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THE SPONTANEOUS USE OF MEMORANDA BY PIGEONS

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ABSTRACT

Two pigeons were trained to engage in an exchange in which each could function as either 'speaker' or 'listener'. When, without subsequent training, each was placed alone in a situation in which it could play both roles, the two repertoires became interconnected. Behavior emerged which can reasonably be called memorandum-making.

Key words: interconnection of repertoires; memoranda; pigeons.

We recently described "the first instance of symbolic communication between . . . two pigeons" (Epstein, Lanza and Skinner, 1980) and here report additional language-like accomplishments. In the original exchange, the pigeons, named Jack and Jill, could observe each other through a Plexiglas partition and peck (and thus illuminate) keys embossed with colors or letters (Fig. 1). Jack's task was to peck a color matching one to which only Jill had access. He invoked Jill's help by illuminating a key labeled WHAT COLOR? Jill then thrust her head through a curtain and pecked a plate on which one of three colors (red, green or yellow) could be seen. She then pecked (and illuminated) a corresponding black-on-white letter (R, G or Y). Having observed this, Jack pecked a key marked THANK YOU, thus operating a feeder for a few seconds on Jill's side of the partition. Finally, Jack pecked the corresponding color, and a correct selection operated his feeder. He invariably then pecked WHAT COLOR? again. (Hidden colors appeared in a pseudo-random sequence.) The birds engaged in this exchange for sustained periods during which both were correct on 90 percent of the trials. Had they been responding at random, accuracy would have been about 11 percent.

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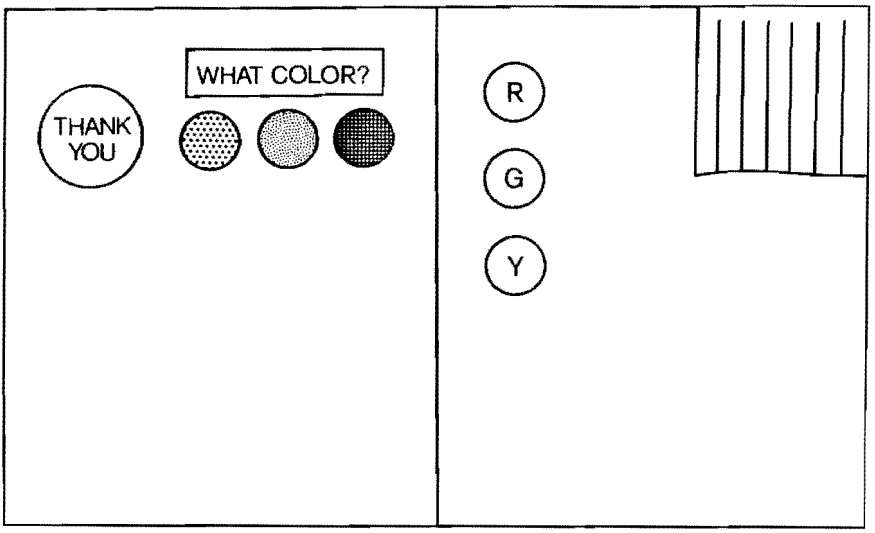

Fig. 1. Adjoining keyboards for the two pigeons. Jack's is on the left and Jill's is on the right. The hidden color is recessed 5 cm behind the curtain in the upper right-hand corner of Jill's keyboard. The R, G and Y on Jill's keyboard are black on white. The three keys below the WHAT COLOR? key on Jack's keyboard are yellow, red and green, respectively.

The simulation was prompted by recent investigations with chimpanzees (Savage-Rumbaugh, Rumbaugh and Boysen, 1978) and was accomplished through standard techniques of operant conditioning. It was designed to call attention to the possible contribution of an environmental history in the acquisition of certain language-like behavior and was offered as an alternative to current mentalistic and purposive accounts.

In the original procedure, each bird was trained in only one role. Jill was, in a sense, a 'speaker'; she 'said something about' a hidden color. Jack was a 'listener'; he waited for and made use of a symbol provided by Jill. In the present experiment we trained each pigeon to play both roles and then conducted a test in which the repertoires became interconnected without our intervention, to produce new behavior. The behavior was studied over a 5-month period and, we believe, can reasonably be called memorandum-making.

