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Does semantic redundancy gain result from multiple semantic priming?

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ABSTRACT

Fiedler, Schröter, and Ulrich (2013) reported faster responses to a single written word when the semantic content of this word (e.g., "elephant") matched both targets (e.g., "animal", "gray") as compared to a single target (e.g., "animal", "brown"). This semantic redundancy gain was explained by statistical facilitation due to a race of independent memory retrieval processes. The present experiment addresses one alternative explanation, namely that semantic redundancy gain results from multiple pre-activation of words that match both targets. In different blocks of trials, participants performed a redundant-targets task and a lexical decision task. The targets of the redundant-targets task served as primes in the lexical decision task. Replicating the findings of Fiedler et al., a semantic redundancy gain was observed in the redundant-targets task. Crucially, however, there was no evidence of a multiple semantic priming effect in the lexical decision task. This result suggests that semantic redundancy gain cannot be explained by multiple pre-activation of words that match both targets.

1. Introduction

A well-established phenomenon in the area of divided attention is that reaction time (RT) decreases with increasing number of proximal target stimuli (e.g., Hershenson, 1962). This redundancy gain for RT (also known as redundant-signals or redundant-targets effect) has been observed within a variety of RT tasks employing different unimodal and multimodal stimuli (e.g., Diederich & Colonius, 2004; Girard, Pelland, Lepore, & Collignon, 2013; Giray & Ulrich, 1993; Grice, Canham, & Boroughs, 1984; Miller, 1982; Mordkoff & Yantis, 1991; Schröter, Frei, Ulrich, & Miller, 2009; Schwarz, 2006).

Two main classes of models have been suggested to explain redundancy gain. According to race models (Raab, 1962), redundancy gain reflects statistical facilitation resulting from independent and parallel processing of redundant targets. This model class must satisfy the race-model inequality (RMI, Miller, 1982). Specifically, the probability of having responded to redundant targets by any given point in time must be less than or equal to the sum of probabilities of having responded to the corresponding single targets by the same point in time. According to the class of coactivation models, the threshold for triggering the response is reached earlier for redundant targets than for a single target because the activation emerging from redundant targets is combined (Miller, 1982). In contrast to race models, coactivation models do not need to satisfy the race-model inequality but are capable of accounting for violations of it (e.g., Miller & Ulrich, 2003; Schwarz, 1989).

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The majority of previous studies manipulated the number of proximal stimuli or stimulus features to investigate the processing of redundant information. It has been shown, however, that redundant proximal target stimuli are neither sufficient nor necessary for the occurrence of redundancy gain. For example, no redundancy gain is observed if redundant proximal target stimuli are fused into a single percept (Schröter, Fiedler, Miller, & Ulrich, 2011; Schröter, Ulrich, & Miller, 2007) whereas redundancy gain can result by fission of a single proximal target stimulus into redundant percepts (e.g., Fiedler, O'Sullivan, Schröter, Miller, & Ulrich, 2011).

Furthermore, Fiedler, Schröter, and Ulrich (2013) have shown that redundancy gain can also be observed for internal target representations that have to be retrieved from semantic memory. These authors conducted a go/no-go task and defined a specific combination of a superordinate category (e.g., "animal") and a color (e.g., "gray") as targets for each participant. In each trial, a single written word was presented and participants were asked to respond if the word's meaning matched the target superordinate-category (e.g., a "beaver" is an animal), the target color (e.g., a "stone" is typically gray), or both targets (e.g., an "elephant" is an animal and typically gray). If the word's meaning matched neither of the two targets (e.g., "salt"), participants were asked to refrain from responding. Fiedler et al. observed faster responses to words whose meaning matched redundant semantic targets as compared to words whose meaning matched only a single semantic target. This semantic redundancy gain did not violate the RMI and thus provided no evidence in favor of coactivation as compared to race models.

Recently, corroborating results were reported by Shepherdson and Miller (2014) in a paradigm employing a two-alternative forced choice categorization task. In a series of experiments, these authors used three types of stimuli, namely words belonging to the target superordinate

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category "animal", words not belonging to this target superordinate category ("non-animal"), and non-words. In each trial, two stimuli were presented (two animal words, two non-animal words, one animal word together with one non-word, or one non-animal word together with a non-word) and participants were asked to press one response key if either one or two animal words were present and the other response key if at least one non-animal word was present. Consistent with the results of Fiedler et al. (2013), Shepherdson and Miller (2014) observed redundancy gain for animal words (i.e., words which matched the target superordinate category) but not for non-animal words (i.e., words that did not match the target superordinate category) and the data also obeyed the race-model inequality.

