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OBSERVATIONAL LEARNING: A TECHNIQUE FOR ELUCIDATING S-R MEDIATION PROCESSES[1]

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Os watched naive models (Ms) perform at a visual discrimination avoidance task. In a 2 × 2 design, task apparatus for M was either in the same orientation or rotated relative to that subsequently used for O, and hand used by M was either the same or different from that later to be used by O. Os' test data conformed in near detail to the prediction that positive transfer would be proportional to similarity between visual stimuli received from M's performance and those later to be received from correct performance ("performing stimuli"). It is suggested that the observational learning paradigm may generally be useful for studying the mediation processes of S-R theory, the data of the present experiment indicating that mediating stimuli are more effective the more they approximate performing stimuli.

In a recent review of the observational learning literature, Bandura (1965) noted that imitative responding can frequently be demonstrated following observation of a model's performance without any intervening practice by *O*. Bandura labeled this finding "no-trial learning" and concluded that such imitative responses

"... are acquired on the basis of stimulus contiguity and *are mediated by cue-producing symbolic responses which exercise discriminative stimulus control over corresponding overt performances.* Thus, in this mode of response acquisition, imaginal and verbal representations of modeling stimuli constitute the enduring learning products of observational experiences [1965, p. 47, italics added]."

Mediational cue-producing responses, such as those mentioned in Bandura's conclusion, are frequently appealed to in some varieties of S-R theory (e.g., Miller, 1959; Osgood, 1953; Spence, 1956). One problem with such developments in S-R theory has been that the mediating process is generally considered to be unobservable, at least with present technology. This inaccessibility of the hypothesized "cue-producing response" has made it difficult to subject the mediating-response forms of S-R theory to as rigorous experimental testing as might be desired.

The "no-trial" observational learning paradigm provides an unusual opportunity to obtain information about the hypothesized mediating process of S-R theory. This would be accomplished with a procedure in which (*a*) different groups of *O*s are exposed to different patterns of modeling stimuli from a standard experimental task, and then (*b*) all *O*s are tested for performance at the task. Part *a* of this paradigm has the effect of establishing different "symbolic responses" (representing the observed performance) in the different groups of *O*s; Part *b* provides a demonstration of possible differential effects on performance of these different "symbolic" or "cue-producing" or "mediating" re-

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sponses. Since no response practice intervenes between establishment of the mediating process (by observation) and determination of its effects on performance, any group performance differences must be attributable solely to the possibly different mediating processes established by the varying modeling stimuli employed.

The present study was designed to test the hypothesis that the greater the similarity of visual *modeling* stimuli to visual *performing* stimuli, the greater will be the transfer from the observation to the test phase of the experiment. By "visual performing stimuli" is meant the visual stimulation the performer would receive from observing his own *correct* performance. To illustrate: Assume the object of teaching a child to tie his shoelaces, using only observational instruction. In this case, the sights of hands, shoes, and shoelaces as seen from the viewpoint (i.e., the eyes) of the child (*O*) constitute the visual performing stimuli. The adult model (*M*) may demonstrate (on the child's shoe) from a position facing *O*, or kneeling side-by-side with *O*, or, alternatively, reaching over and around *O* from behind. Since the last of these modeling positions gives *O* the best approximation of the (proper) performing stimuli, the present hypothesis predicts that it would yield superior observational acquisition of shoelace tying. Generalizing further, it would be predicted that the *M*-facing-*O* position would be the least useful technique since the modeling stimuli thus generated would give the poorest approximation of the performing stimuli.

Our hypothesis is based on a conception of the mediating process basically quite similar to that proposed by James (1890) in his discussion of *ideo-motor theory.* Specifically, it is proposed that the mediating process is, in part, a visual image, or "idea," of the observed response. In the process of performance, an action is *preceded* by and *initiated* by an image in such fashion as to produce visual feedback that matches the mediating image. With these assumptions, it follows that the more closely *O*'s visual inputs match what is seen from the performer's viewpoint (i.e., the "performing" stimuli), the greater will be the positive transfer from observation to test.[2]

In the present experiment, *O*s watched *M*s performing at a visual-discrimination avoidance task. All *O*s watched from over *M*'s left shoulder, with four conditions differing factorially in terms of (*a*) whether M performed with the apparatus in a *standard* or *rotated* orientation, and (*b*) whether *M* used the *left* or *right* hand to make avoidance responses.

