ExpResults

July 20, 2020

[1]:
```
import scipy.io as sci
import numpy as np
import glob
import pandas as pd
import matplotlib.pyplot as plt
from scipy import stats
import pylab
import hddm
from functions import *
```

```
C:\Users\Edwin\miniconda3\envs\hddm\lib\site-packages\IPython\parallel.py:13:
ShimWarning: The `IPython.parallel` package has been deprecated since IPython
4.0. You should import from ipyparallel instead.
  "You should import from ipyparallel instead.", ShimWarning)
```

1 Data Format

[27]:
```
datapath = 'ExpData/*.mat'
datafiles = np.array(glob.glob(datapath))
```

[28]:
```
flashdata = np.empty((1,5))
beepdata = np.empty((1,5))
for i in np.arange(0, len(datafiles)):
    mat = sci.loadmat(datafiles[i])
    matf = np.insert(mat['mixtrF'], 0, int(i + 1), axis=1)
    accf = np.hstack((matf, mat['accMatF'], mat['resptimeF']))
    matb = np.insert(mat['mixtrB'], 0, int(i + 1), axis=1)
    accb = np.hstack((matb, mat['accMatB'], mat['resptimeB']))
    flashdata = np.vstack((flashdata, accf))
    beepdata = np.vstack((beepdata, accb))

flashdata = flashdata[1:]
beepdata = beepdata[1:]
```

[29]:
```
flashframe = pd.DataFrame(flashdata, columns=['subj_idx', 'flashpres',␣
↪'beeppres', 'acc', 'rt'])
```

```
beepframe = pd.DataFrame(beepdata, columns=['subj_idx', 'flashpres',␣
↪'beeppres', 'acc', 'rt'])

congrf = flashframe.loc[flashframe['flashpres'] == flashframe['beeppres']]
unif = flashframe.loc[flashframe['beeppres'] == 0]
congrb = beepframe.loc[beepframe['flashpres'] == beepframe['beeppres']]
unib = beepframe.loc[beepframe['flashpres'] == 0]
```

[30]:
```
fig = plt.figure(figsize=(14, 5))
ax = fig.add_subplot(121, xlabel='RT', ylabel='count', title='Unisensory Flash␣
↪RT distributions (2 flashes)')
for i, subj_data in unif.loc[unif['flashpres'] == 2].groupby('subj_idx'):
    subj_data.rt.hist(bins=20, histtype='step', ax=ax)

ax = fig.add_subplot(122, xlabel='RT', ylabel='count', title='Congruent Flash␣
↪RT distributions (2 flashes)')
for i, subj_data in congrf.loc[congrf['flashpres'] == 2].groupby('subj_idx'):
    subj_data.rt.hist(bins=20, histtype='step', ax=ax)

plt.close()
```

[31]:
```
fig = plt.figure(figsize=(14, 5))
ax = fig.add_subplot(121, xlabel='RT', ylabel='count', title='Unisensory Flash␣
↪RT distributions (3 flashes)')
for i, subj_data in unif.loc[unif['flashpres'] == 3].groupby('subj_idx'):
    subj_data.rt.hist(bins=20, histtype='step', ax=ax)
ax.set_ylim([0, 30])

ax = fig.add_subplot(122, xlabel='RT', ylabel='count', title='Congruent Flash␣
↪RT distributions (3 flashes)')
for i, subj_data in congrf.loc[congrf['flashpres'] == 3].groupby('subj_idx'):
    subj_data.rt.hist(bins=20, histtype='step', ax=ax)
ax.set_ylim([0, 30])
plt.close()
```

