

Serial Response Time Learning in Pigeons (*Columba livia*)

Walter T. Herbranson, Department of Psychology, Whitman College

Abstract: The serial response time task (SRT) initially developed to investigate implicit learning in human patients suffering from Korsakoff's amnesia has recently been adapted to investigate learning and memory in pigeons. Initial investigations have shown that global facilitation (faster average response times to a repeating sequence) may be in part due to the local predictability of individual items appearing in the repeating sequence. A sequence was tested in which the first- and second-order local predictability of each item was identical. Results indicate that global facilitation can persist even when local predictabilities are balanced.

Introduction: In a now classic experiment, Nissen & Bullemer (1989) used a serial response time (SRT) task to investigate implicit learning in humans. Their participants responded to cues appearing in four spatial locations by pressing four associated response keys. With experience, participants showed a global facilitation effect: they responded to cues more quickly if those cues appeared according to a repeating pattern. Furthermore, the global facilitation was obliterated when the pattern of cues was changed so that it was random, indicating that facilitation could not be explained through mere exposure to the experimental apparatus and required responses. While the SRT methodology has been used for decades in human cognitive psychology, it has only recently been adapted for nonhuman animals. Froehlich, Herbranson, Loper, Wood & Shimp (2004) demonstrated the same global facilitation effect in a pigeon version of the SRT task. Their analysis indicated that the global facilitation effect relied on local statistical information. That is, response times could be predicted based on the first- and second-order local predictabilities of cued locations. First-order local predictability is the likelihood that a location comes next given the previous location. Similarly, second-order local predictability is the likelihood that a location comes next given the previous two locations. Given this analysis, it may be the case that a sequence where first- and second-order local predictabilities are all equal, global facilitation might be altered, or might not be obtained at all.

Method: 5 white carneau pigeons (*Columba livia*) were maintained at 80% of free-feeding weight. Daily sessions took place in three-key LVE operant chambers. Each session consisted of a series of 750 pecks to lit left, right or center keys. Following a peck to a lit key, the key was darkened, and after a 0.5 second delay, the next key in the sequence was illuminated (see figure 1). After a random 10% of correct key pecks, reinforcement was provided in the form of access to mixed grain through a food hopper located directly below the center response key. Lit keys were either presented in the sequence shown in figure 1 (blocks 1 and 3) or randomly determined (blocks 2 and 4). Notice that the first order local predictability is always 0.5. For example, the likelihood of the left location being cued given that the center location was just cued is 0.5 (left follows center once, on the second trial, and right follows center once, on the sixth trial). Also notice that the second-order local predictability is always 1.0, following the same logic.

Presented at the 85th annual meeting of the Western Psychological Association. Portland Oregon, April 14 – 17, 2005.

