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PROGRAM ABSTRACTS/ALGORITHMS

CONCEPTS: A program for microcomputer-controlled experimentation in concept attainment

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The CONCEPTS program was originated to study ways in which personality and instructional variables interact to affect concept-attainment skills. The program is also suitable as an aid to teaching about concepts and as an experimental tool in the investigation of other factors affecting cognition.

CONCEPTS Design. The CONCEPTS program is written in APPLESOFT BASIC for use on an APPLE II microcomputer. The APPLE II was chosen for its videographics capability. The program occupies somewhat less than 5,000 bytes of memory and makes extensive use of keyboard-checking procedures to guard against incorrect or inappropriate responses by the subject. Because of its special graphics routines, it is not easily adaptable to other microcomputers. However, the overall schema of the CONCEPTS program is readily implemented on any small microcomputer with a CRT display.

This version of the program was written to permit data storage on an audio cassette tape. Relatively simple modifications would allow the data to be stored on a magnetic disk.

The Concept-Attainment Task. Concept attainment is defined here as the process of defining class identity by identifying the attributes that are shared by two class members, but distinguishing them from a third item that is not a class member. The defining features of class members, used to infer class identity, are termed criterial attributes. An adaptation of the concept-attainment task described by Wickelgren and Cohen (1962), this experimental task requires the subject to identify criterial attributes after presentation of stimulus items in as few trials as possible.

The decision to modify the task devised by Wickelgren and Cohen (1962), which used eight-digit numbers as stimulus items, followed a pilot study in which many subjects expressed "number anxiety" or attempted arithmetical rather than symbolic operations with the stimulus items. A major advantage of the CONCEPTS program, which uses rows of eight dots of differing colors, is that it forces the subject to respond to the abstract property of "color" rather than to attempt numerical operations, thereby eliminating a possible source of uncontrolled variation. For the purpose of this discussion, however, the stimulus items are represented by numbers. Each number represents one color, as shown in Table 1.

Table 1
CONCEPTS Colors and Their Associated Numerical Representations

1 = Magenta	4 = Dark Green	8 = Brown
2 = Dark Blue	6 = Medium Blue	9 = Orange
3 = Purple	7 = Light Blue	0 = Green

The concept-attainment task involves the serial presentation of stimulus items. Each presentation (Figure 1) consists of two rows of colored dots; each row contains eight dots, with four specific dots composing the criterial attributes of the concepts. The concept is defined so that only one color in a certain place can be part of the concept. The concept used is medium blue (6) in Place 2, purple (3) in Place 4, brown (8) in Place 5, and medium blue (6) in Place 8. The presentation schedule is designed to allow optimal inference from a comparison of the bottom row of dots with the top row, which is an example of the concept that remains unchanged throughout all trials. The lower row is designated as being either an example or a nonexample of the concept. The subject's task is to discover how many places, which places, and which colors in these places define the concept. Although the problem is logically solvable in 9 trials, 20 separate trials are provided; the last 11 are repeat presentations of the first trials.

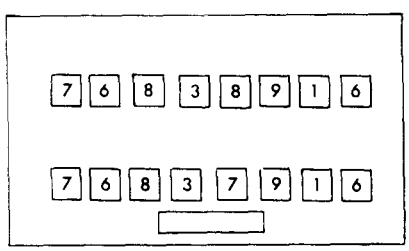

Figure 1. Sample stimulus display of a presentation involving an example and a nonexample. Note–Since the top row is constant, an example of the concept that remains the same for all presentations, a minus sign under the two rows is used to designate that the bottom row is not an example of the concept. Comparisons involving two examples are designated by a plus sign.

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T (TRIAL NUMBER)	TEST (NEW STIMULUS ITEM)	R(+/-) (EXAMPLE OR NONEXAMPLE)	UNSURE (HYPOTHESIS)	SURE (INFERENCE)	G (ATTEMPT TO GUESS CONCEPT)
(CONSTANT)	76838916	+			
1	76837916	-	--------	----8---	-
2	26838916	+	*-------	--------	-
3	74838916	-	-6------	--------	-
4	76838926	+	------*-	--------	-
5	73818916	-	--------	-6------	-
6	76838906	+	------*-	--------	-
7	76828916	-	--------	---3----	*
8	76038916	+	--*-----	--------	-
9	76838913	-	--------	-------6	*

Figure 2. Schedule of presentation and sample display of one subject's performance on the CONCEPTS task. Note–In this example, the subject inferred on Trial 1 that Color 8 in Place 5 was a criterial attribute. This was followed by a hypothesis on Trial 2 that the first place was a noncriterial attribute, indicated by an asterisk. The asterisk in the final column shows that on Trial 7, the subject attempted to guess the concept rule and failed, causing the game to continue. The concept rule was correctly identified on Trial 9, and the game terminated.

When presentations involve rows differing in only one place, the optimal response is to infer that the changed place between an example and a nonexample must be a criterial attribute and that the changed place between two examples of the concept cannot be a criterial attribute. Forming hypotheses or provisional judgments in these situations constitutes an inefficient strategy.

Indicators of Cognitive Processes. The program provides the experimenter with information concerning the subject's performance, namely, the ability to remember, compare, and utilize information correctly and efficiently. CONCEPTS was designed to collect data on four separate indicators: (1) overall performance (number of trials to solution), (2) number of inferences (efficient use of information), (3) number of hypotheses on negative instance trials (an inefficient strategy), and (4) the nonutilization of information. Measures of these processes are obtained by the computer through the delivery of a series of questions presented during each trial. Following the subject's completion of the experimental task, a visual display of each subject's responses is provided to the investigator (see Figure 2). The display presents a record of the subject's performance for each trial, the subject's decision regarding whether the place was a criterial or a noncriterial attribute, whether the judgment was a hypothesis (unsure) or an inference (sure), whether or not the subject attempted to guess the concept rule (all four criterial attributes), and the trial on which the subject correctly identified the concept rule. Other measures can be extracted from the program output, which is a profile of the subject's performance. The subject's use of correct and efficient concept-attainment strategies is easily evaluated by inspecting these summary data, which may be printed or stored on tape for subsequent printout.

An Additional Routine. The program also contains an optional routine designed to provide subjects with a visual display or record of their reasoning on previous trials. This "memory support" consists of a cumulative record of the subject's previous selections of criterial and noncriterial attributes in columns reflecting their expressed level of certainty. The memory support, initially two rows of white dots presented in the lower half of the CRT screen, registers each of the subject's hypotheses and inferences by changing the appropriate dot to the color selected (for a criterial attribute) or by deleting the dot (if selected as noncriterial).

Interactive Aspects. The program is interactive. Instructions and questions eliciting the subject's reasoning are provided by the computer in language that is easily understood by subjects, allowing the absence of the experimenter during task performance.

Availability. Program documentation is available at no charge from the senior author, Department of Health Care Administration, Trinity University, 715 Stadium Drive, San Antonio, Texas 78284.

REFERENCE

WICKELGREN, W. A., & COHEN, D. H. An artificial language and memory approach to concept attainment. *Psychological Reports*, 1962, **10**, 815-827.

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