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MICROCOMPUTER DEMONSTRATIONS IN A MASTERY-BASED
PERSONALIZED SYSTEM OF INSTRUCTION COURSE

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ABSTRACT: The use of demonstrations in a mastery-based Personalized System of Instruction (PSI) Introductory Psychology course is discussed. The specifics of fourteen computer demonstrations in current use is described, as well as how the demonstrations are used to stimulate student involvement in a mastery PSI format.

INTRODUCTION

Approximately twenty years ago, a method of instruction called the Personalized System of Instruction (PSI) was proposed by Keller [1] and applied to college teaching by Johnston and Pennypacker [2] and McMichael and Corey [3]. This method relied upon behavioral principles to make the instruction more individualized, to increase retention of the material learned, and make the teaching process more cost efficient.

The basic format of the method involved what has also been termed mastery learning [4]: rather than all students progressing at the same pace but mastering different amounts of the material, mastery-based instruction permits the time devoted by the student to a topic to vary but demands the student demonstrate attainment of a criterion of understanding of the subject before she or he may continue. Frequent testing with feedback [5] has also been shown to be an effective tool for increasing learning.

An Introductory Psychology course based on this methodology was created at Rochester Institute of Technology and found, in
general, to be successful in transmitting information to the students.[6, 7]

The student was required to read the material in a module (roughly a chapter), be tested on the material when the student felt prepared, and receive feedback as to the questions missed and the score attained immediately after submitting the test answers. Based upon the grade, the student either passed by reaching some criteria of competency, or failed to demonstrate module competency. If passed, the student went on to the next module; if failed, the student restudied the material, returned at some later time for another test, and maintained this cycle until the module was passed or the student decided to attempt a different module. The final course grade depended on the number of modules successfully passed, regardless of the number of examinations attempted or time it took to accomplish this.

However, student evaluations showed dissatisfaction in several areas. Some students felt that there was too little interaction between themselves and the instructor and no interaction between themselves and other students. Other students found it difficult to maintain reading and test-taking when there was no firm deadline involved. Quite a few students said that the method was boring: all they did was read written material and take tests. They wanted more active course involvement.

These criticisms were not specific to the RIT course; indeed, wherever the method was tried similar comments about the passivity of the student, the mechanical nature of the course, and the rigidity of the structure served to doom most courses of this nature to a single semester or year of trial, and then to the dust bin of history. It is a truism in educational psychology that active involvement of the learner is a sine qua non to achieve anything more than rote memory in a student [e.g., 8, p.1113].

Rather than abandon the method, however, we totally redesigned the course, maintaining what we felt were the advantages of the mastery-based PSI method while modifying or discarding those parts that had not worked out:

(1) The concept of student self-control over the pace of learning was modified: the student can still proceed at her own pace as previously, but there is now a deadline. The assignment of the course grade was changed from the number of modules completed
successfully to the grade achieved on a comprehensive final examination which includes questions on all the modules. The student is permitted to attempt the final exam twice with parallel tests and the higher grade is assigned, with "A" requiring 46 out of the 50 questions correct, "B" requiring 41 45, and so on. However, the student is not permitted to attempt the final examination until she has successfully passed all eight module examinations. Student progress in the course is posted on a bulletin board (in terms of a code number the student is assigned at the beginning of the term), printed as a chart using Microsoft's Works program. This change has ensured successful competition of this course with the more traditional courses for student time and attention to the material, and thereby drastically lessened the number of "Incomplete" grades assigned in the course.

(2) The individual module tests were modified with the addition of three review questions at the end of each test. These review questions could cover material from any of the previous modules. This change lessened the advantages of cramming, since material crammed and forgotten often reappeared on subsequent tests causing the student to fail, and had the important psychological effect of reinforcing the previous material through overlearning. In addition, it prepared the student for the comprehensive final examination by encouraging her to integrate the material from the different modules into a single coherent overview. (3) The self-study component was modified by having two faculty members present in the testing room for each session, as well as having the testing room divided into three sections:

Students seated in the first section bring in any notes, module material, or other material they wish, and are encouraged to ask the faculty members any questions about the module material that they didn't understand. When ready to take the examination, they move to the second section of the room.

Students in the second section take the tests, seated one seat apart from each other. The faculty will explain the meaning of any vocabulary they are uncertain of (provided it is not a specifically psychological term that is part of the course instruction), or to rephrase a question whose import the student does not understand. After completing the test, the student turns the exam sheet into two student graders at the front of the room, where it is graded based upon the answer key. The students wait the short time required in the third section.
Students in the third section get their exams returned and are encouraged to ask the faculty members any questions they may have about why an answer was incorrect, or to offer challenges to the questions if they wish. This reintroduces the student-faculty interaction that was absent from the original methodology, and gives the student feelings of involvement in the process.

