**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***

Dropped 14 subjects  
218 subjects  
6120 congruent observations, 539 unlikely observations

**model:**

Converged  
MFonMB estimate = 0.15186  
Wald z-test: SE = 0.01319, z = 11.51, p < 2e-16  
LRT: Chisq = 312.1, df = 2, p < 2.2e-16  
Bootstrapping: p < .001

**model\_all:**

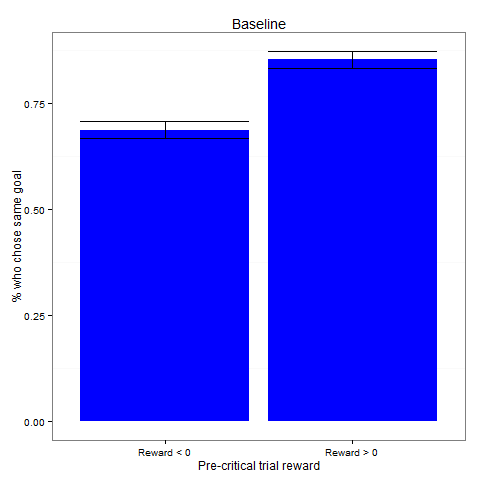
Converged  
MFonMB estimate = 0.15723  
MB estimate = 0.15176 (z = 6.372, p = 1.87e-10)  
MF estimate = 0.07125 (z = 3.259, p = 0.00112)  
Wald z-test: SE = 0.01367, z = 11.503, p < 2e-16  
LRT: Chisq = 326.62, df = 4, p < 2.2e-16  
Bootstrapping: ???

**model\_unlikely:**

Unlikely estimate = 0.18832

**t-test:**

Mean choice when MFonMB > 0: 0.8521680 (SE = .012)  
Mean choice when MFonMB < 0: 0.6871312 (SE = .013)  
Difference = 0.1650368  
t = -11.1849, df = 217, p-value < 2.2e-16



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**t-test (unlikely):**

Mean choice when Unlikely > 0: 0.8344633  
Mean choice when Unlikely < 0: 0.7225989  
Difference = 0.1118644  
t = -2.4721, df = 117, p-value = 0.01487

***2-trial-type***

Dropped 29 subjects  
387 subjects  
5398 congruent observations, 2708 incongruent observations, 204 unlikely observations  
model\_comb=glmer(Choice~MFonMB+MFonMB:Crits+(1|Subj)+(0+MFonMB+MFonMB:Crits|Subj),family=binomial,data=data\_crits\_comb);

**model:**

Converged  
MFonMB estimate = 0.0368 (z = 3.73, p < .0005).  
LRT: Chisq = 16.682, df = 2, p < .0005  
Bootstrapping: ???

**model\_incog:**

Converged  
MFonMB estimate = .012 (z = 1.19, p = 0.23)  
LRT: Chisq = 1.43, df = 2, p= 0.49

**model\_comb:**

Converged  
MFonMB estimate (incongruent trials) = -.0046  
MFonMB:Crits estimate (congruent trials) =0.036 (z = 2.38, p < .02).  
LRT: Chisq = 13.0, df = 3, p < .005  
Bootstrapping: ???

**model\_all:**

Converged  
MFonMB estimate = 0.037 (z = 3.51, p < .0005)  
MB estimate = 0.25149 (z = 9.18, p < 2e-16)  
MF estimate = .046 (z = 2.19, p < .05)  
LRT: Chisq = 16.5, df= 4, p < .005  
Bootstrapping: ???

**t-test (congruent):**

Means & difference: 0.77213329 (SE .012) 0.73037882 (SE .013) 0.04175448  
t-test: t = -3.3164, df = 386, p-value = 0.0009983

**t-test (incongruent):**

Means & difference: 0.492 (SE .015) .477 (SE .016) .0147  
t-test: t = -0.6665, df = 360, p-value = 0.5055

***With A0***

Dropped 19 subjects  
293 subjects  
8086 congruent observations, 677 unlikely observations

**model:**

Converged  
MFonMB estimate = 0.11762  
Wald z-test: SE = 0.01038, z = 11.33, p < 2e-16  
LRT: Chisq = 291.6, df = 2, p < 2.2e-16  
Bootstrapping: ???

**model\_all:**

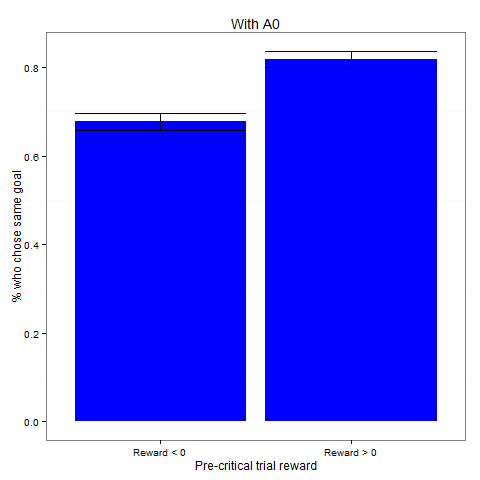
Did not converge  
MFonMB estimate =0.11819  
Wald z-test: SE = 0.01049, z = 11.265, p < 2e-16  
LRT: Chisq = 291.58, df = 4, p < 2.2e-16  
Bootstrapping: ???

**model\_unlikely:**

Unlikely estimate = 0.19699

**t-test:**

Mean choice when MFonMB > 0: 0.8189295 (SE = .010)  
Mean choice when MFonMB < 0: 0.6771297 (SE = .011)  
Difference = 0.1417998  
t-test: t = -10.9006, df = 292, p-value < 2.2e-16



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**t-test (unlikely):**

Mean choice when MFonMB > 0: 0.8477273  
Mean choice when MFonMB < 0: 0.7018939  
Difference = 0.1458333  
t = -3.678, df = 131, p-value = 0.0003419

**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