[32]:
```
fig = plt.figure(figsize=(14, 5))
ax = fig.add_subplot(121, xlabel='RT', ylabel='count', title='Unisensory Beep␣
↪RT distributions (2 beeps)')
#for i, subj_data in unif.loc[unif['flashpres'] == 2].groupby('subj_idx'):
#    subj_data.rt.hist(bins=20, histtype='step', ax=ax)
unib.loc[unib['beeppres'] == 2].rt.hist(bins=20, histtype='step', ax=ax)
ax.set_ylim([0, 200])

ax = fig.add_subplot(122, xlabel='RT', ylabel='count', title='Congruent Beep RT␣
↪distributions (2 beeps)')
#for i, subj_data in congrf.loc[congrf['flashpres'] == 2].groupby('subj_idx'):
```

```
#    subj_data.rt.hist(bins=20, histtype='step', ax=ax)
unib.loc[unib['beeppres'] == 3].rt.hist(bins=20, histtype='step', ax=ax)
ax.set_ylim([0, 200])
plt.close()
```

[33]:
```
uni2flashacc = sum(unif.loc[unif['flashpres'] == 2]['acc']) / len(unif.
 ↪loc[unif['flashpres'] == 2])
uni3flashacc = sum(unif.loc[unif['flashpres'] == 3]['acc']) / len(unif.
 ↪loc[unif['flashpres'] == 3])
congr2flashacc = sum(congrf.loc[congrf['flashpres'] == 2]['acc']) / len(congrf.
 ↪loc[congrf['flashpres'] == 2])
congr3flashacc = sum(congrf.loc[congrf['flashpres'] == 3]['acc']) / len(congrf.
 ↪loc[congrf['flashpres'] == 3])

fig = plt.figure(figsize = (14, 5))
ax = fig.add_subplot(121, xlabel='condition', ylabel='% accurate',␣
 ↪title='Accuracy for Unisensory Flash Trials')
objects = ('Unisensory 2 Flash',  'Unisensory 3 Flash')
y_pos = np.arange(len(objects))
performance = [uni2flashacc, uni3flashacc]

uni2flashaccstd = calcstderr(unif.loc[unif['flashpres'] == 2], 'acc')
uni3flashaccstd = calcstderr(unif.loc[unif['flashpres'] == 3], 'acc')
congr2flashaccstd = calcstderr(congrf.loc[congrf['flashpres'] == 2], 'acc')
congr3flashaccstd = calcstderr(congrf.loc[congrf['flashpres'] == 3], 'acc')

plt.bar(y_pos, performance, yerr=[uni2flashaccstd, uni3flashaccstd],
        color=['#1f77b4', '#ff7f0e'], ecolor='black', capsize=10)

plt.xticks(y_pos, objects)
plt.ylim([0,1])

ax = fig.add_subplot(122, xlabel='condition', ylabel='% accurate',␣
 ↪title='Accuracy for Congruent Flash Trials')
objects2 = ('Congruent 2 Flash', 'Congruent 3 Flash')
y_pos2 = np.arange(len(objects2))
performance2 = [congr2flashacc, congr3flashacc]
plt.bar(y_pos2, performance2, yerr=[congr2flashaccstd, congr3flashaccstd],
        color=['#1f77b4', '#ff7f0e'], ecolor='black', capsize=10)
plt.xticks(y_pos2, objects2)
plt.ylim([0,1])

plt.close()
```

[34]:
```
fig = plt.figure(figsize=(14, 5))
```

```
ax = fig.add_subplot(121, xlabel='RT', ylabel='count', title='Unisensory Beep RT distributions (3 flashes)')
for i, subj_data in unib.loc[unib['beeppres'] == 3].groupby('subj_idx'):
    subj_data.rt.hist(bins=20, histtype='step', ax=ax)
ax.set_ylim([0, 70])

ax = fig.add_subplot(122, xlabel='RT', ylabel='count', title='Congruent Beep RT distributions (3 flashes)')
for i, subj_data in congrb.loc[congrb['beeppres'] == 3].groupby('subj_idx'):
    subj_data.rt.hist(bins=20, histtype='step', ax=ax)
ax.set_ylim([0, 70])
plt.close()
```

