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The Regularities of Recognition Memory

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Three regularities in recognition memory are described with supporting data: the mirror effect, the order of receiver operating characteristic slopes, and the symmetry of movement of underlying distributions. The derivation of these regularities from attention/likelihood theory is demonstrated. The theory's central concept, which distinguishes it from other theories, is the following: Ss make recognition decisions by combining information about new and old items, the combination made in the form of likelihood ratios. The central role of the likelihood ratios extends the implications of signal detection theory for recognition memory. Attention/likelihood theory is fitted to data of 2 series of experiments. One series involves yes–no tests and confidence ratings, the other forced-choice experiments. It is argued that the regularities require a revision of most current theories of recognition memory.

1) There's a single criterion

$$fa(\text{AN}) < fa(\text{BN}) < h(\text{BO}) < h(\text{AO}),$$

where *fa* is the proportion of false alarms and *h* is the proportion of hits. These relations for yes–no tests can be obtained in the following way from the prototypical array in Figure 1. The subject is assumed to make decisions in a yes–no task by placing a criterion on the decision axis. Values of test items that are above the criterion are responded to as old. If a criterion is placed somewhere on the decision axis in Figure 1 and the areas (proportion of yes or old responses) to the right of that criterion estimated for each of the four distributions, then the aforementioned relations are obtained.

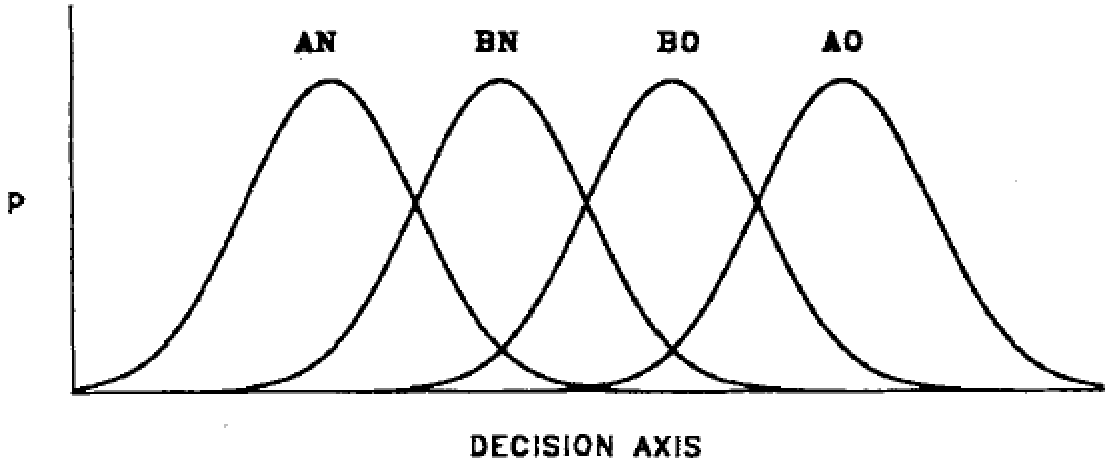


Figure 1. Arrangement of underlying old (signal) and new (noise) distributions, showing the mirror effect. (The figure shows distributions with equal variance. As is shown later, the distributions developed on the basis of the theory presented differ in variances. p = probability; A = superior condition; B = inferior condition; N = new; O = old.)

2)

Regularity 3: The Symmetry of Movement of Underlying Distributions; Concentering and Dispersion

In this section we extend attention/likelihood theory to cover several variables known to affect memory performance: speed versus accuracy instructions, length of study time, encoding task, forgetting, list length, and aging. These variables have been selected for two reasons. One is that each can be related to specific parameters in attention/likelihood theory. The other, and more important, reason is that they all produce a third regularity. This regularity may be summarized as follows. Effects on memory are symmetric. Variables that affect the positions of the old distributions also affect the positions of the new distributions. Conversely, variables that affect the positions of new distributions also affect the positions of the old distributions. Specifically, when a variable is imposed that causes the old distributions to move down on the decision axis (impairs recognition), the new stimuli can be shown to move up on the decision axis. They all move toward a central point on the decision axis. Moreover, when each distribution moves toward that central point, each one also moves closer to its neighbor. We call this effect *concentering*.

