



The Basic Question

Trichromatic color vision in primates evolved largely to facilitate frugivory—this was very likely a co-evolution since several plant species would have benefited from the resulting seed dispersal. Psychophysiological research has shown that spectral tuning of the L and M cone pigments in many primates is optimal for detecting fruits among foliage.

But is there a more general role for color in object recognition? Does color enhance object encoding and retrieval? If so, what mechanisms are involved?



Is the colored scene is more easily remembered?

Previous experimenters, notably Gegenfurtner & Rieger (2000), used a Delayed-Match-to-Sample paradigm and have shown that color does enhance object recognition. We have extended and replicated their results (in part) using a more natural Continuous Recognition procedure.

Continuous Recognition Task

Experimental Method

- Sequence of 120 images
- Color (C) or monochrome (M)
- Lag 1, 2, 4, 8, or 16
- 30 images for each condition {CC, CM, MC, MM}

Task/Response Variables

- 4-Category rating method — Old-New
- Signal Detection Analysis
- For simplicity here, Percent Correct is reported

Exposure Duration

- 20ms, 32ms, 48ms, 64ms, 300ms, 2000ms



Modelling Performance

The design is a 2x2 factorial with two levels at Encoding (C and M) and two levels at Recognition (C and M). The design is illustrated in the diagram below,

	Recognition	
	C	M
Encoding	C	
	M	

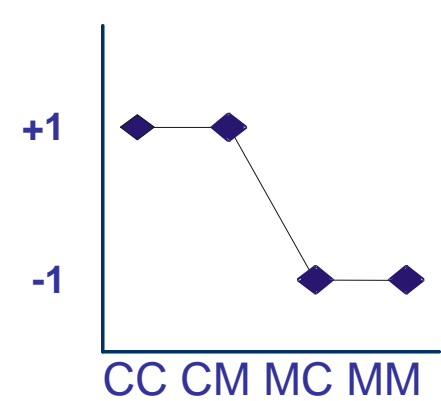
and the cell means may be represented using the familiar linear model:

$$\mu_{ij} = \epsilon_i + \rho_j + \epsilon\rho_{ij}$$

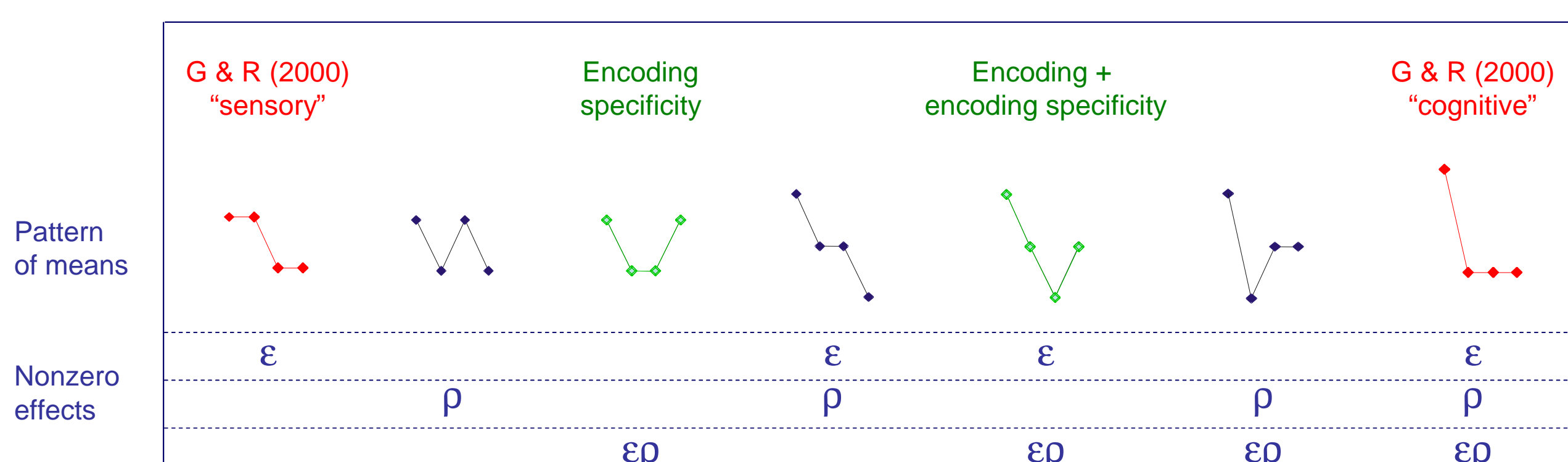
↓ Encoding
← Encoding/Recognition Synergy

