Verbal Responses to Past Events: Intraverbal Relations, or Tacts to Private Events?

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Seventy-five undergraduate students worked through a computer program which taught them to correctly identify four solid geometry figures. The video screen background color was incidently different for each figure. Later, when given a colorless background, students were asked to say what color accompanied the instructional frames for each superimposed figure. Taken as a whole, the 75 students correctly recalled the previously paired colors 53% of the time (p<.0001) when compared to a random probability of 25% (a replication of the experiment produced similar results). Results showed great variability from one student to another in the ability to recall colors but scores did not correlate with gender or performance in the course. Successful responding to "absent" colors was assumed to be the product of multiple variables, among these being the possibilities of conditioned seeing and intraverbal relations acquired prior to and during the tutorial.

In *Science and Human Behavior* (1953) and *About Behaviorism* (1974), Skinner argued that part of the behavior of "seeing" can occur in the absence of the thing seen (he did not use the term "imagination"). As a listener or reader, an individual responds to stimuli generated by a speaker or writer. Both the current stimulation and the changes induced by past conditioning can play important roles. In the act of listening or reading, stimuli "fuse" (Skinner, 1957). A person can read material or observe events which result in "seeing" things in new ways. When a listener says "I see what you mean" he or she is almost certainly responding, in part, to a private effect.

The discussion of private events in a science of behavior has often led to trouble, however, especially when these events have played the role of originators. Many people have argued that such private links may be safely ignored in a functional analysis since they are not loci of origination – merely unobservable links in chains (at best) which can be successfully analyzed only when concentrating upon public concomitants. But all civilized people report responding to private events and it would leave embarrassing gaps in a comprehensive description of human behavior to ignore the role of private events as well as the conditioning techniques which might be developed to alter the role such events play. As is true of all physical events not currently available for inspection, the difficulty is, of course, objective verification of their dimensions.

Procedures which strengthen the role played by covert links could have many practical uses. We learn how to span temporal delays with overt notes, less visible ones when we keep something "in mind." Such "mental notes" are evanescent at best, but they can often play a key role in bridging temporal delays between contingencies, especially when their effects upon us can be deliberately strengthened and when we respond to them more discriminatively.

Therefore, one goal of the present research was to measure the extent to which a sample of adults could respond discriminatively to the effects of events incidental to a learning environment. If such skill were to be shown, could it then

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be related to readily available student demographic variables? Could results then set the stage for the development of more powerful instructional techniques, especially those which enable individuals to more precisely respond to past events.

METHOD

Subjects

Seventy-five (53 female and 22 male, mean age 25) undergraduate education majors served as subjects. The course the students participated in differed from the traditional lecture discussion format. It was a guided reading program punctuated with weekly computer examinations over assigned readings. All students had been working through computer tutorials about behavior analysis and taking weekly tests prior to the commencement of the experiment. They volunteered to participate in the present study in lieu of writing a brief term paper. They were encouraged to do their best but were informed that course credit was not contingent upon anything more explicit than "successful participation." Demographic data about age, gender, and various other characteristics were collected at the beginning of the course.

Setting and Apparatus

The experiment employed a free access lab which contained IBM PS/2 color computers arranged in rows. During the study, about half of the computer stations were occupied by students from other courses or remained empty.

Procedure

The experiment occurred during the third week of a 15-week academic semester. Students were reminded during the second week to allow themselves a minimum of one-half-hour additional time during the next week for the experimental session. Appointments for the experiment immediately followed the regular quiz activities in the course during the week of the experiment.