(4) Which left the problem of student boredom and disinterest in a course that called for just reading and test-taking, and which brought us to the design and use of computer demonstrations...

**THE DEMONSTRATIONS**

**Rationale**

Computers have traditionally been used in education in one of three manners:

1. As a testing tool, testing students either as a study aid or as a grading instrument, with the more sophisticated programs offering branching capabilities so that they can more finely discriminate at what level remediation may be necessary;

2. As a method of presenting textual or graphic material, sometimes permitting interaction between an online educator and distant learning students;

Copies of the demonstrations discussed in this article are available from the authors on 5-1/4" disks to instructors interested in utilizing them in their courses. Please address requests to Dr. Morton Isaacs, RIT, 1 Lomb Drive, Rochester NY 14623 USA; include five dollars for postage and handling. All programs will run on any of the Apple II family of computers which have 64K minimum RAM and at least one disk drive.

3. As a simulation package, where students assume some role (e.g., president of a manufacturing company, a French nobleman of the 16th century) where activities can be carried out that are either not possible or prohibitively expensive in real life.

We opted for none of these: rather we desired to create a fourth area:
4. As a motivating tool to create interest in and introduce some of the terminology of the material which will subsequently be encountered in detail by the student in written form. To accomplish this, we designed and wrote computer demonstrations to entice interest in the subject matter of each module. The demonstrations had to satisfy some strict parameters:

Each had to occupy no more than a maximum of five minutes of the student's time, since we wished to demonstrate and stimulate interest in the many different psychological topics that appear within each module of material, and we had a limited number of microcomputers, time, and lab space available;

Each demonstration had to be very simple, even primitive, in nature, since many of the students had had no experience with computers, and no time or wish to study instructions as to how to use them, or how to work complex demonstrations;

Each had to take advantage of the potential of the computer for program interaction with the student without the presence of other students. Since the course encouraged students to proceed at their own pace (although deadlined), at any one time a student might find no other student present in the psychology laboratory who was working on the same module; the demonstrations therefore had to be able to be conducted without input from any other student. The exceptions to this are the Social Psychology demonstrations which do require two persons to interact. The lab assistant whose major function is to open the lab room, see that the computers do not disappear, and hand out the relevant module material upon a student's completion of the required demonstrations, takes the part of the second student if no other student is available who is up to the Social Module when one is needed.

Each was designed to require active, timely input by the student. Any demonstrations that didn't utilize active feedback and interaction with the student or which were not time relevant, were designed as paper-and-pencil demonstrations, to relieve the student load on the microcomputers in each laboratory period.

Several of the initial demonstrations that we designed had to be discarded because they took too much of the student's time, or they were too complex for the student to master in the few minutes available, or were too static to allow the student to profit from the computer's interactivity. Each year since the course has begun we add,
revise, or discard some of the demonstrations; the list following should therefore be taken as a description of current demonstrations rather than a rigid set that has been used without modification for nine years.

DEMONSTRATIONS PROCEDURE

Students purchase a workbook in which are worksheets that will be used in the demonstrations, and general instructions and information about each demonstration, so that they are prepared in advance for what will occur. Upon entering the lab room, they receive a further packet of information describing in specific terms what to look for during each of the demonstrations, plus any supplementary material that may be needed to perform a demonstration (see Appendix A for a sample introduction sheet). No computer skills are needed to run any demonstration: they are designed to be self-running when a student presses the keyboard letter assigned to that demonstration.

Each demonstration requires active involvement from the student: this may take the form of pressing keys on the keyboard to change the computer screen display, or inputting decisions or information into the computer, or trying to beat the computer in some kind of psychological game.

After the student has finished all the demonstrations for the module, she is given an explanation sheet that describes, in psychological terms, the purpose of the demonstration, the different responses that could have been made and their meaning, and some idea of how the demonstration fits into the module material she will be reading (see Appendix B for a sample Explanation sheet).

Each of the demonstrations is designed to illustrate material in one of the eight modules in the course, and each module has at least three demonstrations associated with it. Not all demonstrations are performed on the microcomputers: fourteen of them are computer programs while 28 use paper-and-pencil or other equipment (and therefore will not be discussed in this article). The concepts and design for the computer-oriented programs were generated mostly from our own ideas, although some were suggested by materials that had been previously published. The module names, and the fourteen computer-oriented programs associated with each follow.
SENSATION/PERCEPTION MODULE

ATTENTION

Program Description: The computer presents a white square in the center of the screen on which the student fixes his attention. Four words then appear briefly in the corners of the screen, and the student tries to identify them. Ele can increase or decrease the length of exposure time of the words by pressing a key. Ele is instructed to continue increasing the length of exposure until he can correctly identify all four words, noting down the time it takes before he correctly identifies one, two, three or all four words. The words change with each exposure to prevent carry over from previous viewing influencing the identification of the words.

