$$\frac{p(D|M_s)}{p(D|M_d)} = \frac{\int_0^1 p(D|s)p(s)ds}{\int_0^1 \int_0^1 p(D|s_1, s_2)\ p(s_1, s_2)ds_1 ds_2}$$

$$= \frac{\int_0^1 \binom{n_1}{k_1} s^{k_1}(1-s)^{n_1-k_1} \binom{n_2}{k_2} s^{k_2}(1-s)^{n_2-k_2}\,\mathrm{Beta}_{(b,\,b)}(s)ds}{\int_0^1 \int_0^1 \binom{n_1}{k_1} s_1^{k_1}(1-s_1)^{n_1-k_1}\mathrm{Beta}_{(b,\,b)}(s_1)\binom{n_2}{k_2} s_2^{k_2}(1-s_2)^{n_2-k_2}\mathrm{Beta}_{(b,\,b)}(s_2)ds_1 ds_2}$$

$$= \frac{B(b+k_1+k_2,\ b+n_1+n_2-k_1-k_2)}{B(b+k_1,\ b+n_1-k_1)B(b+k_2,\ b+n_2-k_2)}. \tag{2}$$

For our example, the counts of the numbers of successes and total trials for each group are $k_1 = 3$, $n_1 = 12$, $k_2 = 5$, and $n_2 = 6$. Substituting these values, together with $b = 1$ for the uniform prior, into Equation 2 gives a Bayes factor of approximately .145 in favor of the same-rate model. This corresponds to the Bayes factor of 1/.145 ≈ 6.9 in favor of the different-rates model reported in the text.

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Postscript: Bayesian Statistical Inference in Psychology: Comment on Trafimow (2003)

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Trafimow (2005) is right in pointing out that our comment (Lee & Wagenmakers, 2005) focused on using Bayesian methods to make statistical inferences about psychological models and data, at the neglect of philosophical issues. And there are certainly some philosophical issues that are worth discussing. It seems, for example, that our comment should have made it clear that the objective Bayesian approach we advocate views probabilities neither as relative frequencies nor as belief states, but as degrees of plausibility assigned to propositions in a rational way, entirely (and uniquely) determined by the available information. Harder philosophical problems that we think are important, but did not mention, are whether it is possible to give a complete statistical characterization for any data-generating process and how incompleteness results (such as Gödel's theorem) might apply to the Bayesian framework.

Unfortunately, these substantial issues are not addressed. Instead, Trafimow (2005) provides a series of consternations making it clear that Bayesian methods cannot work miracles for psychological researchers and that researchers must be resigned to using them to provide coherent and rational analyses of available information. The Fisher example shows that Bayesian inference cannot divine true information with which it was never provided. The amazing theory of memory example and the dating example show that Bayesian inference cannot resolve the indecision of researchers about what hypothesis they are testing and what information they have available. And, while we are not sure we understand the point of the Suppes example, we agree that Bayesian inference cannot account for the quirks of human language production under uncertainty. In the end, these consternations seem to leave Trafimow troubled by all methods for analyzing psychological models and data. Perhaps he is right, and Bayesians should "down tools," waiting for a method of inference that is not only coherent and rational, but can also work miracles. But, even if we had fortunes, we wouldn't bet them on it.

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