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A Lateral Inhibition Account of Release from Proactive Inhibition

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Martindale (1991) suggested a lateral inhibition explanation of buildup and release of proactive inhibition in the Brown-Peterson STM task, but not the neural net architecture and processing details. The present study explains proactive inhibition phenomena as consequences of lateral inhibitory processes in a constraint satisfaction network.

An illustrative network containing hypothetical information about 15 fruits and 15 professions is explored in computer simulations. The category *fruits* is represented by a pool of 15 hidden units corresponding to the fruits (orange, pear, banana, etc.), a pool of 15 units to represent names, a pool of 8 units to represent colors (orange, green, yellow, red, pink, purple, black, brown), a pool of 2 units to represent textures (firm, soft), a pool of 2 units to represent tastes (sweet, sour), and a pool of 2 units to represent shapes (spherical, elllipsoidal). The category *professions* is represented by a pool of 15 hidden units corresponding to the professions (lawyer, teacher, dentist, etc.), a pool of 15 units to represent names, a pool of 3 units to represent status (blue collar, white collar, professional), a pool of 3 units to represent pay (low pay, moderate pay, high pay), a pool of 2 units to indicate complexity (routine, nonroutine), and a pool of 2 units to represent environment (indoor, outdoor). All units within each pool have mutually inhibitory connections. Each hidden unit representing an instance has two-way excitatory connections with all units representing features of the instance. For example, the hidden unit for *lemon* connects to the name *lemon*, the color *yellow*, the taste *sour*, etc. Simulations of the typical release-from-proactive inhibition experiment (Wickens, 1972) were run using the interactive activation subroutine in McClelland and Rumelhart (1988), comparing their activation rule with the Grossberg (1988) activation rule under a variety of parameter values for each rule.

The presentation of a triad of items in the Brown-Peterson STM task results in a brief input to the name units representing those items. Upon removal of the input, the pattern of activation across units in the network evolves during the retention interval. At the end of the retention interval, the three name units with the highest activation among the name units above a resting threshold are recalled. Theoretically, some units coding features of items from prior trials remain partially activated and laterally inhibit other feature nodes in common pools (e.g., *yellow* inhibits *green*, *red*, *orange*, etc.). Since some of the inhibited units are needed to code the features of subsequent items in the same category, the encoding and retention of additional items in the same category is impaired - thus producing buildup of proactive inhibition. Switching to a remote category reduces (releases) proactive inhibition, because fewer features of items in the new category are laterally inhibited by activated features of items in the old category. The more remote the new category from the old category in feature space, the more the release from proactive inhibition.

In each condition in the simulations, there were 5 trials, each trial consisting of the brief presentation of 3 items (external inputs to those three item names), then a retention interval in the absence of any external inputs, then the recall of the 3 names highest in activation. To model the Control condition, one set of simulations were run with fruits on all 5 trials, and another set were run with professions on all 5 trials. To model the Switch condition, one set of simulations were run with *fruits* on trials 1-4 then *professions* on trial 5, and another set were run with the *professions* on trials 1-4 then *fruits* on trial 5. On each trial, a recalled item was counted correct if it was one of the presented items on that trial. Recall was averaged over 30 simulated subjects in each condition.

Two models of recall were compared. Under the *Local Recall* model, the three name units highest in activation above resting level within the appropriate pool were recalled. Under the *Global Recall* model, the three name units highest in activation above resting level across both pools were recalled. The *Local Recall* model exhibited buildup and release of proactive inhibition, across various activation rules and parameter values, parallel to the natural phenomena. Although the *Global Recall* model exhibited buildup of proactive inhibition, it often did not show release from proactive inhibition, because items from prior trials remained more highly activated than subsequent items, even when the subsequent items came from a new category. Release from proactive inhibition must therefore involve a gain control mechanism that nonselectively suppresses activation of old items, enhances activation of new items, or both. Grossberg (1988) describes plausible neural net gain control mechanisms that might serve this function.

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