The four geometric solids (tetrahedron, icosahedron, dodecahedron, and octahe-

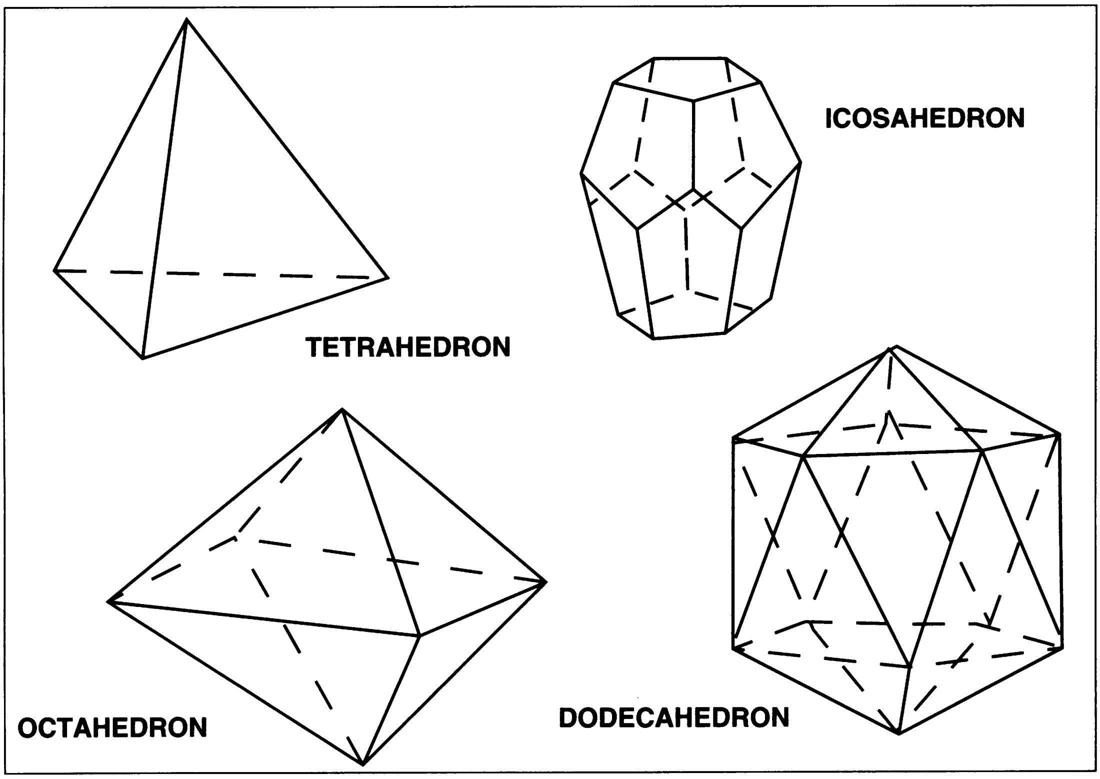

Fig. 1. The four solid geometry polygons used in the tutorials.

dron) in Figure 1 were those used in the tutorial program. These polygons were judged to be unfamiliar to most students in the subject sample.

Each student was ushered to a computer station as far from other class members as possible. The instructional program (including the posttest) was contained on individual 3 1/2 inch diskettes. A diskette was dispensed to each student by the lab assistant and he assisted the student in beginning the computer program.

The initial segment of the tutorial collected the demographic information to be used for subsequent data analysis. The next segment induced the student to tact the four background colors to be used in the program (while being given the choices of green, blue, brown, and red). Each student was repeatedly asked to supply the answer to the statement "The background color of this screen is ______." The student could not leave each of these four color verification frames until he or she had correctly labeled its background color. (This pre-tutorial segment was included because the wavelength of computer background colors used in the tutorial varied slightly from one computer station to another.)

The instructional segments appeared as a series of "loops" presented in a linear sequence. Each instructional loop delivered interactive instruction with respect to one of the four geometric figures. The format was exactly the same for each figure and used the same text. The only variables changed were the figure, the name, and the number of polygon sides. The loop for each of the four geometric solids was 14 frames long, therefore, the entire tutorial program was 56 (14 x 4) frames long. Loops induced the student to say whether the figure was or was not a polygon, a polyhedron, whether it was a solid, to say how many sides it had, to type the correct name of the figure in its presence, etc. In this manner, student responses were brought under the control of the properties of each figure through the processes of priming, prompting, and differential reinforcement. The program gave each student two tries to answer each frame correctly and kept a count of the number of attempts taken to answer each frame. Students eventually typed correct names of the figures without textual prompts in the final frame of each loop.

For experimental control, the geometric figure sequence was ordered in four different sequences and diskettes were randomly assigned to students as they arrived at the site of the experiment. In other words, one fourth of the students experienced the 1-2-3-4 order of geometric figures, another the 2-3-4-1 order, another the 3-4-1-2 order, and the remaining students the 4-1-2-3 order. (These different orders were incorporated to control for possible "primacy/recency" effects with respect to the appearance of any given color and performance on the subsequent posttest).