It was predicted that *O*'s left-handed test performance with apparatus in the standard orientation would be superior (i.e., faster) when *M* performed with the standard rather than the rotated apparatus and when *M* used the left hand rather than the right. A more detailed prediction was that apparatus rotation would impair transfer more than opposite-hand observation since, in this situation, the former procedure produced the greater discrepancy between modeling and performing stimuli, as defined above. Finally, it was expected that the predicted differences would be most apparent on

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[2] In *cybernetic* conceptions of performance (e.g., Miller, Galanter, & Pribram, 1960), a visual image is also seen as an effective mediator as a function of its similarity to performing stimuli. In contrast to ideomotor theory, the image does not *initiate* responding in the cybernetic approach but, rather, *guides* responding by providing a template for matching actual current feedback with desired feedback.

the earliest test trials, with groups of *O*s eventually reaching a common asymptote.

The four observing conditions were equated in terms of *O*'s knowledge of which response was correct for which stimulus, *O*'s knowledge about the task apparatus, etc. If the similarity between visual modeling and performing stimuli is irrelevant to observational learning in this situation, no differences in the test performances of the four groups of *O*s should be obtained.

METHOD

Subjects.—Right-handed female *S*s were recruited in pairs from the introductory psychology course at Ohio State University. Their participation fulfilled part of a course requirement. A total of 104 *S*s (52 pairs) were run and data from four pairs were discarded, three for failure to adhere to experimental instructions and one for equipment failure. The remaining 48 pairs were assigned randomly to four experimental conditions, described below, with 12 pairs per condition.

Apparatus and task.—The *S*'s apparatus was built into a horizontal plywood panel, painted light blue, the surface of which measured 24.5 in. × 28 in. The sides of the panel raised it 2 in. from the surface of a standard height table at which *S*s were seated during the experiment. A white light source, built into a swivel-neck black lamp, and three black pushbutton switches, each $\frac{5}{16}$ in. in diameter and projecting $\frac{3}{16}$ in. above the panel surface, were mounted as shown in Fig. 1. The button nearest the light source served a trial-start function. The other two (response) buttons were each 10 in. from the trial-start button and 17 in. from each other; they served an avoidance or escape function. An aversively loud white noise of approximately 105 db. was delivered through earphones to the *S* performing at the avoidance task, as required by the avoidance contingency.

A trial of the avoidance task started when *E* sounded a soft buzzer that served as a signal for *S* to press the trial-start button. Onset of the light source came 1 sec. after *S* pressed the trial-start button, *if* the button was kept depressed throughout the 1-sec. preparatory interval; otherwise, the trial aborted and was restarted by *E*'s sounding the soft buzzer again, etc. The stimulus light was a 60-w., 120-v. ac incandescent bulb, seen by *S* through a 1$\frac{3}{4}$ in.-diameter disk of $\frac{1}{4}$-in. thick translucent white plastic; this disk was mounted in an opening of the same diameter cut into a 5$\frac{1}{2}$-in. diameter piece of black opaque plastic which covered the opening of the swivelneck lamp. The light was presented at one of two easily discriminable intensities, the dimmer of which was obtained by adding a 60-ohm resistor to the light-source circuit. The aversive noise was delivered .80 sec. after light onset unless *S* made the avoidance response that was correct for the intensity presented. For a given *S*, one of the two response buttons was consistently correct for the dimmer light, the other for the brighter light. If *S*'s response was too late to avoid the noise, the correct response served to escape the noise. The stimulus light remained on until the correct response was made. The *S* was required to respond only with the same forefinger used to press the trial-start button.

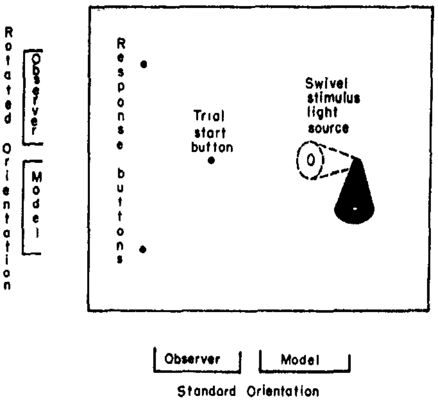

FIG. 1. Schematic diagram of avoidance apparatus, showing positions of model and *O* for standard and rotated observation conditions. (All *O*s were subsequently tested from the perspective of the standard orientation model in this diagram.)

The preparatory and avoidance intervals were controlled by Hunter electrically timed relays. The *S*'s latency to correct response was timed on a Lafayette electric 1/100-sec. clock. White noise was presented from a white-noise tape recording that was running continuously during the experimental session. The *E* and the control and recording equipment were located in a separate room from *S*s, who could be observed by *E* through a one-way vision mirror and instructed by *E* via an intercom.

