**Supplemental Figures**

*Diagram

Description automatically generated with medium confidence*

**Figure S1.** Replicated the Maddison and Fitzjohn (2015) result with our simulation and model fitting framework. Support for a dependent/ correlated model is consistently greater than an independent model.

*Chart

Description automatically generated*

**Figure S2.** The same model set used by Maddison and Fitzjohn (2015), but with the inclusion of a collapsed model. SUpport for the collapsed model is overwhelming.

Diagram, engineering drawing

Description automatically generated

**Figure S3**. The effect of increasing the number of taxa on model support. Shown here are the two standard Pagel (1994) models (independent and correlated) as well as the unsimplified hidden state independent model. Support for the models is consistent across 100, 250, 500 taxa.

Diagram

Description automatically generated

**Figure S4.** Akaike model weights are shown for data simulated under a simplified independent model (ind\_dat), simplified correlated model (cor\_dat) and simplified hidden Markov independent model (ind\_2) for 100 unique datasets (See Figure 6 for model structure). For the simple independent and dependent models, the rates of evolution were 1 and 5 changes per million years. With the addition of the hidden states, we added rates of 2 and 10 for the second rate category as well as a transition rate of 4 between rate classes. Phylogenetic trees of 100 taxa were simulated with a birth rate of 1 and death rate of 0.75. Total branching time in the tree was rescaled to a total of 10 MY.