In addition, the computer program itself randomized the presentation of the four background colors (blue, brown, red, and green). In other words, any color might appear as a background for the frame for the first figure. Any of the remaining three colors could appear during the second loop, any of the remaining two for the third, and then finally the remaining color. Text and figures appeared in white superimposed upon the background colors.

Immediately following the final student response to the tutorial, a message prompted the student to call for the lab assistant. The lab assistant noted the clock time and tapped a key to begin the posttest. The entire posttest appeared as white type and figures on a black background (with no review of color names). The four figures were presented in serial order with the question "What background color accompanied the instructional frames for this figure?" The student supplied his or her answer at the point of a blinking cursor (without color word prompts). A fixed sequence of the four geometric figures appeared three times in succession (i.e., 4 x 3 = 12 presentations). The posttest terminated with a request that the student refrain from discussion of the experiment with any other person until the results of the entire investigation were made known to the class.

Dependent Variables

The computer programs kept records of

the specific responses students entered and the percent correct performances. The programs also recorded the number of seconds students took within segments of the tutorial and the posttest.

Experimental Design

A statistical analysis of grouped scores, rather than a single subject multimanipulation analysis, was selected because the experimenters assumed that pretesting would have sensitized students to the property of color backgrounds and caused them to relate colors with figures during the tutorial. Further, the researchers assumed that experimental effects would not be reversible. A protracted experiment of repeated tutorial program delivery was not feasible.

RESULTS

The primary focus of this experiment was the extent to which students could correctly pair colors with polygons. Table 1 presents results of various statistical analyses. To test the significance of the difference between the students' conditioned seeing score (Mean = 0.53) and the probabil-ity of guessing one of the four colors (NULL =0.25), a paired t-test was performed (SAS) because the two groups of scores were derived from the same set of experimental subjects and were, therefore, not independent measures. Results indicated a statistically significant difference ($t=7.8$, $p<.0001$).

The posttest delivered each of the four geometric figures three times – distributed in an unpredictable order (i.e., 4 x 3 = 12 opportunities). Figure 2 is a histogram showing the distribution of student scores from 0% correct to 100% correct. The bar at the extreme left shows that 5 of the 75 students failed to correctly match the colors with *any* of the four geometric figures. However, the last bar at the extreme right indicates that 11 students correctly matched *all* figures with their respective background colors. The distribution shows that the extent of the scores varied substantially across the sample of undergraduates.

There was no significant correlation between terminal course grades in the undergraduate Human Development and Learning course and the scores these students achieved on the posttest (see Table 1). However, there was a significant positive correlation between the percent correct scores students achieved on the tutorial program and the scores they achieved on the subsequent posttest ($r=.28$ $p<.05$). In other words, students who achieved higher percent correct scores during instruction were more likely to recall the incidental background colors later. Time taken to complete the tutorial did not correlate with posttest scores. Time to complete the tutorial did not correlate with the tutorial percent correct scores. Gender did not correlate with the experimental effects. Time taken to complete the posttest did not correlate with the magnitude of scores. There was no evidence of any special relation between student performance and either the specific solid geometry polygons or the background colors used in this investigation.

A Replication

The previously described experimental program was repeated two academic terms

Table 1

Data analysis for experiment 1.

Comparison	N	Mean	Stat.	Prob.
Seeing scores vs. "Chance"	75	0.53	(paired) t=7.8	0.0001
Course grades vs. Seeing scores	72*		r=0.0527	N/S
Tutorial scores vs. Seeing scores	75		r=0.2792	p<0.0153
Time with tutorial vs. Seeing scores	75		r=0.0838	N/S
Time with tutorial vs. Tutorial scores	75		r=0.1041	N/S
Gender vs. Seeing score	75		r=0.0233	N/S
Seeing test time vs. Seeing score	75		r=-0.1443	N/S

