

from the same semantic list. These results demonstrate that perceptual information can influence recognition judgments when it is linked to semantic information.

However, perceptual information can also affect explicit recognition performance without any semantic similarity. For example, false alarms has been found for semantically unrelated but phonologically and orthographically similar words (Pesta, Murphy, & Sanders, 2001; Sommers & Lewis, 1999). Israel and Schacter (1997) have shown that distinctive perceptual information can influence participants to produce fewer false memories. Word recognition was affected by changes in the voice for auditory tasks (Sheffert, 1998), which the author concluded was evidence that spoken words are represented in episodic memory traces containing both conceptual and perceptual information. Graf and Ryan (1990) found effects of perceptual characteristics when the encoding task focused on perceptual processing.

Strategy selection can be influenced by perceptual information without semantic priming, so that spurious feelings of familiarity are produced. For example, Reder and Ritter (1992) required participants to make a split-second decision as to whether or not they would be able to retrieve the answer to an arithmetic problem or would need to calculate the answer. The participants' judgment of whether the answer was known was influenced by the number of times the problem operands had been presented together. When the participants saw a problem with frequently paired operands but a different operator, they had a spurious feeling of knowing the answer. However, the participants judged that they did *not* know the answer to problems that they had studied when the spatial relations of the operands were inverted. In this case, the answer was known, but the problem looked unfamiliar, and the participants responded accordingly. These results suggest that recognition errors may depend, at least in part, on the familiarity of superficial aspects and, in particular, perceptual features of the stimulus.

The evidence presented above indicates that perceptual information can influence explicit memory tasks in the same way as semantic information. We believe that this finding supports the proposal that perceptual information and semantic information are represented and processed within the same system. In order to further test our hypothesis, we will examine the effects of the frequency of the perceptual information on the production of false memories. Reder, Donavos, and Erickson (2002) demonstrated that perceptual cues *extraneous* to the recognition judgment might affect accuracy. In that study, words were presented in one of 150 unusual fonts. At test, words could be re-presented in the font seen at study (original), a font seen at encoding with a different word (used), or an unstudied font (novel). Memory performance was better when the font matched between study and test; however, this perceptual match effect was greater when the font was presented at a lower frequency. This effect occurred even though the participants were explicitly told to base their judgments on the word, regardless of the font.

Our explanation for the perceptual match effect's being modulated by font frequency (the number of words studied with a font) is analogous to the account of the word frequency mirror effect<sup>1</sup> (e.g., Glanzer & Adams, 1985; Glanzer, Adams, Iverson, & Kim, 1993) offered by Reder et al. (2000). That account posits that recognition can be based on one of two processes, familiarity or recollection, and that prior experience with information affects these processes differently. As words, fonts, and other types of information are seen more often, the number of associations with the concept increases, thereby decreasing the likelihood of retrieving any *specific* memory trace associated with it. This decrease in recollection occurs because the amount of activation that can spread to any contextual association depends on the number of competitors sharing the activation. The less the amount of activation that arrives at a contextual trace, the less likely it is that it will surpass the retrieval threshold. However, when a concept is experienced more frequently, its base activation is raised, making it more prone to elicit a familiarity response and, thereby, raising the number of hits and false alarms. This account of the perceptual match effect proposes that the effects observed are based on differences in retrieval of information, rather than on differences at time of encoding.

This dual-process account of the mirror effect for word frequency predicts changes based on the familiarity of semantic information. Because we propose that perceptual and semantic information have the same properties in memory, we wish to test this account's predictions under this assumption. Therefore, we would expect to find similar effects based on perceptual similarity alone. Some evidence has already been provided by Reder et al. (2002), who demonstrated that the effect of manipulated font frequency (or *fan*, as they call it)<sup>2</sup> on hits and  $d'$  and found better recognition for studied words that were tested in the original font. Recognition was further improved when the font had not been studied with other words than when it had been studied with many words. We reanalyzed Reder et al.'s (2002) Experiment 2 data to determine whether there would be a spurious perceptual familiarity effect on false alarms and found a significant effect [ $F(2,52) = 4.53, p < .05$ ], such that the percentage of false alarms was least when words were presented in novel fonts and greatest for words tested in high-frequency fonts. Their Experiment 3 results did not reach significance on the same contrasts, but the trend was replicated.

The goal of the present study was to further explore (1) how false recognition can be influenced by nonsemantic aspects of test stimuli and (2) whether perceptual information behaves analogously to semantic information. Specifically, we investigated the effects of extraneous perceptual cues on the false alarm rate and the mirror effect, as modulated by font frequency. Therefore, we hypothesized that these experiments would show that false alarms can be made to perceptually familiar stimuli, modulated by the frequency of the perceptual char-