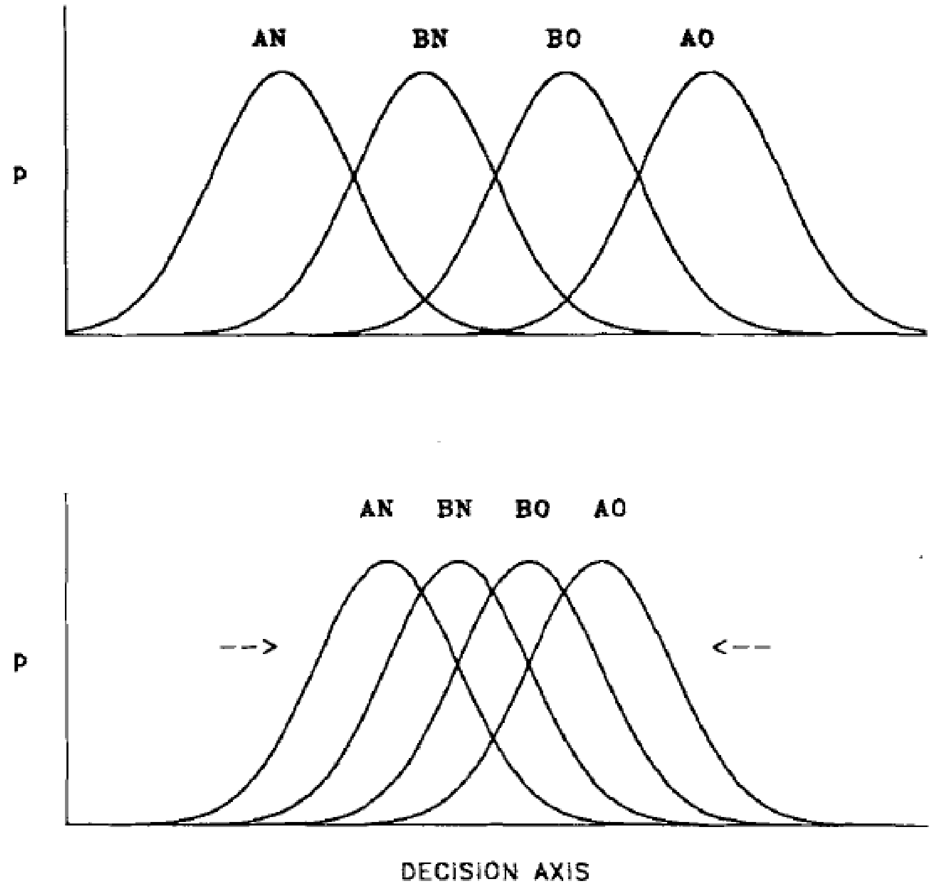


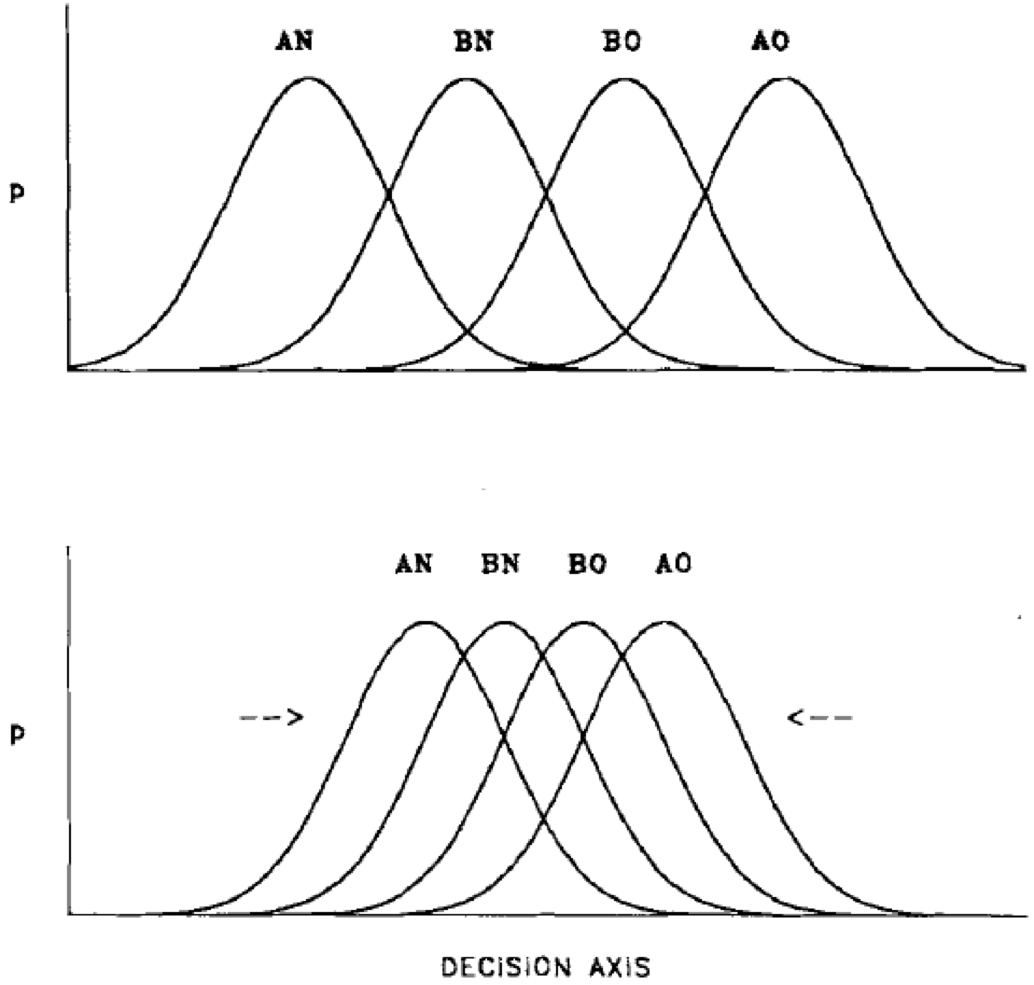
Figure 6. Arrangement of underlying old and new distributions in two conditions. (The upper panel depicts the arrangement in a control condition. The lower panel depicts the arrangement when an experimental condition has been introduced that lowers efficiency of recognition. Note that both new and old distributions move toward a central point. p = probability; A = superior condition; B = inferior condition; N = new; O = old.)

So far we’ve got that:

1) It is assumed that participants respond using a single criterion (Thus, the order of the four underlying distributions).

2) The concentrating effect tells us that the four distributions tend to be ordered around a central point ($\frac{d'}{2}$)

Therefore, the C bias measure (distance between the criterion and the neutral point $\frac{d'}{2}$) should be the same for both clases.