Psychological Purpose: Switching attention from one stimulus to another takes time, although we're not normally aware of it. Based upon how long it takes to identify the different number of words, the computer calculates and presents to the student his average transfer rate of information from sensory memory to short term memory.

GESTALT CLOSURE

Program Description: The computer begins with a blank white screen. Each time the student presses a key an additional row of irregular, small dark areas is exposed from the top of the screen extending down. The student is to try to identify what image these areas form. Typically, the student just sees more and more individual jagged spots, until suddenly they crystallize into a relationship (gestalt) to form an object, with the mind ignoring the intervening white spaces. The student is asked to type in a noun representing his guess as to the identity of the object. The program searches for the correct answer string within the student's input string; if it is found, it flashes "Correct", and prints out the number of steps required to identify the object. If not found, it asks the student to continue. Several images have been broken into these irregular jagged spots, so that students can see if their integrating ability improves once they learn what "putting the spots together to form a gestalt" really means.

Psychological purpose: The gestalt principle that "the whole is different (greater) than the sum of its parts" is one of the most widely quoted of the phrases describing the gestalt viewpoint, and this demonstration illustrates the difference between perceiving the individual parts, which is done immediately upon exposure, and
forming a new perception from the combination of the parts. The image is more than the jagged dark spots that make it up, since it is formed by their relationship to one another rather than their individual shape or size.

COMMON MOVEMENT

Program Description: The program begins with a display of the 26 individual letters of the alphabet apparently scattered randomly over the screen. These are exposed for a very short period, erased, and redrawn in different locations. The student is told to stare at the screen until a word pops out at him and then to press a key, but is not told what the word might be. While the program randomly varies the distance and position of the majority of the letters from one exposure to the next, some letters retain a constant distance from each other while being placed one line lower on each exposure until they reach screen bottom. They then are placed one line higher on each of the following exposures until they reach screen top, whereupon the process repeats from the beginning. When the student presses the key, the program asks him to type in the word he has seen, checks to see it is correct, and then offers him a second screen setup similar to the first but with a different word moving in a different pattern. Again the student presses the key to indicate that he has identified the stimulus word and the demonstration ends. If the student is unable to perceive the stimulus word within 50 exposures, the letters of the stimulus word reverse into black on white so they can't be ignored.

Psychological Purpose: One of the gestalt laws is that we will tend to form a figure from objects that share a common movement pattern. This law is usually very difficult to demonstrate, as things moving together often are physically close to each other (and therefore may be grouped by proximity) or share many attributes in common with each other (and therefore may be grouped by similarity), both of which are other gestalt organizing principles. This demonstration shows the student that pattern of movement can also lead to perceptual organization even when proximity and similarity are missing. The word is usually hard for students to perceive at first, as other letters interweave with those that form the word. If the student tries too hard and focuses on the details of the screen, it is very difficult for him to perceive the word. When he relaxes and gazes at the entire screen at once, the word suddenly emerges from the welter of assorted letters. The module discusses how a concentration on details may obscure patterns, and refers to this demonstration as an example.
PHI PHENOMENON

Program Description: A juggler is drawn on the screen, with an image of a ball coordinated with changing images of the juggler's two hands so that it appears the juggler is throwing the ball over his head from one hand to the other. The student is instructed to press one key to increase the speed with which images of the ball are placed on and then eliminated from the screen, and a different key to slow them down. She is asked to view the juggler working at various speeds, and to count the number of balls which appear to be present during each of these speeds.

Psychological Purpose: Our retinal cells continue to discharge for a fraction of a second after a stimulus has actually stopped exciting the cells (perseverance), and this small carryover of the image helps explain how motion is perceived from still-life displays like those projected in movies or on computer screens. Normally, at slower speeds it appears as if one ball is being juggled since the retinal cells have a chance to recover from one activation before the next one occurs; however, with increasing speeds perseverance causes the first retinal cells to be still firing when the next cells receive a stimulus. If the two retinal cells are near enough, apparent motion occurs. If they are further apart, the brain perceives it as two stimuli occurring simultaneously. The apparent number of balls in the air will therefore be a function of the speed of presentation of the stimuli and the distance between them.

MEMORY MODULE

SENSORY MEMORY

Program Description: A letter is initially displayed on the screen for a very short period of time then quickly is erased and the space where it had been immediately surrounded by a drawn circle. The student is asked to name the letter. The time of exposure is shown in the lower corner. If the student correctly names the letter, the demonstration ends; if she cannot, the same letter is displayed for a slightly longer period of time. The amount of display time keeps increasing until the student is able to correctly identify the letter displayed.
Psychological Purpose: Objects must be identified or labeled before they can be remembered, and this labeling process takes time. It consists of two aspects: (1) Perception of the stimulus, and (2) Labeling of the stimulus. Perception takes place in Sensory Memory, a very shortterm storage area. If the object is replaced by another one before the subject has time to identify it, the image fades from memory and cannot be recalled again.