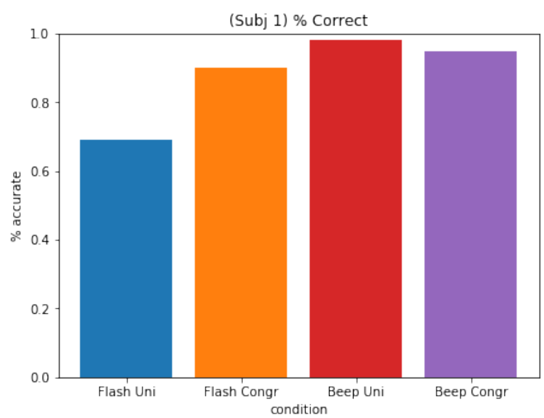
[35]:

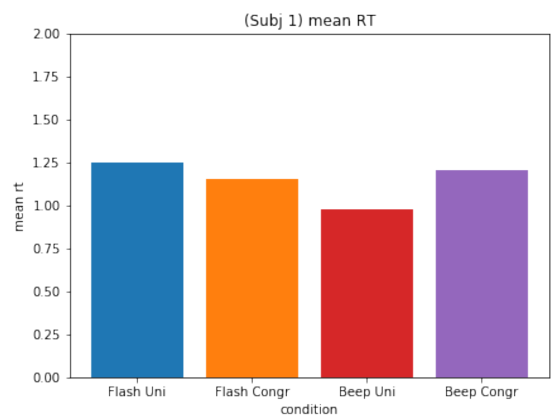
```
uni2beepacc = sum(unib.loc[unib['beeppres'] == 2]['acc']) / len(unib.loc[unib['beeppres'] == 2])
uni3beepacc = sum(unib.loc[unib['beeppres'] == 3]['acc']) / len(unib.loc[unib['beeppres'] == 3])
congr2beepacc = sum(congrb.loc[congrb['beeppres'] == 2]['acc']) / len(congrb.loc[congrb['beeppres'] == 2])
congr3beepacc = sum(congrb.loc[congrb['beeppres'] == 3]['acc']) / len(congrb.loc[congrb['beeppres'] == 3])

fig = plt.figure(figsize = (14, 5))
ax = fig.add_subplot(121, xlabel='condition', ylabel='% accurate', title='Accuracy for Unisensory Beep Trials')
objects = ('Unisensory 2 Beep',  'Unisensory 3 Beep')
y_pos = np.arange(len(objects))
performance = [uni2beepacc, uni3beepacc]

uni2beepaccstd = calcstderr(unib.loc[unib['beeppres'] == 2], 'acc')
uni3beepaccstd = calcstderr(unib.loc[unib['beeppres'] == 3], 'acc')
congr2beepaccstd = calcstderr(congrb.loc[congrb['beeppres'] == 2], 'acc')
congr3beepaccstd = calcstderr(congrb.loc[congrb['beeppres'] == 3], 'acc')

plt.bar(y_pos, performance, yerr=[uni2beepaccstd, uni3beepaccstd],
        color=['#1f77b4', '#ff7f0e'], ecolor='black', capsize=10)

plt.xticks(y_pos, objects)
plt.ylim([0,1])

ax = fig.add_subplot(122, xlabel='condition', ylabel='% accurate', title='Accuracy for Congruent Beep Trials')
objects2 = ('Congruent 2 Beep', 'Congruent 3 Beep')
y_pos2 = np.arange(len(objects2))
performance2 = [congr2beepacc, congr3beepacc]
plt.bar(y_pos2, performance2, yerr=[congr2beepaccstd, congr3beepaccstd],
```

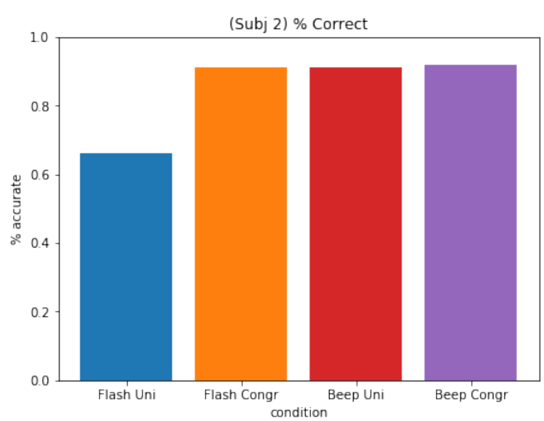
```
        color=['#1f77b4', '#ff7f0e'], ecolor='black', capsize=10)
plt.xticks(y_pos2, objects2)
plt.ylim([0,1])

plt.close()
```

