Cognitive Psychology 59 (2009) 297–319

Contents lists available at ScienceDirect

Cognitive Psychology

journal homepage: www.elsevier.com/locate/cogpsych

The distribution of subjective memory strength: List strength and response bias

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ARTICLE INFO

Article history:
Accepted 19 July 2009
Available online 17 September 2009

Keywords:
Episodic memory
Mathematical models
Mirror effects
Encoding
Recognition memory
Signal detection theory
Strength

ABSTRACT

Models of recognition memory assume that memory decisions are based partially on the subjective strength of the test item. Models agree that the subjective strength of targets increases with additional time for encoding however the origin of the subjective strength of foils remains disputed. Under the fixed strength assumption the distribution of memory strength for foils is invariant across experimental manipulations of encoding. For example, the subjective strength of foils may depend solely on the pre-experimental history of the item, thus encoding manipulations have no impact. In contrast, under the differentiation assumption the subjective strength of foils depends on the nature of the traces stored in episodic memory. If those traces are well encoded, the subjective strength of foils will be lower than the case where noisy traces are stored (e.g., when targets received minimal encoding). The fixed strength and differentiation accounts are tested by measuring direct ratings of memory strength. In Experiments 1 and 2, item strength is varied via repetition and in Experiment 3 response bias is varied via the relative proportion of targets on the test list. For all experiments empirical distributions of memory strength were obtained and compared to the distributions predicted by the two accounts. The differentiation assumption provides the most parsimonious account of the data.

1. Introduction

Recognition memory experiments require participants to endorse target items that were studied on an earlier list and reject foil items that were not studied. Manipulations that improve recognition

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doi:10.1016/j.cogpsych.2009.07.003

memory accuracy often do so via a mirror effect: the simultaneous increase in the probability of correctly endorsing a target item (hit rate, HR) and decrease in the probability of erroneously endorsing a foil item (false alarm rate, FAR, e.g., Glanzer & Adams, 1990). One such example is the strength based mirror effect (SBME). The SBME is the finding that HRs increase and FARs decrease when accuracy is improved by increasing the strength of the studied items, typically via increased encoding time or repeated presentations of the study items (e.g., Stretch & Wixted, 1998). For example a strong list might contain targets, each studied five times and a weak list might contain targets, each studied once. HRs are higher and FARs are lower following the strong list than following the weak list. That participants are better able to recognize a strong target which received multiple opportunities for more encoding than a weak target is not a surprise. Of greater theoretical interest is why the FAR differs between the strong and weak lists. Two explanations will be considered here – the criterion shift assumption and the differentiation assumption.

1.1. The criterion shift assumption

One class of models adopts the *criterion shift assumption* wherein participants adopt a more stringent criterion following a strongly encoded list than a weakly encoded list. This assumption is adopted by models from two classes: global matching models where variability increases with strength resulting in the prediction of a higher FAR following a strong than weak list (see Shiffrin, Ratcliff, & Clark, 1990) and those that assume the subjective strength of unrelated foils is not affected by the encoding conditions, called fixed strength models and illustrated in the top panel of Fig. 1 (e.g., Cary & Reder, 2003; Stretch & Wixted, 1998; Verde & Rotello, 2007; a subset of the dual process models discussed in Yonelinas (2002)).[1]

The *fixed strength assumption* was first adopted as a convenient means of constraining signal detection theory (e.g., Lockhart & Murdock, 1970; Parks, 1966; Wickelgren & Norman, 1966). Signal detection theory (SDT) as applied to recognition memory assumes that the subjective strength of targets and foils are two overlapping normal distributions as illustrated in the top panel of Fig. 1.[2] Participants select some criterion (the vertical lines in Fig. 1) and any item evoking a subjective response greater than the criterion is endorsed, other items are rejected. Thus in the basic yes–no recognition memory paradigm, SDT requires five parameters (mean and standard deviation for each distribution and location of the criterion) for two data points (HR and FAR). Fixing the foil distribution as the standard normal (mean = 0 and standard deviation = 1) eliminated two free parameters. When multiple conditions were compared, the foil distribution across all conditions was constrained in the same way thus the fixed strength assumption was born. Though this assumption might be described as a simple convenience, it has been justified by attributing the subjective memory strength evoked by foils during a recognition memory test to the pre-experimental familiarity of the foil item. Thus manipulations of the history of the foil (e.g., normative word frequency) but not encoding conditions (e.g., repetition during the study list) were suggested to affect the subjective memory strength of foils (e.g., Lockhart & Murdock, 1970). The fixed strength assumption has persisted over decades and has moved beyond SDT models. Indeed, a number of current episodic memory models including both single and dual process models have embraced the fixed strength assumption.

Stretch and Wixted (1998) adopted the fixed strength assumption within a SDT model of recognition memory and applied it directly to the SBME (see also Hirshman, 1995). They proposed that additional encoding of items on the strong list increases the mean of the target distribution, hence the increase in the HR while the foil distribution does not change as a function of encoding conditions (see top panel of Fig. 1). However, participants adopt a stricter criterion for the strong list resulting in a lower FAR for that list despite the fixed foil distribution. The global matching models referred

[1] The term subjective strength refers to the scalar output generated from comparing the test item (and context) to the contents of episodic memory. In the literature it is also called subjective response, memory strength, global match, familiarity, activation, etc.

[2] An unequal variance model is illustrated because that is the model advocated by Mickes, Wixted, and Wais (2007) who introduced the direct ratings paradigm and by Stretch and Wixted (1998) who first applied SDT to the SBME. Further, in the top panel of Fig. 1 the variance of the strong and weak target distributions are equal. These choices were made for ease of illustration and do not represent a prediction or an assumption by a particular model or by the author.