MEMORY MATCHING IN STM

Program Description: Two letters are simultaneously displayed on the screen approximately 2 cm. apart. Each letter may be an uppercase "A", uppercase "B", a lowercase "a", or a lowercase "b". The student is told to press the "S" key (for Same) if the same letters are similar in meaning regardless of their case, and to press the "D" key (for Different) if they are different in meaning even if their case is the same. Thus, eight possible combinations may be displayed:

[A A] or [B B], similar in both meaning and case;

[A a] or [B b], similar in meaning but different in case;

[A B] or [B A] different in meaning, but similar in case;

[A b] or [B a], different in both meaning and case.

The time required by the subject to respond to ten randomly presented sets of each of these eight possibilities and the number of errors made by the subject when judging similarity or difference of the stimuli are recorded for each trial, and the average time for each combination and number of errors made are displayed to the subject after the demonstration has been completed.

Psychological Purpose: The more processing a comparison input requires, the more time will the comparison take and/or the more errors will be made. Comparing two identical stimuli requires a simple matching process, and should be (and usually is) the fastest and least errorful of the comparisons. Comparing stimuli which differ either in case or in letter requires one additional processing step, that of translating the case and then matching, or retrieving the meaning and then matching, and therefore these two should produce equally as many errors. Comparison of stimuli that differ in both letter and case should be and usually are the slowest and most errorful, since it requires that one stimuli first be translated into the case of the other,
then matched for similarity. The module discusses the matching process in sensory storage and short term memory and relates it to this demonstration.

CAPACITY AND CHUNKING IN STM

Program Description: Individual numbers are displayed for one second each at the same location on the computer screen, with a short delay between each exposure. The student is instructed to try to remember the numbers in the order that they are presented, and to type them into the computer when asked to do so. First the student is presented with a sequence of five randomly selected numbers, then seven, nine, and finally twelve numbers not randomly selected, "149217761988", although he is not told that they are not random. After each set has been displayed, there is a short delay, the subject then is asked to type the numbers in sequence into the computer, which then displays the correct sequence and informs him as to the accuracy of his input; the screen is then cleared. Most subjects cannot match the nine and extremely few match the twelve number sequences. The subject is then informed that he should have less trouble recalling the twelve number sequence if they are chunked as "the year in which Columbus discovered America", "the year when the American Revolution began", and the current year. He is then informed that the digits will be redisplayed one at a time, and again he is to enter the sequence into the computer when it is finished. This time few students make any errors when asked afterwards to replicate the sequence.

Psychological Purpose: The concept of chunking as an organizing tool is fundamental to an understanding of how people normally can recall more than the five to nine bits of information that research shows is the total capacity of Short Term Memory. When individual bits can be organized using some cognitive structure such as previously learned important dates, there are not twelve individual numbers to remember but only three chunks, which can usually be recalled with little difficulty. In the module, the student is encouraged to apply this concept to memorization of necessary material in other courses, such as physics, math, etc.

LEARNING MODULE

OPERANT CONDITIONING
Program Description: The student is presented with a mouse drawn on the screen inside a border, which has a gate in the middle of the border at one end. He is told he can give the mouse food by pressing the "R" key (for Reinforcement), or administer a shock to the mouse by pressing the "P" key (for Punishment). He is also warned that too much food will satiate the mouse, while too much punishment may cause the mouse to freeze and stop moving; in both cases, the student then will have to get a new mouse. He is also told that punishment has been shown to tend to suppress an incorrect response but not to strengthen a correct one, while reinforcement tends to strengthen the correct response but also strengthen responses similar to it. At the beginning of the sequence the mouse is equally likely to move in any direction; the student is to try to get the mouse to go through the goal through using the available reinforcement, punishment, or doing nothing (extinction).

Psychological Purpose: The effects of the application of reinforcement, extinction, and punishment on behavior, and the concepts of generalization and discrimination are demonstrated to the student by the effect of their own actions upon the computer mouse. Those students who are unable to get the mouse to move in the direction they want are given cues to the proper way to teach behaviors based upon learning theoretical principles; with an unlimited supply of mice, a ruined mouse can be sacrificed without concern over expense or animal rights, and a new one introduced into the learning box. (See Appendix C for a more detailed program description and psychological discussion.)