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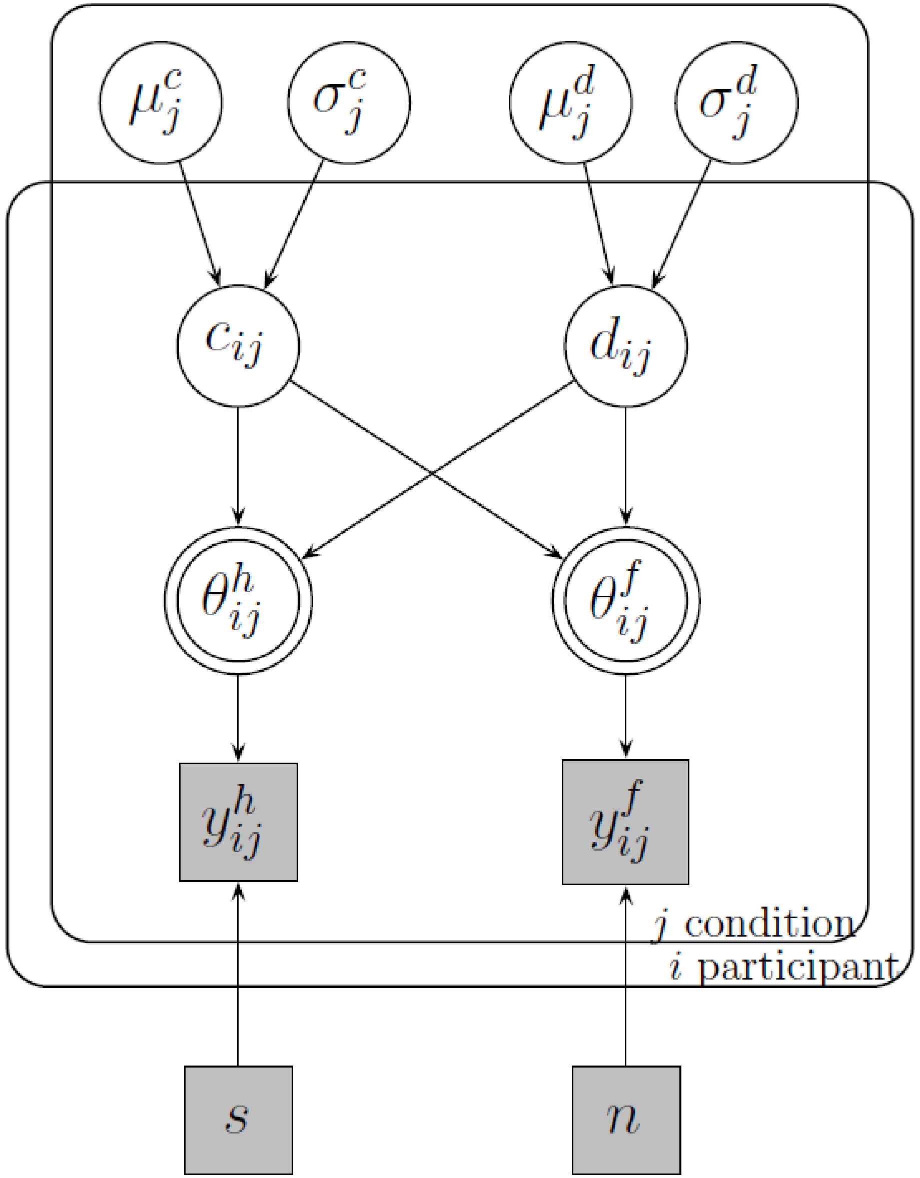
We apply a Hierarchical Bayesian SDT model



