A Serial Reaction Time Task for Rats: Individual Differences in Sequence Encoding

Stephen B. Fountain & Amber M. Chenoweth, Kent State University, Kent, OH 44242

Introduction

The serial reaction time (SRT) task is a popular procedure for assessing sequential learning capacity in human neuropsychology and functional imaging studies. The most common form of the task requires human participants to respond to the successive positions of light flashes in a 4-position horizontal array on a computer screen. Participants track the changing light positions by pressing buttons as quickly as possible in a corresponding 4-button linear "keyboard" below the computer screen. The sequence of flashing lights is either truly random or a pseudorandom repeating sequence. The measure of interest is reaction time; participants typically learn to respond faster for the repeating sequence than the random sequence, often without explicit awareness that the sequence is repeating. A considerable body of work has shown that the task can be used to distinguish between implicit and explicit processes in sequence learning, that the task can be used to characterize deficits in these processes in diseases such as Huntington's disease, and that the task can be used in functional brain imaging studies to characterize the brain processes that contribute to sequential behavior.

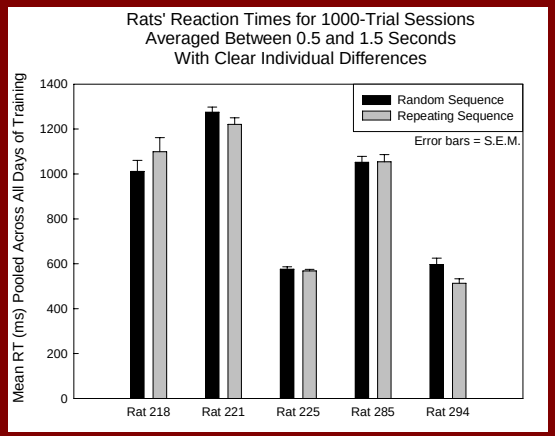
We developed an operant SRT procedure for rats that is a close analogue of the human SRT procedure. We examined rats' ability to learn a repeating 4-element sequence compared to a truly random sequence.

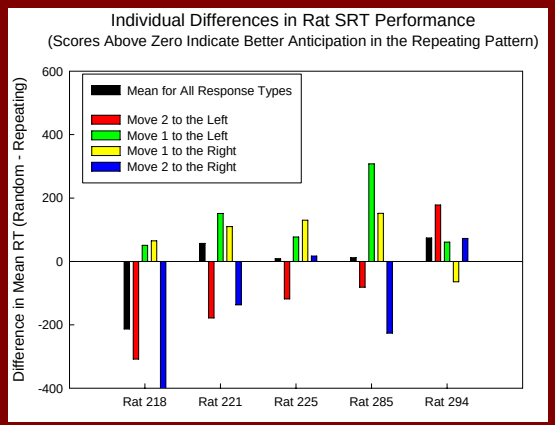
The 4-Position Array of Lights and Levers

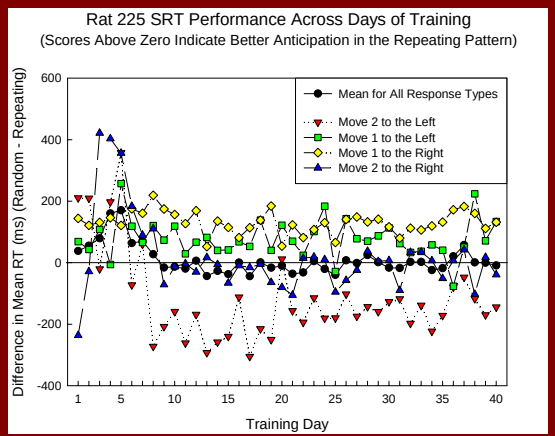
Method

Subjects. Subjects were 5 male hooded rats implanted with electrodes for hypothalamic brain-stimulation reward (BSR).

Training. Rats learned to track the successive positions of a light that appeared in one of four positions in a horizontal array on one wall of an operant chamber by pressing levers in a corresponding 4-lever array below the lights for BSR. Each day, rats were presented 20 random warm-up trials followed by 10 blocks of 100 trials each, alternating between blocks of a random sequence and a repeating sequence, 2-4-3-1, where digits indicate the positions of the light in the array on successive trials (numbered left-to-right). Incorrect responses produced a 3-s time-out followed by correction.







Results

All data are for trials following an error-free trial so that results were not influenced by a time-out on the preceding trial.

Figure 1 (top figure): RTs Averaged Across All Days of Training

Rats' reaction times (RTs) were similar to those observed in human studies, averaging 500-1500 ms for 1000-trial sessions. Individual differences were apparent, with some "fast" rats averaging only 0.5 s per trial whereas others averaged more than 1.2 s per trial. Note that trials were not separated by ITIs.

Figure 2 (middle): Individual Differences in SRT Performance

Rats' RTs were shorter for some response types in repeating patterns than in the random sequence, indicating that rats did learn the repeating sequence. RT data were categorized by direction and distance moved to produce a correct response. All rats responded faster when the required response of the repeating pattern was "1 to the left" and 4 out of 5 rats also responded faster for "1 to the right" compared to responses of the same direction and distance in the random pattern. Rats showed considerable individual differences in learning other response types.

Figure 3 (bottom): Rapid Learning & Consistency Across Days

Rats learned the simple repeating pattern in this task in a single session, as shown in example data for Rat 225. Individual differences in sequence encoding appeared in rats' first daily session and remained consistent across days.

Discussion

- In an analogue of the human SRT task, rats quickly learned an unstructured pattern of responses, producing shorter RTs for elements of a repeating vs. a random sequence.
- Rats' RTs were comparable to those observed in the human task. Rats averaged approximately one trial per second over 1000-trial sessions.
- Individual differences in sequence encoding were evident, but these differences were persistent across days.
- The rat SRT task may provide unique opportunities for identifying and studying explicit and implicit learning processes in nonhuman animals.