* *Three scores unavailable*

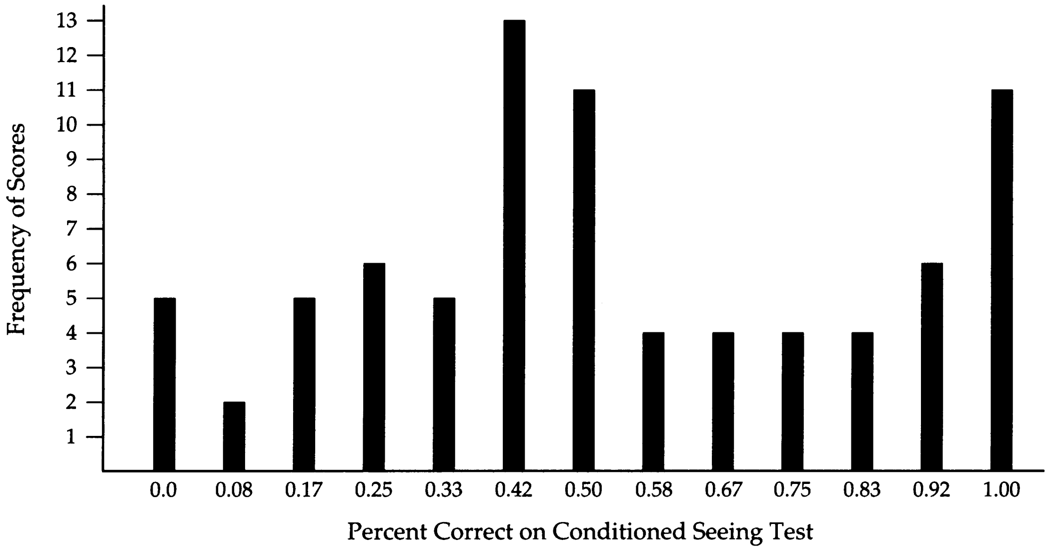

Fig. 2. A distribution of the number of (total = 75) scores which occurred at each of the 13 possible score values on the conditioned seeing posttest (e.g., five students failed to correctly pair any background color with the polygon previously superimposed over it, however, 11 students obtained a perfect score).

later with a different class of somewhat older students. The students were registered in a special education extension course with essentially the same curriculum content. This course section contained 3 males and 27 females. Ages ranged from 19 to 48 with a mean of 34. The experiment was conducted by the same investigators with methods similar to those described previously. The computer tutorial program was identical. Students completed the program as part of the course requirements but without an explicitly stated relation to the course grade.

Similar results were obtained (see Table 2). This systematic replication produced a mean conditioned seeing score of 0.53, $p<.0001$, which was nearly identical to results obtained with the large undergraduate section on the main campus. No correlations between posttest scores and other measured variables were found. In contrast to results in the initial study, however, the correlation between scores on the tutorials and on the conditioned seeing posttest failed to reach statistical significance, possibly due to the relatively small number of students in this second sample (N=30).

As in the first experiment, time taken to work through the tutorial was not significantly correlated with either the percent correct "frame" score on the tutorial or the

Table 2

Data analysis for experiment 2.
(replication)

Comparison	N	Mean	Stat.	Prob.
Seeing scores vs. "Chance"	30	0.53	(paired) t=4.4810	0.0001
Course grades vs. Seeing scores	30		r=0.1541	N/S
Tutorial scores vs. Seeing scores	30		r=0.1832	N/S
Time with tutorial vs. Seeing scores	30		r=-0.0519	N/S
Time with tutorial vs. Tutorial scores	30		r=-0.0519	N/S
Gender vs. Seeing score	30		r=0.0081	N/S
Seeing test time vs. Seeing score	30		r=-0.2859	N/S

score achieved on the posttest. Time taken to complete the posttest was also not significantly correlated with scores on the posttest. Gender was unrelated to posttest performance.

An analysis of the relation of specific colors or polygons to the posttest performance was not possible due to the small number of students in this sample.

DISCUSSION

The present investigation revealed that stimuli not directly part of reinforcement contingencies leave their effect to a greater or lesser degree with different people. The effect that remained may have resulted from the combination of several processes.

All students were requested to identify background colors in frames immediately prior to the tutorial (in which they appeared incidently). The students were required to correctly tact each of the four background colors (in their presence) in an effort to restrict these verbal responses to the wavelengths actually presented by the tutorial computer screens. (The experimenters were concerned that variability in color synonyms given by students on the posttest might confuse the identification of an experimental effect). Thus, the "pre-tutorial exercise" repeatedly mentioned the four colors, green, red, brown, and blue, asking each time for the student to supply the missing word to – "The background color of this screen is _______." In this manner, the word "color" was repeatedly part of a textual prompt for each of the four colors. This procedure may have predisposed all students to respond discriminatively to color backgrounds later during the tutorial even though the tutorial did not arrange explicit contingencies for this.