Procedure.—Pairs of *S*s were randomly assigned to one of four observing conditions: Left Standard (LS), Right Standard (RS), Left Rotated (LR), or Right Rotated (RR). In each condition name, the first word refers to the hand (Right or Left) used by *M* in task performance, the second to the apparatus orientation (Standard or Rotated) during *M*'s performance. Upon arrival at the laboratory, *E* assigned each *S* to either the *M* or *O* role on the basis of a coin-toss done in *S*s' presence. The *M* and the *O* were then seated at the apparatus in accordance with their condition, as shown schematically in Fig. 1. Printed instructions described the functions of the apparatus and the nature of the avoidance problem. A final paragraph advised that "of each pair of subjects, one will perform at the problem immediately and the other will observe and be tested later ... The one who is selected to observe should watch the other's performance carefully and attempt to learn as much as may be learned by observation."

The *M* was then run through 20 trials, using a preset random sequence of bright and dim stimuli that was the same for all *M*s. The interval between trial onsets was not automatically controlled, but was maintained at an average of about 12 sec. for all *S*s, with little trial-to-trial variation. From *O*'s vantage, it was possible to observe all stimuli and responses without obstruction. The *O* could not hear the white-noise punishments received by *M*, but could observe *M*'s startled reaction that was generally quite noticeable for the first punishments. All *O*'s had the opportunity to observe *M* make several errors, since *M* was not initially acquainted with either the correct contingencies or with the different stimulus intensities. The correct response on each trial was always clearly apparent to *O*, being coincident with offset of the stimulus light.

At the completion of *M*'s 20 trials, the two *S*s exchanged seats and *O*, who was about to be tested, was given further instructions. For the LS condition, *O*s were instructed that their task would be the same as *M*'s and were reminded to respond only with the left forefinger. For RS, *O*s were told that, unlike *M* (who had responded with her right forefinger), they were to use only the left forefinger for the task. LR and RR *O*s received one of these instructions, as appropriate, and were additionally asked to rotate the apparatus 90° clockwise. This changed the apparatus from the Rotated to the Standard orientation. (After rotating the apparatus, *O* was also asked to swivel the light source so that it faced her.) These instructions resulted in all *O*s being tested using the left forefinger and standard-orientation apparatus, irrespective of hand and orientation observed.

The time interval between *M*'s last trial and *O*'s first was held constant at 1 min. for all conditions. All *O*s were then tested for 30 trials (continuing the 12-sec. average intertrial interval), pilot data indicating this number to be sufficient to obtain asymptote in all observing conditions. During the intertrial intervals, *E* recorded the previous latency and manually reset the latency clock.

Within each condition, the stimulus-response contingencies that were correct for six pairs of *S*s were reversed for the remaining six pairs. However, the contingencies were never changed from *M* to *O* within a given pair. Therefore, *O*s in all conditions received equal knowledge about stimulus-response contingencies and the functioning of the apparatus. Only observation of the specific actions used by *M* in making correct responses varied across the four conditions.

RESULTS

The data were prepared for analysis by selecting the median latency for each block of five trials for each *O*. Since it was found that the smallest average median latencies occurred in the fifth block for all four conditions, the sixth block data (Trials 26–30) were omitted from consideration.

It was predicted that the conditions would be ordered RR, LR, RS, LS in terms of increasing transfer from observation to test and that the intercondition differences would be greatest on the early test trials. These predictions may be compared with the data as plotted in Fig. 2.

The basic analysis was a three-factor, repeated-measures analysis of variance (Winer, 1962) in which the two between-*S*s factors were Hand used by *M* (Right or Left) and apparatus Orientation for *M* (Standard or Rotated), while the within-*S*s factor was

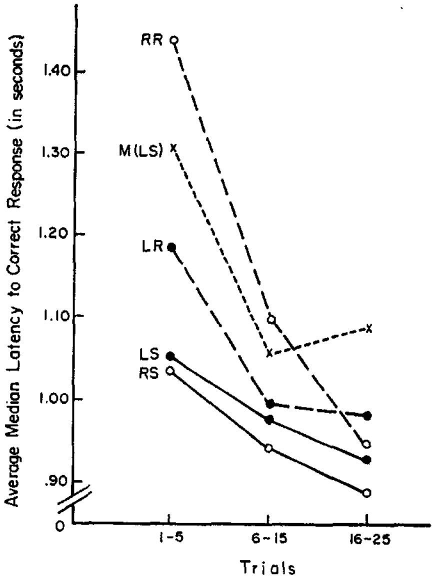

FIG. 2. Test performances of *O*s in the four observation conditions. (Blocks 2 and 3, 4 and 5 have been combined to smooth the curves for graphic presentation. The points labeled "M(LS)" are for naive models in the LS condition and are presented for comparison; the third point for this group includes only Trials 16–20, their last five trials.)

