Imitation and cooperation by hooded rats: A preliminary analysis

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A necessary setting factor for imitation might be prior modification of the imitating organism's behavior in a similar situation. A technique for exploring this possibility is described, in the context of reporting a preliminary study. Imitator and model were then required to cooperate in performing alternate components of a 6-operant chain. Appropriate behavior was sustained following specific training to work under delay of reinforcement. This behavior was found to be independent of opportunity for mutual observation. A further procedure rapidly produced a 'worker-master' relationship between the two rats.

Apparatus

The experimental chamber was a Plexiglas box, 60 cm x 32 cm x 25 cm high, initially divided into halves by a transparent screen. Each half contained two levers, a wire trapeze, a 2.2-W house light, a 2.2-W light immediately above each lever, and a foodwell containing the outlet of a pump which impelled 5% sugar solution according to the state of remote, electro-mechanical logic circuitry. Attached centrally to one of the vertical sides was a small loudspeaker outlet. The floor of the chamber consisted of steel bars, suspended 5 cm above a sand tray. The vertical partition extended from just below floor level to the top of the box, which consisted of two hinged Plexiglas panels. The disposition of the contents within each half of the box is demonstrated in Fig. 1. The experimental chamber was in a sound proofing enclosure which permitted observation of the chamber from above.

Subjects

Four naive, male, black-hooded rats were used, numbered 1, 3, 4, and 5, all aged approximately 120 days at the beginning of the study. Following a three-week deprivation period, each rat was maintained at 85-90% of its free-feeding weight at the beginning of the study, by daily feeding after experimentation.

Procedure and Results

Pretraining. Rat 5 was trained to emit a chained sequence involving each of the three manipulanda in the left-hand half of the box. Pressing the speaker lever when the light above it was switched on, switched off the light and produced a 2000 cycle tone; pulling the trapeze when the tone was on removed the tone and switched on the light above the foodwell lever; when the light above the foodwell lever was on, pressing that lever switched that light off, operated the sugar-

water pump for 4 sec., and concurrently extinguished both house lights for 15 sec. (TO), following which the light above the speaker lever came on and the cycle became available to the rat again. This three-response chain is referred to as the three-stage chain. The three-stage chain required in the right-hand side of the box was similar except that a low pitched electric doorbell provided the discriminative stimulus for a response involving the trapeze. Similarly, the two-stage chain in either half of the box involved only the foodwell lever and the trapeze, and the one-stage chain involved only the foodwell lever.

Rat 3 was trained on the one-stage chain in the right-hand side of the box, also with 15 sec. TO between reinforcement and the opportunity for reinforcement. Rat 4 spent as much time in the box as Rat 3. Rat 4 was given no explicit training procedure and never pressed the lever.

Up to this point the rats were present in the box individually. Usually daily sessions of approximately 1/2 hr. duration were run with each rat.

At the end of the pretraining phase, when Rats 3 and 5 were performing reliably, Rat 1, which had never been in the box, was present in the left-hand half of the box when Rats 3 and 4 were in the right-hand half. This had little noticeable effect upon the behavior of either Rat 3 or Rat 4, and Rat 1 did not appear to be observing either rat.

Imitation study. The apparatus was now arranged so that response chains leading to reinforcement were available in each half of the box alternately. If the latency of the first response of a chain was greater

Fig. 1. Plan of experimental chamber. Each half of the chamber has similar contents, although not all are labelled. Position of contents, but not size, is given to scale. Each of the four levers has a light above it (not shown).

than 30 sec., the discriminative stimulus for this response was removed and the discriminative stimulus for the first response of the chain required in the other half of the box was presented. Also, completion of the chain in one half of the box produced the discriminative stimulus for the first response of the chain required in the other half. Both house lights were on throughout the sessions of the imitation study; there were no TO periods.