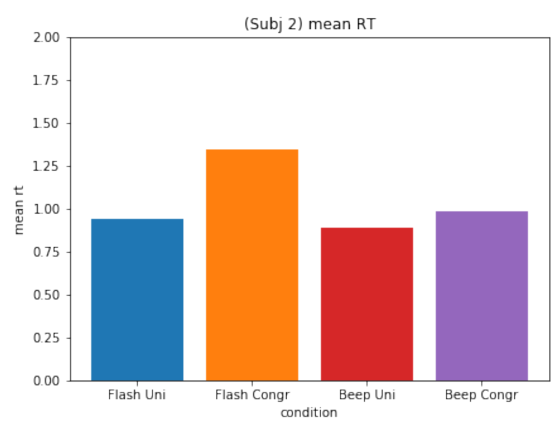
2 Plots

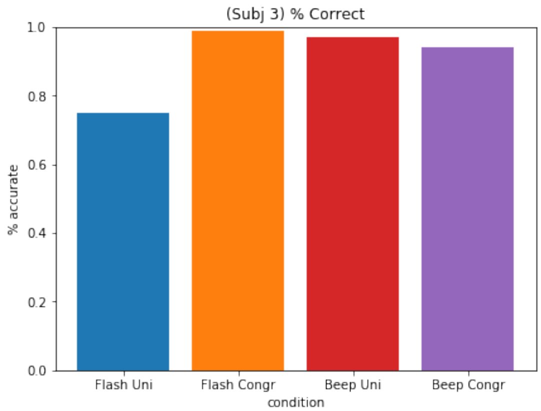
[36]:
```
for i in np.arange(max(unif['subj_idx'])):
    plotbars(unif, unib, congrf, congrb, "(Subj " + str(int(i + 1)) + ") %␣
 ↪Correct",
             "(Subj " + str(int(i + 1)) + ") mean RT", int(i + 1))

plotbars(unif, unib, congrf, congrb, "Percent Correct", "mean RT")
plotbars(unif.loc[unif['subj_idx'] != 15], unib.loc[unib['subj_idx'] != 15],
         congrf.loc[congrf['subj_idx'] != 15], congrb.loc[congrb['subj_idx'] !=␣
 ↪15],
        "Percent Correct without Subj 15", "mean RT without Subj 15")
```