The new repertoires were established using standard fading, shaping, chaining and discrimination procedures (Skinner, 1938; Catania, 1979) in the same manner as the original performances. We were not able to omit any steps in training nor to reduce the necessary training time in establishing the new roles – in other words, we found no evidence that a bird had benefitted from being a listener in becoming a speaker or vice versa.

When each bird had mastered both roles, we conducted the following test: The

partition was removed and one bird placed alone in the chamber with access to both panels at once. All keys were active, as they had been in the two-bird situation, though the contingencies were changed slightly as follows: Pecks at the THANK YOU or WHAT COLOR? keys illuminated them as always, but pecks were no longer required, since no exchange was possible. For the same reason, a peck at the THANK YOU key did not operate the right-hand feeder. A peck at the hidden color, followed by a peck at a corresponding letter illuminated the letter, as in the two-bird situation, though a peck at the letter was not necessary. A peck at the hidden color, followed by a peck at the corresponding color on the left-hand panel would operate the left-hand feeder.

A half-hour session was conducted with each bird under these conditions. At first, Jack played the role occasioned by the nearest panel. Facing the left panel, he pecked WHAT COLOR? and then THANK YOU and the color keys, as he had done in the listener role. After a few minutes he moved to the right, checked the hidden color and then pecked the corresponding letter, as he had done in the role of speaker. He walked from one position to the other, pecking keys in this fashion until, midway through the session, a sequence occurred that produced food: He checked the hidden color, pecked the corresponding letter, and then crossed the chamber and pecked the corresponding color. During the remaining 15 minutes, this sequence occurred 20 times and stabilized in a manner suggesting that he was using the symbol keys as memoranda. He would check the hidden color, peck the corresponding symbol key, cross the chamber, and then, before pecking the appropriate color, *look back* (sometimes, several times) at the illuminated letter (Fig. 2). The social responses (WHAT COLOR? and THANK YOU) disappeared entirely. Jill's performance was remarkably similar. The sequence emerged in much the same manner and occurred 21 times during a half-hour session. The performances grew more stable and accurate in subsequent sessions. Color-to-color sequences did not occur.

We found ample evidence in subsequent tests to support our supposition that pecks at the symbol keys were functioning as memoranda. We first noted that these pecks could have been mediating the delay that necessarily occurred between a peck at the hidden color and a peck at a matching color key. Delays can interfere with accurate matching (Spear, 1978; Cumming and Berryman, 1965) and have been known to produce mediating behavior (e.g., Blough, 1959). With a sufficiently short delay, a memorandum should not be necessary; at long delays, it should be critical.

We reduced the delay by removing the curtain from in front of the hidden color. Within three weeks, the responses to the symbol keys disappeared. (Their disappearance was gradual. The pigeons often pecked weakly at or in the direction of a letter as they crossed the chamber. These 'glancing' pecks became weaker and less frequent over a period of days.) When we reintroduced the curtain, Jack reverted to the use of memoranda almost immediately. Jill did not.