$$y_{ij}^h \sim \text{Binomial}\left(\theta_{ij}^h, s\right)$$

$$y_{ij}^f \sim \text{Binomial}\left(\theta_{ij}^f, n\right)$$

$$\theta_{ij}^h \leftarrow \phi\left(\tfrac{1}{2}d_{ij} - c_{ij}\right)$$

$$\theta_{ij}^f \leftarrow \phi\left(-\tfrac{1}{2}d_{ij} - c_{ij}\right)$$

$$d_{ij} \sim \text{Gaussian}\left(\mu_j^d, \sigma_j^d\right)$$

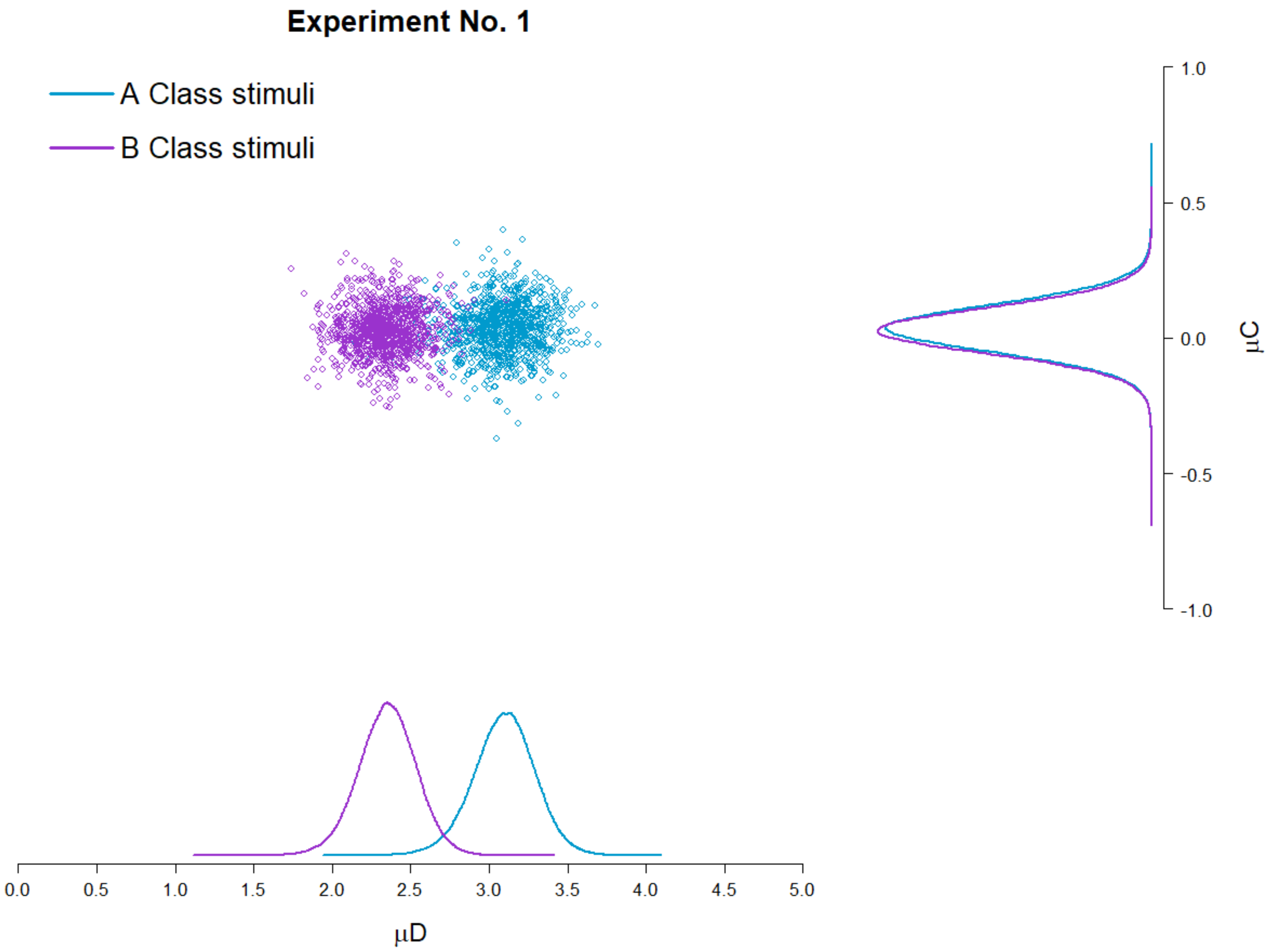
$$c_{ij} \sim \text{Gaussian}\left(\mu_j^d, \sigma_j^c\right)$$

$$\mu_j^c, \mu_j^d \sim \text{Gaussian}\left(0, 2\right)$$

$$\sigma_j^c, \sigma_j^d \sim \text{Gamma}\left(1, 1\right)$$

Plot 1

It is interesting to note that **for Experiment No. 1,** yes, some differences are found in terms of the mean d’ estimations for each class of stimuli, but this doesn’t happen for C, which according to the proposed hierarchical model could be described by the same mean value for both classes of stimuli.



Plot 1

Even more interesting should be the fact that this doesn't hold up **for Experiment No. 2,** where differences between classes of stimuli are observed both for d' and C.