced (BR), blend of reinforced and unreinforced (BRU), and unreinforced (U) are presented according to the phase of which each response could be considered a member. Phases are on the x-axis along with the other/word category. Percentage of overall extinction responses are along the y-axis. Other/word responses were not divided into pattern element contribution and are presented separately.



PURE
BR
BRU
U
S22
S23
S24
S25
S26
S27
100
80
60
40
20
0
1
2
3
4
other
Percentages
Pattern or Row Number

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