The actual tutorial frames about geometric figures, however, contained no prompts or contrived reinforcement for responding to colors. In other words, tutorial instruction included no reference to color, nor did the tutorial ask the student to respond in any way to figure backgrounds while instruction about the four figures was going on.

One possible explanation for correct color recall during the posttest was that a student may have developed covert (or overt) intraverbal "color identification responses" while supplying figure-related responses during the tutorial. When a student counted the number of sides on the figure or supplied the word "dodecahedron," this response "product" may have become a stimulus which evoked covert (or even overt) color statements. In other words, a student may have said to him- self – "This is an icosahetron," perhaps while typing the actual response, and also have coincidently said, "The background color is blue." All of this is highly speculative, however, and even post-study questionnaires would not have solved the problems of privacy. The probability of tacting the background color even though not called for by the tutorial was probably increased by the pre-tutorial color identification exercise and this explanation of the observed effects seems to be a reasonable one.

A second explanation is consistent with Skinner's notion of "conditioned seeing." In answering the question "What background color accompanied the instructional frames for this figure?" students were clearly responding, in part, to the questions as verbal discriminative stimuli. But the individuals, taken as a whole, responded *differently* to the same question when the *figures* were different. In contrast to the "intraverbal interpretation" given above, we might alternatively speculate that students' private visual stimulation was generated by the figures. In other words, the students may have, to some lesser extent, "seen" a color, then responded to it as a "tact" to a private stimulus generated by the presentation on the computer screen. Skinner (1957) defined a response to such an incidental stimulus as a "metonymical" tact – the controlling stimulus has only a tenuous (incidental) relation to the response it evokes. We might speculate from data in the present study that correct color identifications were metonymical tacts to private effects remaining from prior incidental pairing of colors with figures.

Results of the present research provide

the basis for speculation about variables and processes not directly available for objective inspection. But this kind of construction from observable evidence is a part of other well-established sciences which must infer important phenomena (e.g., sub-atomic physics, evolutionary theory, and astrophysics) because the inferred phenomena are too small, distant in time, or otherwise out of reach. Research about such processes and events will necessarily be accomplished by "affirming the consequent" (Sidman, 1960).

Other evidence might support the "conditioned seeing" interpretation. A high percent correct score during the tutorial meant a high probability of reinforcement. The correlation between tutorial scores and posttest scores was significant ($r = .28$, $p<.05$) in the present (first) experiment. In other words, the effect of incidental background colors was greater for those students who responded more successfully during the tutorial. This suggests that the *probability of reinforcement* in the presence of the incidental stimulus may have been responsible for, or at least directly related to, the posttest effect. If this were true, we are led to propose that instructional programs should be refined to the point that induced performance achieves reinforcement a high percentage of the time – a position long taken by many advocates of linear programmed instruction.

CONCLUSIONS

An experimental analysis has clearly confirmed that stimulus control is established during the event called "reinforcement." These results appear to have both conceptual and applied significance. The importance of operant reinforcement is apparently not well understood by many designers of instruction and has not been deliberately and carefully incorporated into computer-assisted instructional programs available today.

If the results of the present research are a fair representation, the ability to respond to the after-effects of instructional circumstances appears not to correlate with demographic variables such as age, ongoing course test performance, gender, etc. This seems to point to fundamental behavioral principles. Future research should focus upon methods of experimentally identifying the functionally related variables. Other research could then determine whether the same functional relations hold true for sense modalities such as auditory, olfactory, or tactile stimulation – all of the research providing the foundation for a more powerful applied technology, one which enhances the ability to respond to the after-effects of past events.

The present research was a beginning. The procedures clearly left the possibility for multiple causation of correct color recall. Among the interpretations possible are both the "intraverbal" and the "conditioned seeing" phemonena, as well as many others. Future research designs must tease out the contribution of relevant relations—all of which enter into processes made particularly difficult to evaluate because of their privacy. If conditioned seeing is involved, these results might be interpreted as supplying evidence that behavior often referred to as "imagination" can be investigated with greater scientific rigor. It was a beginning step in an area which may prove to have many ramifications for the efficiency of instruction. Combined with the rigorous stimulus control and consistency of program delivery now possible with instructional technology, the relationships implied in the present research program might be used to greatly enhance the quality of instructional programs. Programs which produce more profound and durable changes in behavior – changes which spread to novel environments – would greatly advance the efficiency of education.

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