Hebbian Learning for Tactile Sequences

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Introduction

The Hebb repetition effect refers to the improved serial order recall for a list following surreptitious repetition of that sequence (Hebb, 1961). This effect has been found across a range of stimuli including unfamiliar-faces (Horton et al., 2008), novel vocabulary (Szmalec et al., 2009), and odours (Johnson et al., 2013). Such cross-modal findings led Parmentier (2011) to propose an amodal mechanism for order memory.

Rationale: Fendrich et al. (1991) reported implicit learning of motor sequences and the present study expands upon this observation to examine the Hebb repetition effect with differing forms of tactile stimulation.

Experiment 1

Task: Participants (n=24) wore an eye-mask to limit visual dual-coding of the tactile stimuli. Participants received 30 6-item tactile sequences. The task was divided into 10 3-trial epochs where two sequences are "filler" (non-repeated) sequences and one is the (repeated) Hebb sequence.

Tactile stimulation was administered via a plastic pen probe with the experimenter touching the intermediary phalange of the *digitus secondus, digitus thertius,* and *digitus quartus* on the dorsal aspect of the right and left hands (see Figure 1). Following the sixth item in the sequence, participants were required to reconstruct the preceding order by moving their digits in the order of original presentation.

Figure 1: Tactile presentation protocol

The task produced strong primacy and some recency consistent with immediate serial order recall/reconstruction (ISR) of other stimulus types (e.g. Ward et al., 2005).

There was clear evidence of learning for the repeated tactile sequences across the 30 trials (see Figure 2).

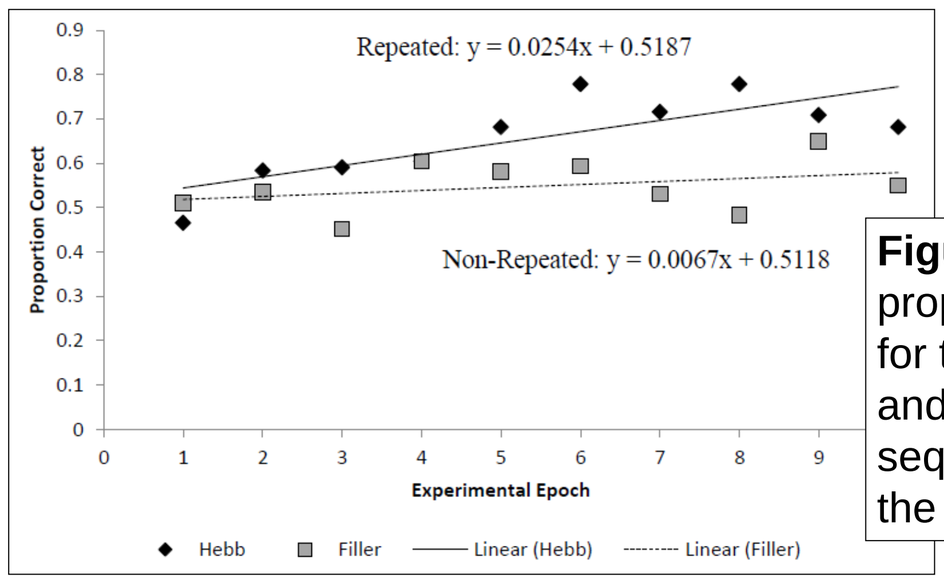

Figure 2: Mean proportion correct for the repeated and non-repeated sequences across the 10 epochs

Experiment 2

Experiment 2 examined if sequence learning in Experiment 1 was underpinned by verbal recoding/rehearsal. The method was as described above with the exception that participants (n=24) completed the task twice: once with articulatory suppression (repetition of "1, 2, 3, 4" during the presentation phase) and once in silence.

Suppression did not modify the gradient of learning.

Experiment 3

This experiment employed a different tactile presentation protocol. Five tactile locations (30mm in diameter) were drawn on the underside of each participants' forearm. Following stimulation of five tactile locations, participants (n=30) were required to reconstruct the sequence by touching the 5 locations in the same order as the preceding sequence. Once again, there were 30 sequences wherein every third trial comprised a repeated sequence.

The experimental epoch by sequence type interaction indicated learning of the repeated sequence (see Figure 3).

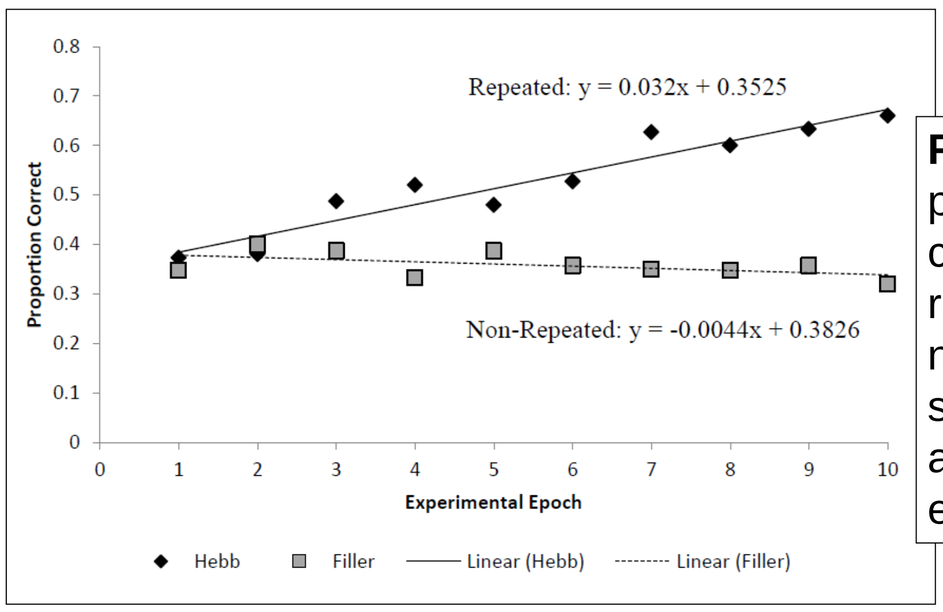

Figure 3: Mean proportion correct for the repeated and non-repeated sequences across the 10 epochs

Discussion

The Hebb repetition effect is reported across two different tactile stimulation tasks. This effect is not reliant upon verbal recoding/rehearsal and supports the observation of the Hebb effect across other stimulus modalities. The Hebb effect, in addition with the typical ISR function, supports the employment of an amodal (or at least analogous) sequence learning mechanisms across different stimulus modalities. The Hebb effect has been implicated in language acquisition (e.g. Szmalec et al., 2009) and the present data suggests that any model used to explain the phenomenon (see Page et al., in press for review) should operate at an amodal level beyond merely verbal memory.