Order Learning for Tactile Sequences: Further Cross-Modal Equivalence in Sequence Learning

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Introduction

- The Hebb Repetition Effect concerns the improved recall for a sequence of items following the surreptitious re-presentation of that list (Hebb, 1961). Over a series of trials, serial recall for the repeated (Hebb) sequence improves relative to the non-repeated (filler) trials.
- This repetition effect has been associated with language acquisition, with the process analogous to the learning of novel vocabulary (Szmalec *et al*., 2009).
- The Hebb repetition effect has been found across a range of stimulus types including: verbal (Hebb, 1961), non-verbal visual (Horton *et al*., 2008), auditory-spatial (Parmentier *et al*., 2008), visual-spatial (Couture & Tremblay, 2006), and olfactory (Johnson *et al*., 2013). These cross-modal Hebb repetition effects led Parmentier (2011) to argue that an amodal mechanism underpinned sequence learning.
- The current set of studies examined Hebb repetition effects for tactile stimuli.

Tactile Serial Memory Task

Blindfolded participants received a sequence of 5 different tactile stimulations to the underside of the non-dominant arm. Each tactile stimulation was administered to the centre-point of each circle (diameter 50mm).

Participants recalled the sequence by touching the tactile positions in the order of original presentation. Responses were video-recorded and scored offline.

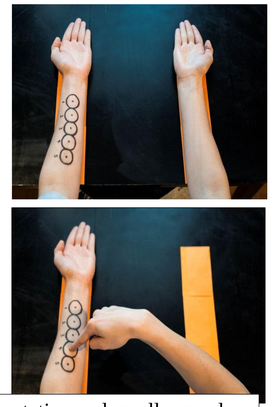

Figure 1. Sequence presentation and recall procedure

Sequence Repetition and Analysis

In each experiment, participants received 30 trials. The same repeated (Hebb) sequence was presented every third trial. The remaining 20 non-repeated (filler) trials were unique. The experiment was divided into ten 3-trial epochs (each containing one Hebb and two filler trials). Repetition learning is assessed by comparing the recall difference between each Hebb and the average of the two filler trials across the ten experimental epochs.

A sequence type by experimental epoch interaction would indicate greater learning for the repeated (Hebb) sequence.

Experiment 1 (n=30)

Recall of 5-item lists of tactile stimulations were shown to exhibit a Hebb Repetition Effect.

Recall for the repeated (Hebb) sequences improved across epochs relative to the non-repeated (filler) sequences, $F(9,261) = 5.33$, $p<.001$, $\eta_p^2 = .16$.

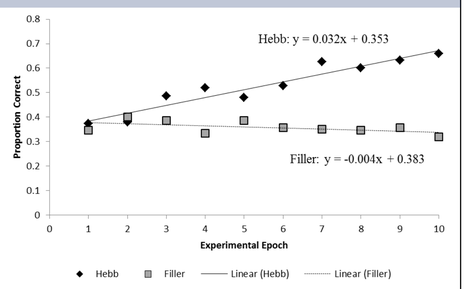

Figure 2. Mean proportion correct for the non-repeated (filler) and repeated (Hebb) sequences as a function of experimental epoch (1-10).

Experiment 2 (n=20)

Mahrer and Miles (2002) argue that tactile memory involves the deployment of verbal re-coding and verbal rehearsal. Any effects may therefore be a product of verbal, rather than tactile, memory. Experiment 2 tested the verbal rehearsal account by participants undertaking the 30-trial study twice: in quiet and under conditions of articulatory suppression (repetition of "1, 2, 3, 4" at learning).

Repetition learning was again found ($F(1,19) = 4.339$, $p = .001$, $\eta_p^2 = .186$) but the rate of learning was not affected by suppression ($F<1$), suggesting that the tactile Hebb Repetition Effect is not reliant upon verbal rehearsal.

Experiment 3 (n=20)

Experiment 3 tested the extent to which the learnt sequence was localised to the arm on which it was presented. Across trials, tactile sequences were presented to alternate arms.

The rate of repetition learning did not differ when the arm was alternated compared to a condition in which sequences were presented to the same arm.

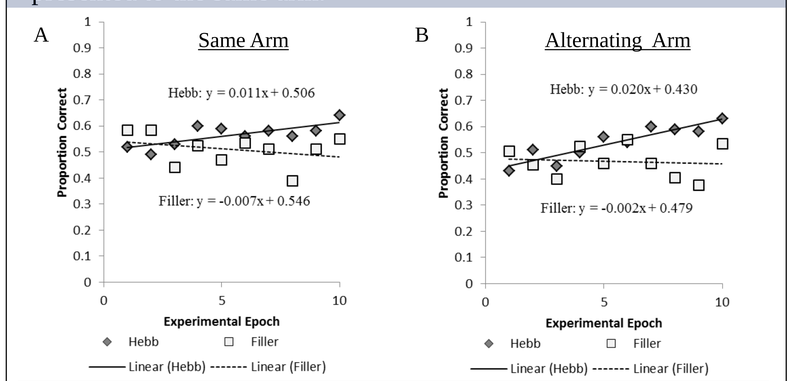

Figure 3(a-b). Mean proportion correct for the non-repeated (filler) and repeated (Hebb) sequences as a function of experimental epoch (1-10).

General Discussion

Hebb Repetition Effects are further generalised to tactile stimuli, with this effect not reliant upon verbal rehearsal. Learning rate is not reduced if the learning arm is alternated suggesting that the sequence may be stored as an abstract representation. One possible explanation is that these sequences are stored as visual spatial representations within the visual-spatial sketchpad.