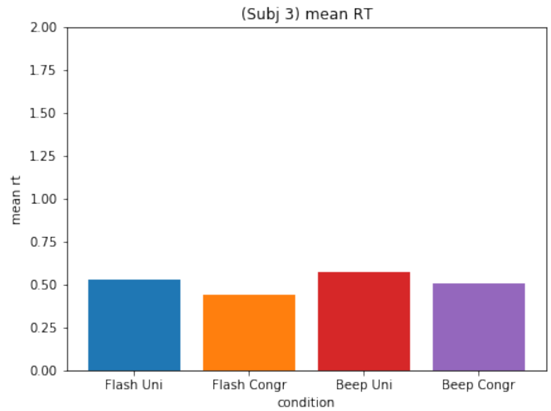


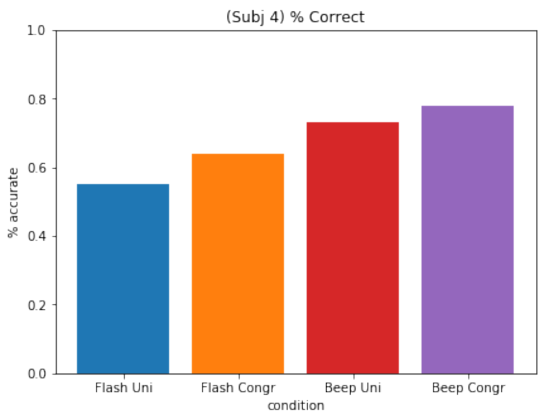


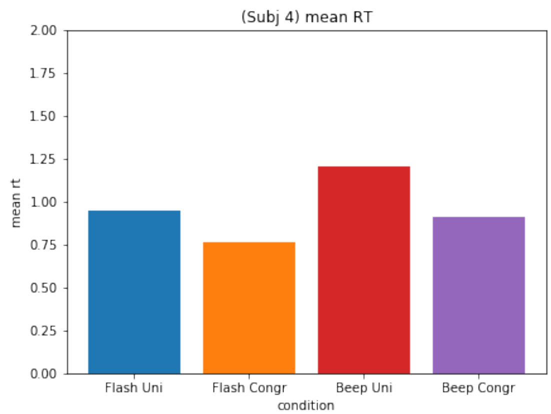


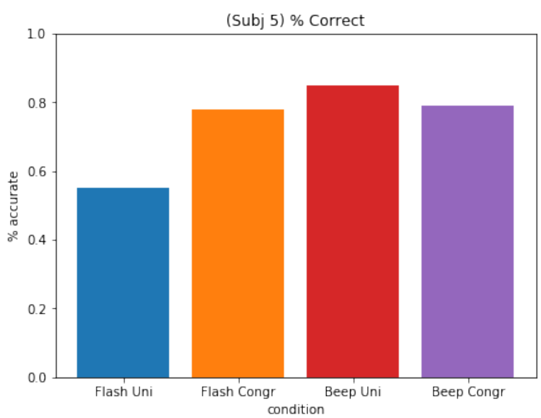


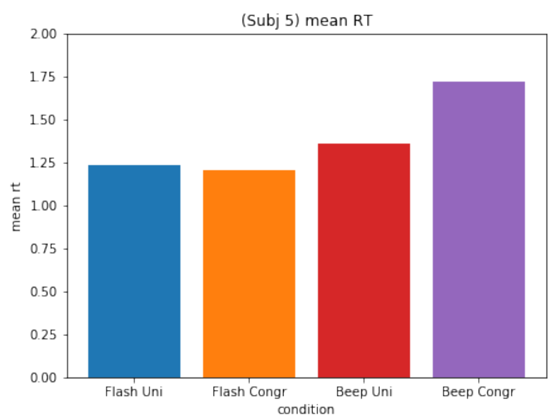

(Subj 3) % Correct
% accurate
0.0
0.2
0.4
0.6
0.8
1.0
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

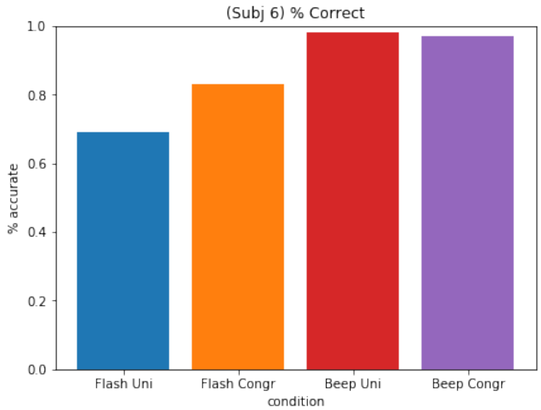

(Subj 3) mean RT
mean rt
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

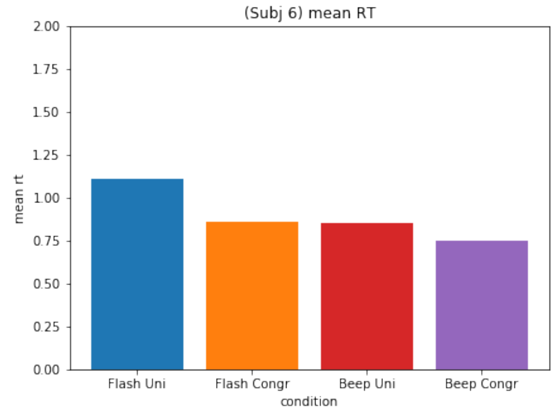

(Subj 4) % Correct
% accurate
0.0
0.2
0.4
0.6
0.8
1.0
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