INTELLIGENCE MODULE

COGNITIVE STRUCTURING

Program Description: In sequence, the student is exposed to various verbal, counting, logic, and visual problems, in the center of the screen. The student can examine each problem as long as he wants, then records his answer to the question, and presses a key to continue to the next problem. Upon completion of the demonstration, the problems reappear on the screen one at a time with a display of the number of students who gave each of the various possible answers to the question, along with the correct answer.

Psychological Purpose: The questions posed are not knowledge questions but rather ones designed to illustrate characteristics that
represent leftbrain versus rightbrain thinking, as well as allow a
discussion of cognitive styles in general. The problems were selected
because certain thinking and problem solving styles will produce one
answer, while other styles produce other answers, in spite of the fact
that many of the problems appear trivial. One of the problems, for
example, is "John buys a car for $500 and sells it for $600. He buys it
back for $700 and then sells it for $800. How much has John made in
this transaction? (a) Nothing. (b) $100 (c) $200 (d) $300 (e) $400".
Some students view the process more than the details, and believe
that John first gains $100 by selling the car, then loses $100 when he
buys it back, and so on. Leftminded students generally tend to get the
question correct and to be amazed that anyone can miss it, while
rightminded students tend to be amazed that they got it wrong (if they
did) and happy to see that many other students also chose the wrong
answer. Other of the problems involve counting letters, where gestalt
effects can interfere with attending to the details, while still others
involve perceptual problems where rightminded persons generally do
better than leftminded. Because the differentiation between synthesis
and analysis underlies the understanding of hemispheric specialization
as well as that of cognitive style, these demonstrations are effective in
introducing students to these concepts in the module.

ARTIFICIAL INTELLIGENCE DEMONSTRATION

Program Description: This demonstration is based upon ELIZA,
one of the first AI (Artificial Intelligence) programs, but extensive
revision has been made in the original program based upon the
collection of a database of the RIT college students' interactions with it
over a twoyear period of time. The program no longer takes a
completely nondirective role although it still often reflects the subject's
input, but occasionally offers warm support or asks friendly questions.
Basically, the program asks the student to pretend that she has come
to a psychologist with a problem, and to respond to the computer's
questions and comments by typing in input as though she were talking
to a human counselor.

Each input from the student is parsed by the program for certain
key words (e.g., "hurt", "boyfriend", etc.) and a response is displayed
on the screen from a set of statements preprogrammed to that key
word. If no key word is found in the student's response, a generalized
comment is randomly selected from a different set of responses (e.g.,
"You sound a bit unhappy; can you tell me why?"; "I don't understand;
can you rephrase what you wrote?"). If the subject responds with the
single word "No", or another single word, the program prompts or
gently criticizes the student (e.g., "I sense you are being negative"). The program ends whenever the student presses the Escape key.

Psychological Purpose: AI has come a long way from ELIZA, it is true, but many students are still fascinated by the contact with a nonhuman therapist, to such an extent that we are careful in the instructions to point out that this is a primitive version of what is at present a much more sophisticated area of research, and not to get too involved with the program. We discuss AI as a field that is just developing, and mention that more useful and workable programs are being written continually.

**MOTIVATION/EMOTION MODULE**

**ACHIEVEMENT MOTIVATION**

Program Description: The computer places a square of light at the top of the screen, and offers the student the opportunity to decide how fast the square will fall toward the screen bottom. He is to try to press any key to catch the square prior to its reaching the bottom. Points are awarded to the student based upon the speed of fall (the faster the square descends the more points awarded if caught) and the higher up it is when the student presses a key (the earlier the student catches the square, the more points are awarded). After the student presses a key to begin a trial, a randomly set delay period occurs after which the square falls toward the bottom of the screen. The student is given five trials in which to accumulate the highest score he can, and a record is kept of the level of aspiration he chooses for each trial, whether he caught the square or not, and the amount of points he received, all of which are displayed to the student following the final trial.

Psychological Purpose: The Need to Achieve, levels of aspiration, and the Fear of Failure and Fear of Success aspects of motivation are all illustrated in this demonstration. Different personalities choose different patterns of speeds based upon the results of their initial choice: people high in Need for Achievement will tend to begin at the middle range of speeds and move gradually upward or downward depending on their success or failure at the choice level; people high in Fear of Failure may consistently choose the slower speeds and maintain them regardless of the possibility of increasing score by
increasing the speed; people high in the Fear of Success may choose the fastest speeds regardless of feedback.

CONTEXT OF EMOTIONS

Program Description: The program displays a short story to the student one line at a time; after each line the student is asked to input what emotion she feels the subject of the story is experiencing at that time. Each line adds a detail of description of the scene or of the background of the events or the participants. After seven lines the program terminates and displays the emotions the student had input for her inspection.

