**Behavioral Data**

* Toss criteria: Dropping any subject w/ numTrialsCompleted < 200 or > 250.
* Analyzed with R.
* model=glmer(Choice~MFonMB+(1|Subj)+(0+MFonMB|Subj),family=binomial,data=data\_crits);model\_all=glmer(Choice~MB+MF+MFonMB+(1|Subj)+(0+MB+MF+MFonMB|Subj),family=binomial,data=data\_crits)  
  model\_unlikely=glmer(Choice~Unlikely+(1|Subj)+(0+Unlikely|Subj),family=binomial,data=data\_unlikely)
* MB and MF in model\_all have no distance cutoff, but are time-discounted (gamma = .85)

***Baseline***

t-test: 135 subjects, 3806 observations  
model:

**model:**

Converged  
MFonMB estimate = 0.191  
Wald z-test: SE = 0.016, z = 12.1, p < 2e-16  
LRT: Chisq = 266.0, df = 2, p < 2.2e-16  
Bootstrapping: ???

**model\_all:**

Converged  
MFonMB estimate = 0.200 (z = 12.3, p < 2e-16)  
MB estimate = 0.221 (z = 7.3, p = 2.82e-13)  
MF estimate = 0.0543 (z = 1.87, p = 0.0621)   
LRT: Chisq = 298.2, df = 4, p < 2.2e-16  
Bootstrapping: ???

**t-test:**

Means: 0.89476980 0.01085237 0.68624149 0.01672222  
t = -12.5377, df = 134, p-value < 2.2e-16

***2-trial-type***

t-test: 303 subjects, 4231 congruent observations, 2137 incongruent observations  
model: dropped 2

**model:**

MFonMB estimate = 0.056 (z = 4.51, p < .0001).  
LRT: Chisq = 27.8, df = 2, p < .0001  
Bootstrapping: ???

**model\_incog:**

Converged  
MFonMB estimate = .009 (z = .784, p = 0.433)  
LRT: Chisq = .615, df = 2, p= 0.74

**model\_comb:**

MFonMB estimate (incongruent trials) = .009 (z = .782, p = .434)  
Crits estimate = 1.76 (z = 18.6, p < .0001)  
MFonMB:Crits estimate (congruent trials) =0.049 (z = 2.62, p < .01).  
LRT: Chisq = 10.65, df = 4, p < .05  
Bootstrapping: ???

**model\_all:**

Converged  
MFonMB estimate = 0.053 (z = 3.97, p < .0001)  
MB estimate = 0.313 (z = 8.87, p < .0001)  
MF estimate = .051 (z = 2.04, p < .05)  
LRT: Chisq = 27.3, df= 4, p < .0001  
Bootstrapping: ???

**t-test (congruent):**

Means & difference: 0.82846475 0.01159931 0.76237993 0.01421754  
t-test: t = -4.8426, df = 302, p-value = 2.05e-06

**t-test (incongruent):**

Means & difference: 0.49657019 0.01730872 0.47247182 0.01910213  
t-test: t = -0.9361, df = 282, p-value = 0.35

***With A0***

t-test: 173 subjects, 4755 congruent observations  
model: dropped 8

**model:**

MFonMB estimate = 0.143 (z = 9.62, p < .0001)  
LRT: Chisq = 238.1, df = 2, p < 2.2e-16  
Bootstrapping: ???

**model\_all:**

MFonMB estimate =0.146 (z = 9.56, p < .0001)  
MB estimate = .149 (z = 5.44, p < .0001)  
MF estimate = .045 (z = 1.65, p = .10)  
LRT: Chisq = 249.1, df = 4, p < 2.2e-16  
Bootstrapping: ???