↑ Recognition

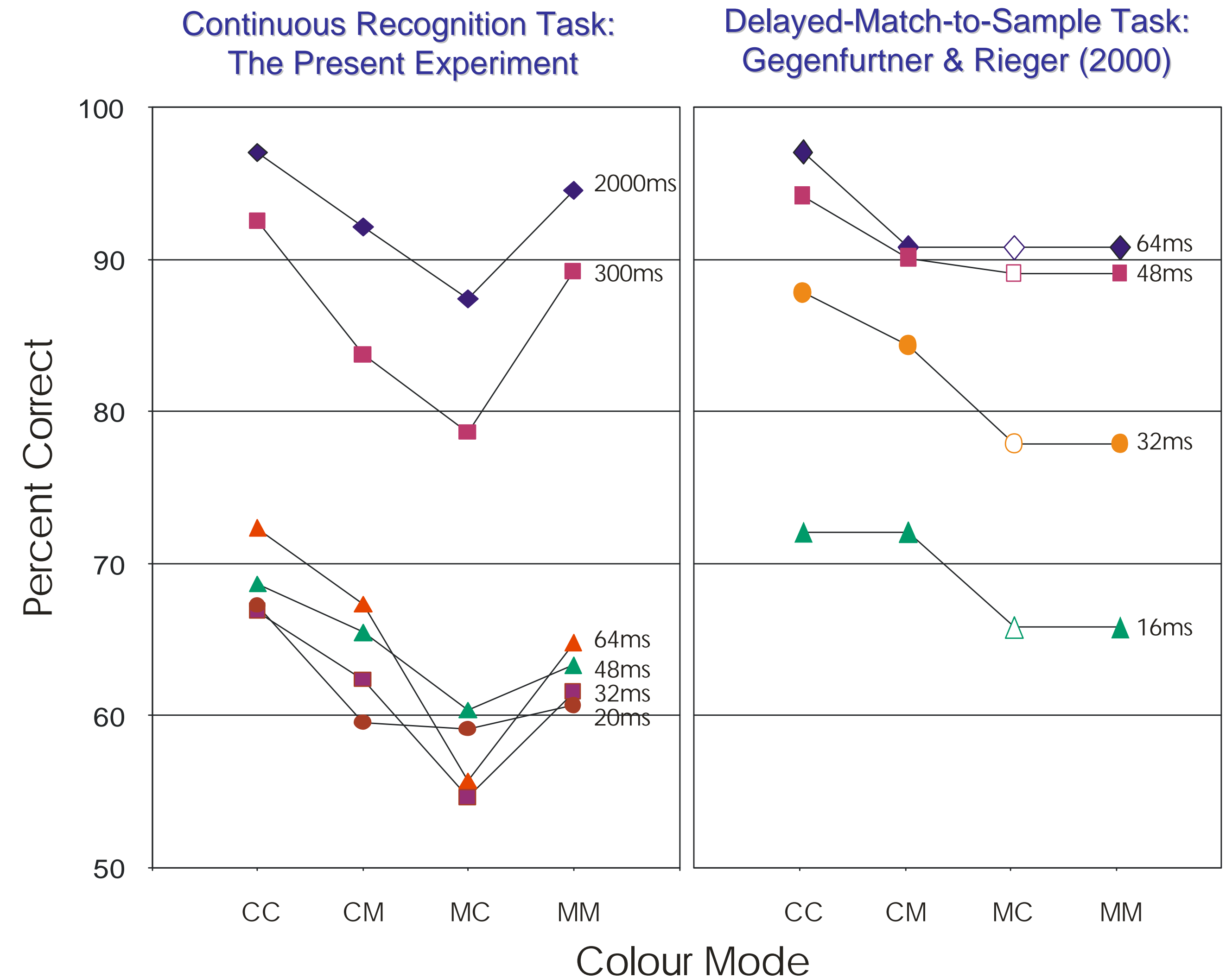
If we set each of these model terms to an arbitrary non zero value (such as unity), we may visualize the seven possible general patterns of means. For example, if color has an effect only during encoding, the ϵ_j terms alone will be nonzero and the patterns of means will be:



All seven possible patterns are shown in the tableau below:



Results Using the Two Different Tasks



N.B. Gegenfurtner & Rieger (2000) assumed that the CM and MC conditions should be equal on logical grounds; hence they did not include MC means in their graph. However, they reported that the MC means were substantially identical to the CM means—we have portrayed their MC means using open symbols to indicate that the exact numbers are missing

Comments Regarding the Two Experiments

Continuous Recognition Task: The Present Experiment

- Task eliminates focusing strategies and is ecologically valid
- Only natural scenes were used
- No lag differences were found; hence means are collapsed over lag
- Essentially the same pattern of means holds from 20ms to 2000ms
- The similar patterns suggest that both encoding and encoding specificity effects operate even at very short exposures
- Encoding accounts for 48% of variance
- Recognition accounts for 3% of variance
- Encoding-Recognition nonadditivity (Encoding Specificity) accounts for 51% of effect variance

Delayed-Match-to-Sample Task: Gegenfurtner & Rieger (2000)

- Strategy of focusing on a single small area can produce artificially high performance
- Non-nature stimuli included in set
- At 16ms, pattern suggests an encoding effect. G & R call this a "sensory" effect
- At 32ms (and above), the pattern suggests encoding and recognition main effects, and non-additivity of encoding and recognition
- G & R interpret this change as being due to the growing influence of "cognitive" effects
- G & R (2000) results are not consistent with Wichmann, Sharpe, & Gegenfurtner (2002) whose results are more similar to ours
- If the unreported G & R (2000) MC means were lower, their pattern of means would not be dissimilar to ours

Conclusions

- Participants' recognition memory for natural scenes is better with color images than with monochrome images
- The role of color is critical during the encoding phase
- There is no simple role for color during the recognition phase
- The large encoding-specificity effect suggests that color is "bound" in the representation and plays a more complex role than simply enhancing contour detection mechanisms
- This "binding" may even interfere at recognition since the MC condition was consistently worse than the CM condition
- Since the pattern of means is consistent at all exposures, color is probably "bound" in the representation at the very earliest stage
- If cognitive effects are involved, as suggested by Gegenfurtner & Rieger (2000), they probably operate even at the shortest exposures