Psychological Purpose: Understanding of emotions depends not only on the objective facial expressions or behavior of the individual but on our interpretation of the meaning behind the behavior. This interpretation changes as we receive and evaluate new information, and our perception of the emotion being experienced by others, therefore, is an evolving dynamic process rather than a determination made at the first sight of the person. Normally, the process of evaluation is so quick completed that we believe we perceive the emotion directly without cognitive intervention; this demonstration shows how our evaluation changes with changing context.

BIOFEEDBACK

Program Description: Input from the resistance offered across the skin is detected through two electrodes attached to the student's fingers through the Apple's I/O socket, and the result displayed on the screen in the form of a graph line with the middle representing the initial skin resistance of the subject. The student is directed to try to relax for several minutes and then to observe the graph line; as relaxation occurs (if it does), the graph line should descend on the screen and eventually stabilize. After stabilization, a fellow student (or the lab assistant) asks the subject a series of three questions. The subject is told to try to lie to one of the questions by giving a purposefully wrong answer, while giving truthful answers to the other two. Based upon changes in the graph, the other student then tries to identify which question was answered with a lie.

Psychological Purpose: Selfmonitoring and efforts to control bodily functions (biofeedback) has been shown to be useful in many different ways: e.g., relaxation training, as an aid in migraine headache control, and in helping control Reynaud's disease. However,
the most famous use of the monitoring of body functions is when it is used antagonistically against the subject, as part of a lie detector. The demonstration allows the student to experience the possibility of controlling his own tension level as he tries to relax, and to experience the possibility of involuntary increase in tension level as a result of classically conditioned anxiety responses to telling a lie.

ABNORMAL MODULE

RORSCHACH INKBLOT TEST

Program Description: A card containing an inkblot similar (but not identical) to those used in the Rorschach Test is given to the student, who examines it and writes down in a workbook as many different images as he sees therein. When he has finished, he is given directions as to how to dichotomize his own responses into whole/part, movement/ non-movement, and color/non-color categories. The computer asks the subject to input the number of each type of response he has scored himself as giving, as well as the response words themselves. Based upon a extremely simplified AI system, the program analyzes these inputs and prints out an "analysis of the person's personality" based upon the number of images seen and the relative size of the three categories. Students are warned that this is only a demonstration of the way in which projective tests might be scored and that the results are not to be taken too seriously.

Psychological Purpose: Students receive some exposure to a projective test, and some idea of what persons who use these tests as tools in therapy or personality analysis search for in the subject's responses. The advantages and disadvantages of projective tests are discussed and compared to objective tests, which the student has encountered in the demo in the form of a paper-and-pencil personality test.

MEASUREMENT OF THE EFFECTIVENESS OF THE DEMONSTRATIONS

There are both objective and subjective measures of the success of the demonstrations. Objective evaluation centers upon answers to Student Evaluation Forms which have been distributed continually over the nine years that the course has been conducted. These have yielded an overall average of 5.37 on a 7point scale to the question "How
effective do you feel the demonstrations are in helping you to understand the course material", and a 6.11 on a 7 point scale to the question "How much did you enjoy the computer demonstrations".

Subjectively, students have often asked if they could bring in friends to "run through the demonstrations even if they're not in the course". Student interaction with each other during the demonstrations appears to break the isolation of the traditional PSI course, and student friendships have developed around the contact initiated while performing the demonstrations. The vividness of the demonstrations often makes them remembered more easily than the written module material; referring to the demonstrations while answering questions on the module material turns out to be a quick, helpful way for the instructor to clarify concepts that might not have been made clear by the module reading material.

The demonstrations also give an alternate route of exposure to much of the information in the module. Receiving the information behaviorally as well as cognitively appears to aid in memory retention.

No major disadvantages of using the computer demonstrations have been discovered, other than the logistics involved. It is necessary to have student assistants to help run the laboratory, set up the equipment, pass out the modules, etc., and of course it is necessary to make the initial investment in the microcomputers to conduct the laboratory. These expenses, however, are more than offset by the costeffectiveness of the large numbers of students who can all take the course at the same time, and by the increase in learning and enjoyment evidenced by the students.

Perhaps the best evidence for the course's effectiveness is how often we are asked the question, "Are there any other courses like this offered at RIT?" to which we must regretfully answer "No". There is a great deal of work required to create and design programs, set up and run a laboratory, and handle all the details of the course. Not all courses would lend themselves to the PSI format, nor would demonstrations be easily designed or conducted for all subject material. The Introductory Psychology course is continually being revised by the authors based upon feedback from the students, our own changing interests, and new information in the field of psychology, each of which factors may induce us to drop or modify one of the demonstrations, or add another one to the set.
It is, however, extremely satisfying to see the students' enthusiasm and learning increase due to the interaction with both the demonstrations and the module material, and the amount of work that must be done to keep the demonstrations and course up to date is well worth it.