Rats 3 and 5 were put into their respective halves at the same time, with a two-stage chain being required from each. During the first two sessions under this procedure, Rat 3 spent much time pressing its pump lever. Towards the end of the second of these sessions it was noticed that Rat 3 was following Rat 5 while it was performing, i.e., it would adopt the "mirror-image" posture. Shortly after the beginning of the third session under this condition Rat 3 pulled the trapeze for the first time, and by the end of the fourth session Rat 3 would pull the trapeze as soon as the bell sounded.

Rats 3 and 5 were now required to emit the three-stage chain with the procedure otherwise the same as that just described. During the first three sessions under this procedure Rat 3 failed to gain reinforcement. For the first 5 min. of the next two sessions only a two-stage chain was required from each rat, with a three-stage chain required for the remaining 25 min. Rat 3 now appeared to be observing Rat 5 closely and was again seen to be following Rat 5 when it was performing. During the second of these two sessions Rat 3 began to press the speaker lever. After a further two sessions it would press the speaker lever usually as soon as the light above it came on.

Rat 4 was also taken through the above procedure with Rat 5. On no occasion did Rat 4 press either lever or pull the trapeze. It followed Rat 5 a little, occasionally to the extent of putting its head in the foodwell simultaneously with Rat 5.

Cooperation study. The apparatus was now arranged so that all six operanda were included in a six-stage chain which involved left-hand and right-hand operanda in alternation. Following TO, both house lights and the left-hand speaker lever light came on—presses in its presence produced the right-hand speaker lever light. An appropriate response on this lever produced the discriminative stimulus for pulling the left-hand trapeze, and so on. Pressing a pump lever appropriately produced sugar-water from the respective pump; an appropriate press on the left-hand pump lever also produced the discriminative stimulus for the right-hand pump lever, and an appropriate press on the right-hand pump lever also produced 15 sec. TO for both animals. Thus the original three-stage chain was required from each rat, but the availability of the discriminative stimuli for the separate components of

each chain was determined also by the behavior of the other rat.

Initial performance under this condition, by Rats 3 and 5 in their usual halves, was poor. Typically a rat would not wait for the other rat to provide the occasion for its next response and would run off its contribution prematurely. Thus reinforcement was gained infrequently.

The rats were then tested separately for several days at their respective three-stage chains, with gradually increasing delays (up to 15 sec.) being scheduled between a response and its programmed consequence. When then tested together as before, the performance of the six-stage chain was much improved with respect to the number of reinforcements received per session.

An attempt was made to eliminate the discriminative stimuli for both rats. Removing the pump lever lights disturbed the behavior of both, but original performance returned after a few sessions under this condition. Removing the discriminative stimuli for both the pump levers and the trapezes disrupted performance at the six-stage chain, and an improvement with practice was not noted.

The availability of all discriminative stimuli was restored and previous performance under this condition was re-established. The transparent dividing screen was replaced by an opaque black partition. Performance was disturbed slightly, but by the third session under this condition the rate of receipt of reinforcements was the same as before the change in partition.

The transparent screen was replaced and the discriminative stimuli for Rat 3 alone were removed. After three sessions Rat 3 was performing the chain as well without as it had been with the discriminative stimuli. It appeared to be looking at Rat 5. The opaque screen was introduced again and, after a short period of "random" performance, Rat 3 stopped responding.

The discriminative stimuli for the right-hand side of the box were again made available, and both rats were put into the box without a partition. After some minutes of exploration of the opposite half by each rat, Rat 3 pressed both speaker levers. After further exploration for several minutes, Rat 3 pulled both trapezes. Then both rats pressed their respective pump levers for reinforcement. A pattern quickly emerged of Rat 3 pressing both speaker levers and both trapezes, and Rat 5 pressing only its own pump lever for reinforcement when appropriate. During the first three such sessions, Rat 5 occasionally pulled the left-hand trapeze, or pressed the left-hand speaker lever, but then it remained by the left-hand pump lever, waiting for Rat 3 to emit the first four responses of the six-stage chain and thus provide the discriminative stimulus for pressing this lever.