**t-test:**

Means: 0.84918540 0.01316517 0.68780502 0.01553888  
t-test: t = -9.1679, df = 172, p-value < 2.2e-16

**Simulations**

* 200 agents, 50 practice rounds, 175 real rounds. 26 critical trials (in 2-trial-type versions, half are incongruent).
  + Agents have 5 free parameters: learning rate, temperature, eligibility trace, model-based weight, and model-free weight. Goal weight = 1 – (model-based weight) – (model-free weight).
  + lr ~ U(0,1); temp ~ U(0,1.5); elig ~ U(.5,1); all weights ~ U(0,1) and then normalized. (For “No MF-goal” versions, goal weight = 0.)
  + Agents implement ??? for model-based learning and SARSA for model-free learning. Simple version of SARSA for MF-goal.
* Rewards/transitions are randomly generated the same way as in the behavioral experiments

***Baseline – no MF-goal***

**model:**

Converged  
MFonMB estimate = 0.003431  
Wald z-test: SE = 0.007893, z = .435, p = .664  
LRT: Chisq = 1.1514, df = 2, p = 0.5623   
Bootstrapping: ???

**model\_all:**

Didn’t converge, but close (maxgrad = .009)  
MFonMB estimate = 0.003306  
LRT: Chisq = 2.4276, df = 4, p = 0.6576  
Bootstrapping: ???

**t-test:**

Mean choice when MFonMB > 0: 0.60398555   
Mean choice when MFonMB < 0: 0.59155541  
Difference = 0.01243014  
t = -0.8452, df = 199, p-value = 0.399

***Baseline – with MF-goal***

**model:**

Converged  
MFonMB estimate = 0.080286  
LRT: Chisq = 111.4, df = 2, p < 2.2e-16  
Bootstrapping: ???

**model\_all:**

Converged  
MFonMB estimate = 0.10453  
LRT: Chisq = 156.12, df = 4, p < 2.2e-16  
Bootstrapping: ???

**t-test:**

Means & difference: 0.6994049 0.5693178 0.1300871  
t-test: t = -8.383, df = 199, p-value = 9.312e-15

***2-trial-type – no MF-goal***

**model (congruent):**

Converged  
MFonMB estimate = -0.003643  
LRT: Chisq = 0.4826, df = 2, p = 0.7856  
Bootstrapping: ???

**model (incongruent):**

Converged  
MFonMB estimate = 0.006283  
LRT: Chisq = 0.1796, df = 2, p = 0.9141  
Bootstrapping: ???

**model\_comb:**

Did not converge  
MFonMB estimate = 0.005513  
MFonMB:Crits estimate = -0.009174  
LRT: Chisq = 0, df = 3, p = 1  
Bootstrapping: ???

**model\_all:**

Converged  
MFonMB estimate = -0.003807  
LRT: Chisq = 2.3346, df = 4, p = 0.6745  
Bootstrapping: ???

**t-test (congruent):**

Means & difference: 0.56072367 0.57508820 -0.01436454  
t-test: t = 0.7055, df = 199, p-value = 0.4813

**t-test (incongruent):**

Means & difference: 0.5033665 0.4845827 0.0187838  
t-test: t = -0.5889, df = 181, p-value = 0.5567

***2-trial-type – with MF-goal***

**model (congruent):**

Converged  
MFonMB estimate = 0.08129 (z = 7.350, 1.98e-13)  
LRT: Chisq = 63.072, df = 2, p = 2.014e-14  
Bootstrapping: ???

**model (incongruent):**

Converged  
MFonMB estimate = 0.009828  
z = 0.649,p = .516  
LRT: Chisq = 0.4213, df = 2, p = 0.81  
Bootstrapping: ???

**model\_comb:**

Converged  
MFonMB estimate = 0.009894  
MFonMB:Crits estimate = 0.068537  
LRT: Chisq = 14.43, df = 3, p = 0.002375  
Bootstrapping: ???

**model\_all:**

Converged  
MFonMB estimate = 0.09080  
LRT: Chisq = 71.681, df = 4, p = 1.002e-14  
Bootstrapping: ???

**t-test (congruent):**

Means & difference: 0.6628425 0.5123697 0.1504728  
t-test: t = -6.9417, df = 199, p-value = 5.35e-11

**t-test (incongruent):**

Means & difference: 0.485536033 0.475948561 0.009587471  
t-test: t = -0.2923, df = 186, p-value = 0.7704