REFERENCES


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APPENDIX A

EXAMPLE OF INSTRUCTIONS GIVEN THE STUDENT PRIOR TO BEGINNING THE DEMONSTRATION ILLUSTRATING THE CONCEPT OF GESTALT CLOSURE

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SENSATION/PERCEPTION DEMO 6: GESTALT CLOSURE
INSTRUCTIONS

BACKGROUND This demo illustrates another of the principles of Gestalt psychology: that of Closure. Often the bits and pieces we have to put together to make a complete figure are not complete; they have gaps between them. However, if we are given enough pieces we tend to fill-in the gaps (by using mental imagery) to complete the figure. This is called CLOSURE. You will notice that this is similar to the camouflage experience in a previous demo, but it differs in two important ways: in camouflage, all the parts of the figure can be visible but in closure there must be missing parts; in camouflage, the background distracts your focus from the figure, but not in closure.

DIRECTIONS FOR THE COMPUTER When the Demo begins, you will see a white screen. Press key 1, 2 or 3 to chose the picture you would like to try and identify. There are three different pictures available in the computer. Press any key (except ESC) to reveal some of the picture (behind the white). If you think you know what the picture is, press the ESC key and you'll be allowed to guess. If you are right, the demo will end. If you are wrong, you'll be sent back to where you left off on the picture. If you've revealed the whole picture and still don't know what it is, you'll be told. Try to identify the picture using a minimum amount of exposure. (Note on your answer sheet the number at which you identified the picture: the computer will tell you this number).

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APPENDIX B

EXPLANATION SHEET GIVEN TO THE STUDENT SUBSEQUENT TO THE COMPLETION OF THE DEMONSTRATION ON GESTALT CLOSURE

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SENSATION/PERCEPTION DEMO 6:

EXPLANATION

As was mentioned in the instructions for this demo, Closure is another of the Gestalt laws. It states that we tend to fill in the gaps once we perceive a cluster of separate elements as belonging to a single figure. Once you saw that the blots could be organized into a
horse, a woman's face or Uncle Sam, your perception filled in the empty spaces and made it a complete picture. The same thing, of course, happened with the triangle composed of the circles in the PARTS AND GESTALT WHOLES demo. Closure helps us to form complete perceptions of the world even if we're only exposed to part of an image or of a situation.

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APPENDIX C

MECHANICS OF THE OPERANT CONDITIONING DEMONSTRATION: THE MOUSE

Initial Screen Setup: The initial screen displays a square box which represents the limits to which the mouse can go in any direction before it hits a wall. On the left of the box is a direction chart with a set of letters representing the relative strength of movement in each of the eight permitted directions: East (E), Southeast (SE), South (S), Southwest (SW), etc. Initially, all the relative strengths are equal. Between the direction chart and the box are two smaller rectangles labeled "REINFORCEMENT" and "PUNISHMENT", with the Reinforcement rectangle being approximately twice as large as the Punishment one. A darker vertical band is drawn centered on the eastern wall approximately onequarter the wall length, with the word "GOAL" placed vertically behind it. A mouse is graphically drawn using the Apple Toolkit program, and placed horizontally in the center of the screen, about three moves away from the Western wall and 10 moves away from the goal (see enclosed picture).

Program Flow (1) The program initially sets up a matrix pairing a relative strength number (20 to begin) with each of 8 numbers representing a move in one of the permitted directions. (2) It randomly selects a number from 1 to the highest current relative strength number, and selects a subset of the direction indicators from those numbers which have relative strengths equal to or higher than the randomly selected number. It then randomly chooses the direction to move from this subset, and moves accordingly (e.g., "1" produces a mouse redrawn one move North of its original position, "2" one redrawn one move Northeast, and so on). (3) The program first checks to see if the mouse has touched the goal; if so, it exits the program. (4) The program then checks to see if the mouse has passed a border of the box; if it has, it is redrawn back in its previous position, and
squeaks (bumped its nose). (5) It then waits approximately onehalf second and checks to see if a key has been pressed:

If the "R" key has been pressed, the words "YUM YUM" appear briefly on the screen above the mouse's head and then are erased. If this is the first, second, or third time that a reinforcement has been given for movement in this direction, the relative strength of direction number in the matrix for that direction is increased by three; otherwise, it is increased by five. The two directions on either side of the reinforced direction are increased by one unit.

If the "P" key has been pressed, the word "OUCH" appears briefly on the screen above the mouse's head and then is erased; the mouse also squeaks briefly. If this is the first, second, or third time a punishment has been delivered for movement in the direction, the relative strength of direction number in the matrix for that direction is decreased by three; otherwise, it is decreased by five. The two directions on either side of the punished direction are decreased by one. The relative strength of movement indicator is not permitted to fall below 1.