Fiedler et al. (2013) explained the semantic redundancy gain in terms of statistical facilitation due to independent and parallel retrieval from semantic memory. However, the authors could not rule out the possibility that the semantic redundancy gain resulted from semantic priming (e.g., Meyer & Schvaneveldt, 1971; see also Collins & Loftus, 1975). According to this account, the ongoing processing of the predefined targets (e.g., "animal" and "gray") might continuously activate the internal representation of the target. This activation might spread out and automatically pre-activate all concepts in semantic memory that match one or both of these two targets (i.e., everything that is an animal and/or everything that is gray). Crucially, concepts matching both semantic targets (e.g., "elephant") might be pre-activated more strongly than concepts matching only a single target (e.g., "stone"). Such internal multiple semantic priming could result in shorter RTs for words matching redundant than single targets, that is, a semantic redundancy gain.

In fact, several studies have provided evidence that the facilitatory effects of externally presented multiple semantic primes can sum up (e.g., Balota & Paul, 1996; Klein, Briand, Smith, & Smith-Lamothe, 1988) whereas other studies failed to do so (e.g., Angwin, Copland, Chenery, Murdoch, & Silburn, 2006; Chenery, Copland, McGrath, & Savage, 2004; Herlofsky & Edmonds, 2013). Even though there were no externally presented primes in the redundant-targets task of Fiedler et al. (2013), and previous studies employing externally presented primes provide inconsistent evidence of multiple semantic priming, internal multiple priming is still a reasonable alternative explanation for the semantic redundancy gain observed by Fiedler et al. (2013). The present experiment aimed to test this alternative explanation. In this experiment, each participant performed both a redundant-targets task and a lexical decision task in different blocks of trials. Fig. 1 shows a schematic illustration of trial structures and conditions of the two tasks.

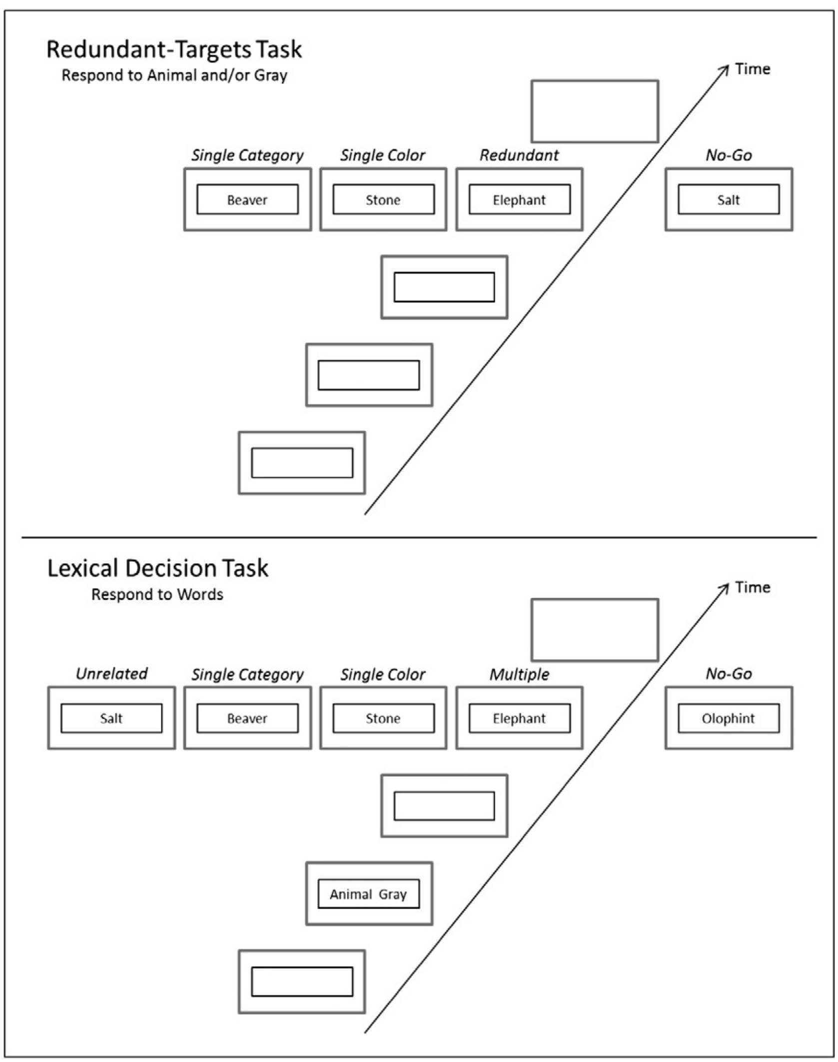

Fig. 1. Schematic illustration of the trial structure and conditions in the redundant-targets task (upper panel) and the lexical decision task (lower panel). In this example, the targets (primes) in the redundant-targets task (lexical decision task) are "animal" and "gray".