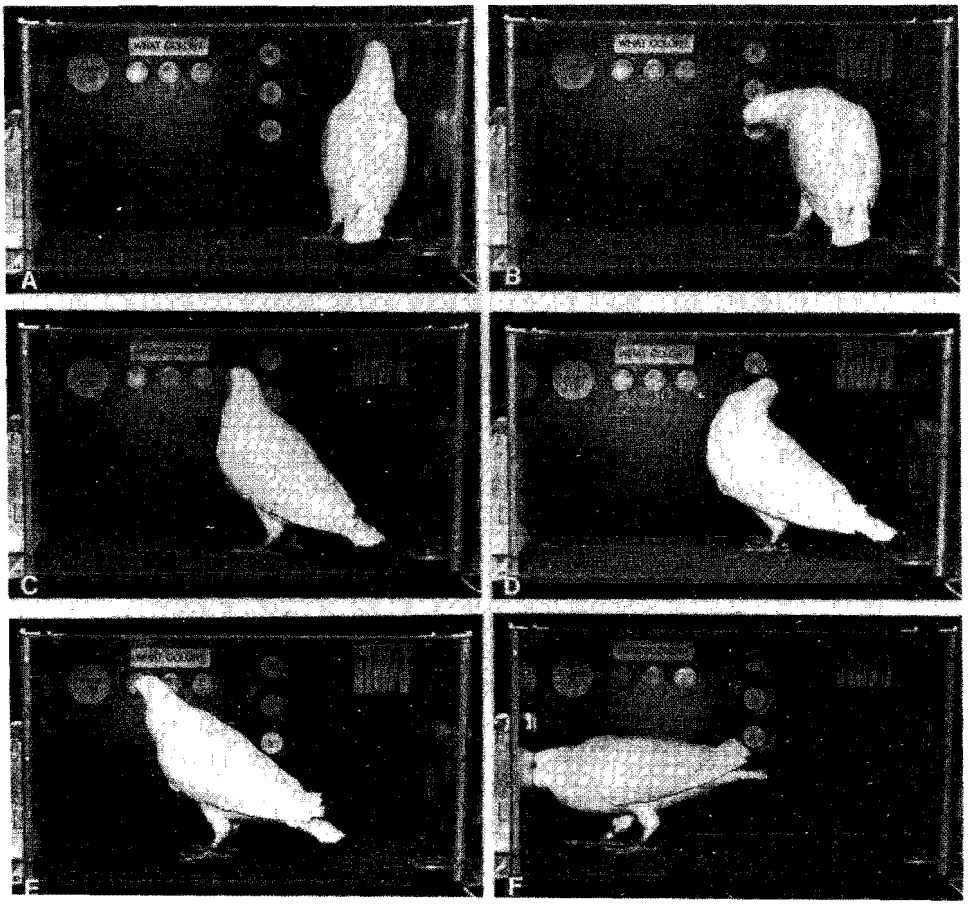

Fig. 2. Though it was never explicitly trained and though it is not required, Jack uses a symbol key as a memorandum as he crosses the chamber from right to left. (A) Jack looks behind the curtain at the hidden color. (B) He pecks the letter corresponding to the color (in this case, Y for yellow), which is then illuminated. (C) He walks to the color keys (yellow, red and green, from left to right). (D) He looks back at the illuminated letter. (E) He pecks the yellow key. (F) The feeder is operated and he eats. If the task is made easier, steps B and D disappear; if it is then made more difficult, they reappear. If he is distracted as he is about to peck the color (E), he looks back again at the letter before completing the sequence.

After Jack had continued to make memoranda for 11 sessions, we looked at the effect of a distraction on his performance. He would peck the hidden color, peck the corresponding symbol key, and walk across the chamber to the color keys. As he was about to peck, we would operate a loud buzzer, placed in the right-hand feeder opening. Jack would start, *look back* at the illuminated symbol, and, finally, peck the color key.

After 17 sessions, we removed the curtain once again. One color-to-color match

occurred within the first session, and the use of memoranda disappeared almost entirely within five sessions.

Though the curtain had been restored for 25 sessions, Jill did not revert to pecking the symbol keys. To make the task still more difficult for her, we introduced a delay between the peck at the hidden color and the illumination of the color keys. The delay was brief at first (0.75 sec) and was increased very gradually (and occasionally decreased as necessary) over 10 sessions to shape good waiting behavior in front of the color keys. With the delay at 1.75 sec, Jill still matched colors with greater than 60 percent accuracy.

Finally, the delay was increased during a half-hour period to 5 sec. Jill's performance was seriously disrupted. She would peck the hidden color, extinguishing the color key lights, and then, finding the color keys dark, typically peck the hidden color again, thus resetting the delay. On the 15th trial she rechecked the hidden color (red) 13 times, then pecked the corresponding symbol key (R) repeatedly during the delay, and, finally, pecked the matching color. She bridged the delay intervals in this fashion on 16 of the remaining 24 trials and pecked an inappropriate symbol key only once. She had not pecked the symbol keys for 67 days before this session.

That the pigeons were using the symbol keys as memoranda is indicated in several ways. First, before pecking a color key, they commonly looked back at the symbol key they had illuminated. Second, they relied less on the symbols when the task was easier and more when it was more difficult. Third, when distracted before pecking a color key, Jack would look back at the symbol he had illuminated.

We emphasize that after establishing the 'speaker' and 'listener' repertoires we did not intervene in any way to promote their interconnection. The use of a memorandum emerged when previously established behavior brought the pigeons into contact with new contingencies. A similar phenomenon may be responsible for a variety of novel behaviors in animals and humans.

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