Appendix

Equations for Finding Parameters of STREAK and of the Unequal-Variance Process-Pure Model From Response Proportions

STREAK

Rotello et al. (2004) provided equations that express response proportions in terms of model parameters; this appendix provides the inverse result. For the parameters, we adopt the notation of Rotello et al.: Global and specific sensitivity are denoted by d_x and d_y, the old–new and remember–know criteria by C_o and C_r. The data may be summarized by the hit and false-alarm rates (H and F) and the remember hit and false-alarm rates (*RH* and *RF*).

To follow the proof, it is helpful to consult Figure 4 in Rotello et al. (2004), which is an expanded version of Figure 2C in the present article. Some helpful notation is as follows: The distance between the means of the New and Old distributions is, by the Pythagorean theorem, $\sqrt{d_x^2 + d_y^2}$, which we denote as D. The distance D can also be partitioned into two components in another way, as the Pythagorean sum of distance along the old–new decision axis (d_o) and along the remember–know decision axis (d_r). Thus it is also true that

$$D = \sqrt{d_o^2 + d_r^2} = \sqrt{d_x^2 + d_y^2}\,. \tag{A1}$$

It can be shown by geometry that

$$d_o = \frac{2d_x d_y}{\sqrt{d_x^2 + d_y^2}} \tag{A2}$$

and

$$d_r = \frac{d_x^2 - d_y^2}{\sqrt{d_x^2 + d_y^2}}\,. \tag{A3}$$

Comparison with Appendix B of Rotello et al. (2004) shows that

$$C_o = (-s)z(F)$$

$$C_r = z\left(\frac{RH}{H}\right)$$

$$d_o = z(H) + C_o$$

$$d_r = C_r - (s)z\left(\frac{RF}{F}\right), \tag{A4}$$

where s is the standard deviation of the new distribution, and z is the inverse of the normal distribution function. Equations A1 and A2 can be solved for d_x and d_y, with the result

$$d_x = \sqrt{\frac{1}{2}(D^2 - d_r D)}$$

$$d_y = sign(d_o)\sqrt{\frac{1}{2}(D^2 + d_r D)}\,. \tag{A5}$$

Equations A1, A4, and A5 can be used to find the four model parameters. Although the algebra is more complex than for the process-pure model, the calculation is easily done on a spreadsheet and no simulation or parameter search is needed.

An Unequal-Variance Process-Pure Model

Murdock's (2006) model is summarized in his Equations 3–6, which give expressions for the remember hit and false-alarm rate (here denoted *RH* and *RF*) and the know hit and false-alarm rate (*KH* and *KF*). The model is easily extended to allow for unequal variance of the Old and New distributions. As with STREAK, we set the standard deviation of the New distribution to s and that of the Old distribution to 1. Expressions corresponding to Murdock's Equations 3–6 are

$$RF = \Phi\left(-\frac{a}{s}\right)$$

$$RH = \Phi(d_y - a)$$

$$KF = (1 - RF)\Phi\left(-\frac{\mathrm{b}}{\mathrm{s}}\right)$$

$$KH = (1 - RH)\Phi(d_x - b)\,, \tag{A6}$$

where Φ is the normal distribution function, a is the remember criterion and b is the know criterion. Equation A6 can be readily solved for the parameters:

$$a = (-s)z(RF)$$

$$b = (-s)z\left(\frac{KF}{1 - RF}\right)$$

$$d_y = z(RH) + a$$

$$d_x = z\left(\frac{KH}{1 - RH}\right) + b. \tag{A7}$$

We fit the unequal-variance version of the process-pure model to the data in Table 2 and found that, in all cases, the criteria a and b and the sensitivities d_x and d_y were lower than if equal variance were assumed. The discrepancy is reduced if these parameters are scaled in units of the New rather than the Old distribution. The qualitative pattern of results is similar for both variants.

Received November 16, 2005
Revision received January 9, 2006
Accepted January 10, 2006 ■

Postscript

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We are in partial (but only partial) agreement with all the points in Murdock's (2006) postscript. To take his comments in order:

1. Certainly it is important to connect remember–know experiments with other work on recognition memory, although we have argued that Murdock's approach is not uniquely successful in doing so.

2. The decision axes in STREAK are indeed rotated from the strength axes, but the model as a whole is not simply

a transformed version of Murdock's process-pure proposal: Half of the decision space in STREAK is devoted to the "old" response, whereas half of the process-pure space is devoted to "remember." There is no ambiguity involved in simulating either model.

3. We look forward to seeing Murdock's analysis of rating data (which he believes to be "not hard"). It is not at all clear to us whether the remember boundary, the know boundary, or both would be varied in either an old–new or a remember–know rating task; we expect that determining the decision rule will not be easy.

4. Finally, we agree that Murdock's approach is "not exactly a new model" in that the identification of the axes is drawn from TODAM. Our meaning was that the decision rule is new, but in fact it is the same as that of Reder et al. (2000).

References

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Reder, L. M., Nhouyvanisvong, A., Schenn, C. D., Ayers, M. S., Angstadt, P., & Hiraki, K. (2000). A mechanistic account of the mirror effect for word frequency: A computational model of remember–know judgments in a continuous recognition paradigm. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 294–320.