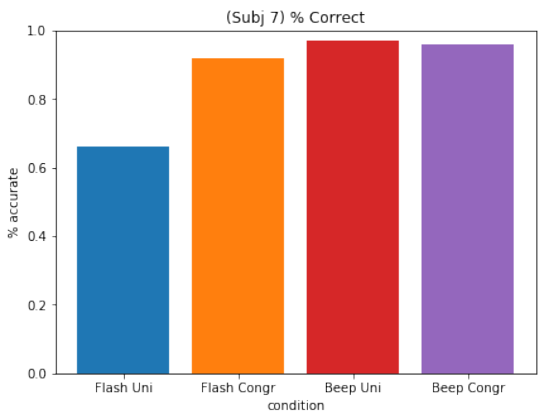

(Subj 4) mean RT
mean rt
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

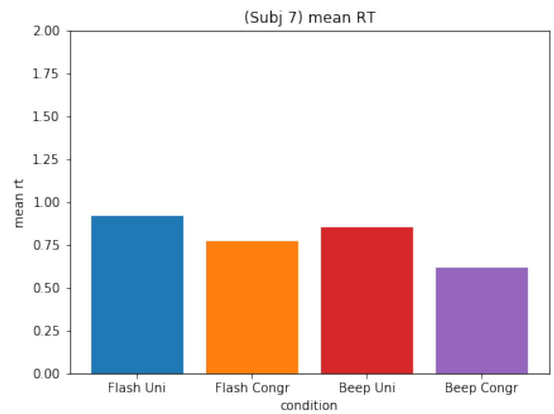

(Subj 5) % Correct
% accurate
0.0
0.2
0.4
0.6
0.8
1.0
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

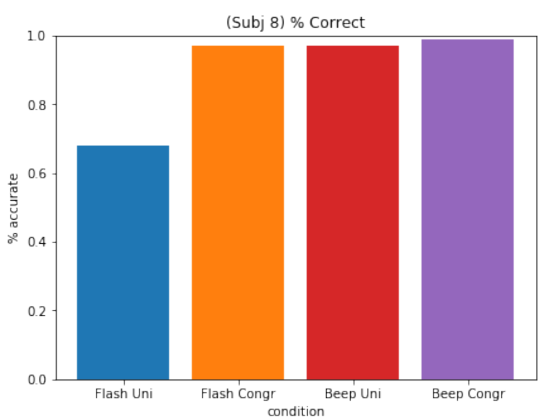

(Subj 5) mean RT
mean rt
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

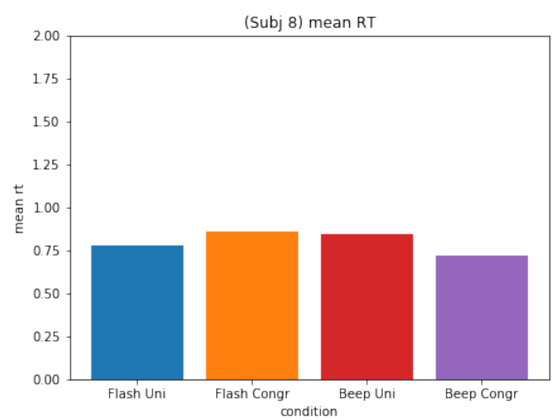

(Subj 6) % Correct
% accurate
1.0
0.8
0.6
0.4
0.2
0.0
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