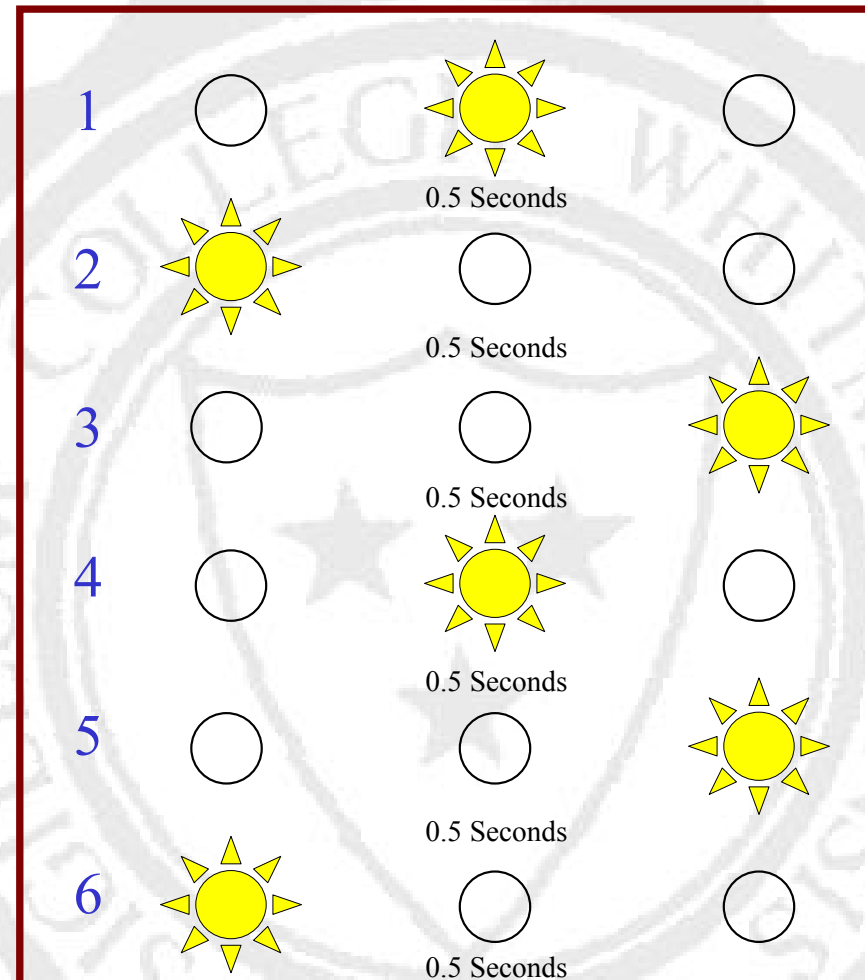


Figure 1: The six-item repeating sequence used in the structured conditions

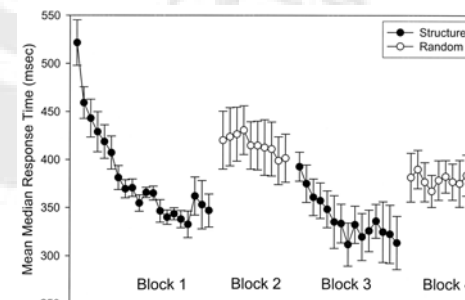


Figure 2: Daily average response times during structured and random conditions. Error bars represent 1 standard error.

Results: Figure 2 shows the global facilitation effect as a function of training and sequence structure. Data points are daily median response times averaged across all 5 birds. Filled circles indicate days when cued locations followed the sequence shown in figure 1. Open triangles indicate days when cued locations appeared in randomly selected locations. Response times over the last five days of block 1 were reliably faster than over the last five days of block 2, $t(4)=2.80, p<.05$. The same effect was seen when the sequence was replicated in blocks 3 and 4. Response times over the last five days of block 3 were reliably faster than over the last five days of block 4, $t(4)=3.80, p<.05$.

Discussion: These data reinforce the idea that the SRT task might be as useful for comparative psychology as it has been in the study of human cognition. It also extends the findings of Froehlich et al. (2004) by clarifying the relationship between global facilitation and local facilitation. That is, global facilitation was still seen, even though there were no differences in first- or second-order local predictability across the list that would make some cued locations easier to anticipate than others. Also note that the structure of the list places a heavy emphasis on second-order local predictability. All first-order local predictabilities were 0.5, equivalent to the first order local predictabilities of the randomly structured list (a cued location in a random block was not allowed to immediately repeat itself). Thus, any learning that resulted in faster response times would necessarily have to be of second-order (or higher) local predictabilities. The fact that all of these second-order local predictabilities were equal to 1.0 (perfect, unambiguous predictability) is consistent with Froehlich et al.'s notion that global performance depends on local statistical information

References:

- Froehlich, A.L., Herbranson, W.T., Loper, J.D., Wood, D.M. & Shimp, C.P. (2004). Anticipating by pigeons depends on local statistical information in a serial response time task. *Journal of Experimental Psychology: General*, 133(1), 31-45.
- Nissen, M.J. & Bullemer, P. (1989). Attentional requirements of learning: Evidence from performance measures. *Cognitive Psychology*, 19, 1-32.

