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W-2. Timecourse, Context Effects, and the Processing of Lexical Ambiguity in the Cerebral Hemispheres

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Burgess and Simpson (1988) found that the patterns of activation for dominant and subordinate meanings of ambiguous words differed in the two hemispheres as a function of timecourse. After an initial automatic spread of activation in both hemispheres, the left hemisphere actively selects the dominant meaning (in the absence of sentential context) and attenuates activation to the subordinate meaning; the right hemisphere was a more passive mechanism allowing activation for subordinate meanings to grow over time. In the experiment reported here, a naming task was used and highly biased and equibiased meanings of ambiguous words were presented to the left and right visual fields with SOA's of 50, 300, and 750 msec. For the strongly biased homographs, activation for dominant word meanings is immediate and sustained for both hemispheres. In contrast, the pattern of activation for subordinate meanings differs over time between the left and right cerebral hemispheres similar to the original Burgess and Simpson experiment. For the equibiased

homographs, facilitation occurs in both VFs at both SOAs. The results are consistent with the idea that the LH initially has a widespread activation of concepts, followed by an attenuation of activation. The RH maintains activation for both central and more peripherally related information.

A number of investigators have produced evidence that supports the idea that a passive spread of activation occurs in both the left and right cerebral hemispheres between words that are related either by associative or semantic relationships (Burgess & Rosen, 1988; Burgess & Simpson, 1988; Burgess, Bonnet, & Goldstein, 1994; Chiarello, 1985; Chiarello, Burgess, Richards, & Pollock, 1990). In addition, they have demonstrated that strategic post-lexical processes, at least those associated with these word relationships, seem more localized to the left hemisphere (Burgess & Simpson, 1988; Chiarello, 1985).

In particular, Burgess and Simpson (1988) showed that, at a 35-msec SOA, both dominant and subordinate meanings of an ambiguous word are facilitated by the ambiguous word in the left hemisphere. At a 750-msec SOA, dominant meanings in the left hemisphere still showed facilitation while the subordinate meaning was inhibited relative to the unrelated trials, presumably showing the effect of the attentional selection of the dominant meaning. In the right hemisphere, however, the pattern of activation was different; activation for the dominant meanings decreased over time, while activation for subordinate meanings increased.

We had four goals with the current experiment. First, we looked at the activation process over time for ambiguous word meanings that were either highly biased or equibiased. We were interested in evaluating two different levels of meaning dominance. Burgess and Simpson (1988) had defined as dominant any word meaning that had a 60% or greater probability of association with the homograph. In this experiment, biased includes only items with a 80% or greater association with the homograph. Second, we also include equibiased meanings where the dominant meaning was associated to the homograph less then 60% and the subordinate meaning was associated at least 30%. Third, Burgess and Simpson had only two prime durations. With a prime duration of only 35 and 750 msec one is left to speculate about meaning activation in the intervening 700 msec. Lastly, Burgess and Simpson used a lexical-decision task. In this experiment, a naming task is used to minimize the possibility that the inhibition effect, in particular, and the differential hemispheric effects, in general, were due to strategic processes.

Methods. Subjects were 172 undergraduate students, right-handed, native speakers of English. All subjects had normal or corrected vision. All target stimuli were three to seven letter words. The targets were balanced for word length and printed frequency. Stimuli consisted of two blocks of 96 prime-target pairs. The second block consisted of the same trials presented in the first block except that the VF was reversed. Each block was preceded by four "warm-up" trials. Eight word lists were formed so that, across lists,

dominant and subordinate targets followed related and unrelated primes. A 386 PC computer was used to present the stimuli with a Digitry CTS system for response collection and timing. A head-rest was used to maintain accurate distance to the CRT.

The experimental design was a 2 (visual field: left, right) × 2 (relatedness: related, unrelated) × 2 (dominance: dominant subordinate meaning) × 2 (meaning bias: biased, equibiased) × 3 (SOA: 50, 300, or 750 msec) mixed-factorial design. SOA was the only between-subjects factor. The dependent variables were naming latency and naming accuracy.