If no key has been pressed, or some other key than an "R" or "P", the relative strength of direction number in the matrix for that direction is decreased by one (but not lower than 1).

(6) The program then updates The relative strength of direction chart to correspond to the numbers current for each direction in the matrix;

(A) If the "R" key had been pressed, the Reinforcement rectangle is filled in one unit higher and the reinforcement counter is incremented; if the counter has reached 15, the program prints, "SORRY, YOU HAVE OVERFED YOUR MOUSE AND IT IS SATIATED: IT WON'T RESPOND FURTHER... YOU MUST GET A NEW MOUSE", and exits the program.

(B) If the "P" key had been pressed, the Punishment rectangle is filled in one unit higher and the punishment counter is incremented; if the counter has reached 8, the program prints, "SORRY, YOUR MOUSE IS FROZEN WITH FEAR AND IT WON'T RESPOND FURTHER... YOU MUST GET A NEW MOUSE", and exits the program.

(C) A movement counter is incremented; if the number of moves reaches 100, the program prints, "YOU HAVE TAKEN TOO LONG TO
TRAIN YOUR MOUSE AND IT IS TOO TIRED TO MOVE... YOU MUST GET A NEW MOUSE", and exits the program.

(7) If none of the exits has been reached, the program returns to Step 2 and repeats from there. (8) Exits (A) If the program has been exited because the limits for the counters of reinforcement, punishment, or movement have been reached, the student is instructed to start over by pressing a key for a new mouse. All counters are reset and the student returns to Step 1. (B) If the mouse has crossed the goal, the student is congratulated and then presented with a screen that shows the relative strengths of movement in each direction that his training has produced; a written explanation sheet discusses how this training exemplifies the findings of psychology in terms of reinforcement, generalization, punishment, and extinction procedures, and the best (e.g., most efficient) way to train the mouse according to Learning Theory.

Psychological Explanation Learning theory has shown that a reinforcer delivered shortly after a behavior has been emitted will tend to strengthen that behavior. Increasing the Relative Strength of Direction index simulates this by increasing the likelihood that a number representing that behavior will be chosen by the program randomly on the next move. In addition to directly strengthening the actual behavior, reinforcement causes similar but not identical behaviors to also be strengthened to a lesser degree; this generalization effect is simulated in this program by incrementing the directions on either side by one unit.

Extinction is shown to occur when a response is not reinforced or punished; the response tends to be exhibited less often, as shown by a decrement of one unit for any nonreinforced or punished response in the matrix. This permits simulation of the process of discrimination, since extinction will tend to depress the mouse's responding to similar behaviors to the reinforced one and therefore counteract the effects of generalization. Punishment, on the other hand, has been shown to (at least temporarily) lessen the likelihood of the performance of the punished behavior, but not necessarily strengthen a desired behavior. The program simulates the effect of punishment by decrementing the relative strength of direction index for the punished direction of movement. As it does with reinforcement, generalization effects also occur with punishment; this is simulated in the program by reducing the indices on either side of the punished direction by one unit.
Students are at first puzzled by the mouse's behavior: following a reinforcement, the mouse may move in the exact opposite direction; following a punishment, the mouse may repeat the same behavior on the next move. Anyone who actually worked with mice can testify that this is precisely what does occur in in vivo research, and in the explanation sheet it is pointed out to the student that reinforcement and punishment are not magic wands that immediately cause behavior to be exhibited or suppressed; response strength only builds up slowly over time, as it does in this simulation. Originally, we had intended to have the students run their mouse in the box five times, and have the mouse exhibit a learning curve over trials, perhaps even working in the advantages of variable ratio or interval, or fixed ratio or interval schedules of reinforcement. However, this fell hostage to our desire to keep the demonstrations short enough to have several different ones during a single 30 minute laboratory session. The authors would be happy to discuss the implementation of some of these ideas with any parties interested in developing the simulation further.

BIOGRAPHICAL SKETCHES

Morton Isaacs has a PhD in Social Psychology and has been teaching psychology at the Rochester Institute of Technology for 17 years. His initial interest in behaviorism as an innovative approach to learning led him to become involved in the design of the PSI course described in this article, and dissatisfaction with the partially negative feedback from the students to the methodology led him to try to create something that would generate more enthusiasm than the traditional approach. After teaching himself programming and helping create some of the programs discussed above, he created three other simulation programs in psychology which were marketed commercially, as well as helping design new, and reworking older, programs used in the PSI course.

Roger Harnish is Associate Professor of Psychology in the Division of Behavioral Sciences at the Rochester Institute of Technology. He is very interested in microcomputers, having produced and commercially sold several programs written in Assembly and in BASIC for the Apple II family. He is currently involved in the use of student-faculty networking on the VAX (the NOTES program) as an aid in instruction, as well as continuing to write programs on his Apple IIIGS.