Trials (Blocks 1–5). In this analysis, the main effect of Trials was significant, $F\ (4,\ 176) = 15.08,\ p < .001$, that for Orientation approached significance, $F\ (1,\ 44) = 3.84,\ p < .10$, and the interaction of Orientation × Trials was significant, $F\ (4,\ 176) = 3.79,\ p < .01$.

Evaluation of the predicted effects required an examination of simple effects within the above analysis (Winer, 1962, p. 340). In Trial Block 1, the main effect of Orientation was significant, $F\ (1,\ 44) = 16.40,\ p < .001$, that for Hand approached significance, $F\ (1,\ 44) = 3.19,\ p < .10$, and their interaction was also significant, $F\ (1, 44) = 4.06,\ p < .05$. This interaction in Block 1 may be summarized by noting that the simple main effect of Hand was significant for the Rotated condition in Block 1 ($F = 7.21,\ p \cong .01$), but was nil for the Standard Orientation condition ($F = .03$, *ns*). In Trial Block 3, F for Orientation was 2.71 ($p \cong .10$), F for Hand was .42 (*ns*), and F for their interaction was .76 (*ns*). In Block 5, there were no longer any effects that even approached significance, the three Fs being, respectively, .04, .05, and .51.

DISCUSSION

The obtained findings were in near accord with the details of our original predictions. The only minor exception was that impairment of transfer due to observation of right-handed performance did not quite reach significance.

Figure 2 displays, in addition to the data of the four groups of *O*s, the data for *M*s in the LS condition, i.e., *M*s who performed with the same hand and orientation as all *O*s. These comparison data provide the basis for two observations on quantitative aspects of observational learning in the present experiment. First, Trial Block 1 performance of *O*s in the standard orientation conditions was superior to the Trial Block 4 performance of the comparison *M*s; this indicated that learning by observation was as efficient as learning by practice in the visual discrimination avoidance task. Second, RR *O*s' mean Block 1 performance was inferior (though not significantly) to Block 1 of the comparison *M*s. It was expected that, at least, the RR *O*s would show positive transfer as a result of learning the visual discrimination and the stimulus-response contingencies. Their impairment of performance suggests that inappropriate competing responses were facilitated by the RR observation condition.

In interpreting the present data, two possibilities that exclude reference to visual-image mediation should be considered. The first, which can be dismissed readily, is that differences between groups of *O*s may reflect differences in response speed of the *M*s they observed. In fact, however, *O*s in the RR condition observed the fastest average performance by *M*s, while LS *O*s observed the slowest, so that any direct matching of response speeds would have worked against the obtained effects. The second possibility is that proprioception from peripheral responses, rather than central visual images, may have provided the primary mediating stimuli for *O*s. Although no *O*s were observed to make overt limb movements during the observation period, the possibility that rather minor directional movements of the hand were being made unobtrusively cannot be excluded. If this were the case, then only a minor restatement of the present interpretation would be required; it would be necessary to refer to similarity between proprioceptive modeling and performing stimuli, rather than to similarity in the visual modality.

In light of Bandura's (1965) evidence indicating an important mediational role for visual images in observational learning, our preference is to consider that visual images were the basic mediators of observational learning in the present experiment. Further, the data offered substantial support for the hypothesis that mediating images are more effective the more nearly they approximate visual stimuli that the performer receives from performance of correct responses.

Perhaps more important than our specific findings and conclusions, the outcome of the present experiment indicates the promise of observational learning techniques for systematic study of the usually elusive mediating processes of S-R theory. The general paradigm by which observational learning procedures may be so used has been described in the introductory section, above.

The present findings do not allow us to choose between what we feel are the two most likely mechanisms by which visual-image mediation may control overt responding: (*a*) the ideo-motor conception that an image, or "idea," precedes and initiates responding; or (*b*) the cybernetic conception that the visual image guides responding by providing a "template" for processing and evaluating current feedback.[3]

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[3] Theoretical discussion bearing on the decision between these alternative conceptions of visual-image mediation is given by A. G. Greenwald in an unpublished manuscript entitled "Response Selection Mechanisms," copies of which may be obtained from the senior author.

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