Stimuli were presented horizontally and subtended a maximum visual angle of 5.0° with a 1.4° foveal eccentricity to the left or right. Each experimental trial began with the presentation of a central fixation cross. The prime appeared at this location for either 35, 300, or 750 msec. Targets were presented either to the right or left visual field following prime offset for 185 msec and were masked. The next trial began 2 sec following the subject's pronunciation of the target. There were three sets of practice trials (22 prime-target pairs each). Accuracy feedback was provided during the practice trials; during the experimental trials the only feedback was a time-out signal when responses took longer than 2 sec. There was a 1500-msec ITI.

Results. Biased meanings: In the RVF/LH, the reaction time results show facilitation for both dominant and subordinate meanings at the brief SOA. At the intermediate SOA there is an increased amount of priming for both meanings. At the longest SOA, priming is maintained for the dominant meanings but not the subordinate meanings, which instead show inhibition. This differs from the pattern of results seen in the LVF/RH. Here dominant meanings show facilitation at all SOAs (like the LH), and subordinate meanings show an increase in activation over time with no inhibition at the 750-msec SOA. The analysis of the subjects' errors show facilitation occurring with dominant trials at all SOAs in both VFs, whereas, no facilitation is obtained with the subordinate trials in any condition.

Unbiased meanings: The results for the unbiased meaning are straightforward. Facilitation occurs for related trials relative to unrelated trials in both VFs at all SOAs. This results holds for both reaction time and error rate.

Discussion. The results with the biased meanings are consistent with those found by Burgess and Simpson (1988). Activation for dominant word meanings is immediate (at least by a 50 msec SOA) and sustained (at least to the 750-msec SOA) for both hemispheres. In contrast, the pattern of activation for subordinate meanings differs over time between the left and right cerebral hemispheres. The priming pattern in the LH shows activation through 300 msec for the subordinate meaning followed by inhibition of that meaning. In the RH, the subordinate meaning activation increases over time. Ambiguous word meanings that are (relatively) equally likely when primed by a homograph show similar activation patterns over the time course investigated in this experiment. Given the statistical fact that one meaning is about as likely as the other, it follows that the lexical system may not immediately inhibit one equiprobable meaning over another, unless the meaning was constrained by a sentence context.

The overall pattern of results is consistent with the idea that the LH initially has a widespread activation of concepts that last at least 300 msec, followed by an attenuation of activation for more remotely related concepts. The RH exhibits a slower activation pattern for remote concepts and maintains their activation over a sustained duration. The present experiment replicates one of the earlier results (Burgess & Simpson, 1988) and extends it to unbiased-meaning activation and obtains the results with the naming task. The pattern of results reported here is consistent with the notion that the LH is a more active, attentionally driven language processor, whereas, the RH plays an important but more passive role in the comprehension process.

References

Burgess, C., Bonnet, A., & Goldstein, S. 1994. A right hemisphere locus for mediated semantic priming? Paper presented at TENNET V, Fifth Annual Conference on Theoretical and Experimental Neuropsychology, Montreal, Quebec.

Burgess, C., & Rosen, A. 1988. Priming of emotional words in the cerebral hemispheres. Paper presented at the Fifth Annual Linguistic Studies Conference on Language and Communication, Syracuse, NY.

Burgess, C., & Simpson, G. 1988. Cerebral hemispheric mechanisms in the retrieval of ambiguous word meanings. *Brain and Language,* 33, 86–103.

Chiarello, C. 1985. Hemisphere dynamics in lexical access: Automatic and controlled priming. *Brain and Language,* 26, 146–172.

Chiarello, C., Burgess, C., Richards, L., & Pollock, A. 1990. Semantic and associative priming in the cerebral hemispheres: Some words do, some words don't, . . . sometimes, some places. *Brain and Language,* 38, 75–104.