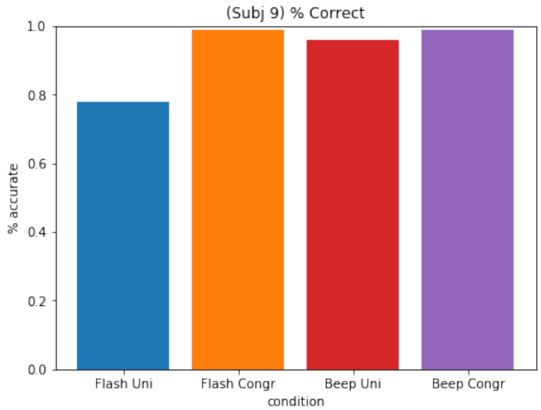

(Subj 6) mean RT
mean rt
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

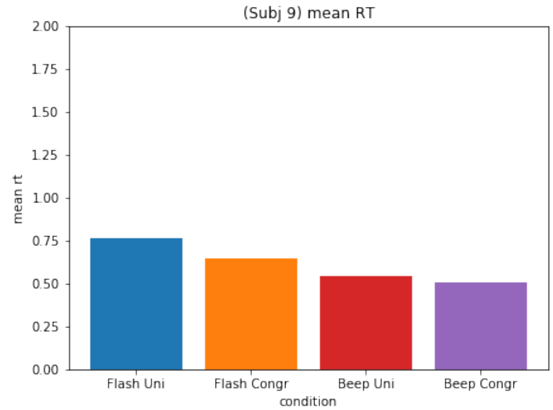

(Subj 7) % Correct
% accurate
1.0
0.8
0.6
0.4
0.2
0.0
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

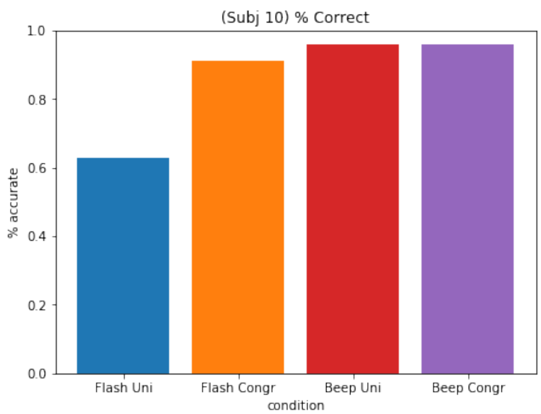

(Subj 7) mean RT
mean rt
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

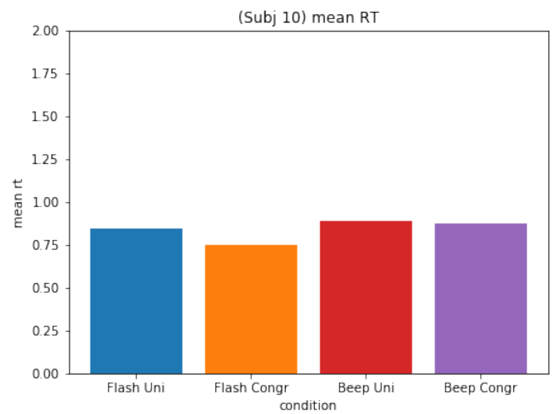

(Subj 8) % Correct
% accurate
1.0
0.8
0.6
0.4
0.2
0.0
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

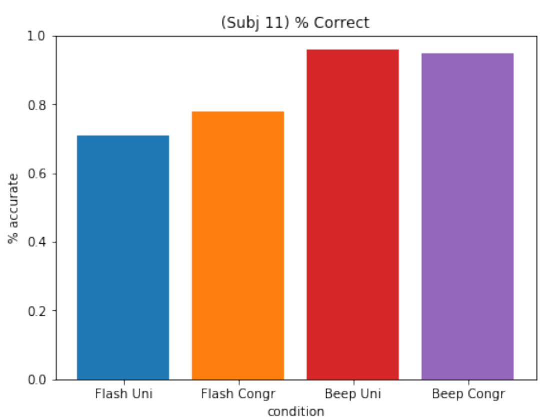

(Subj 8) mean RT
mean rt
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

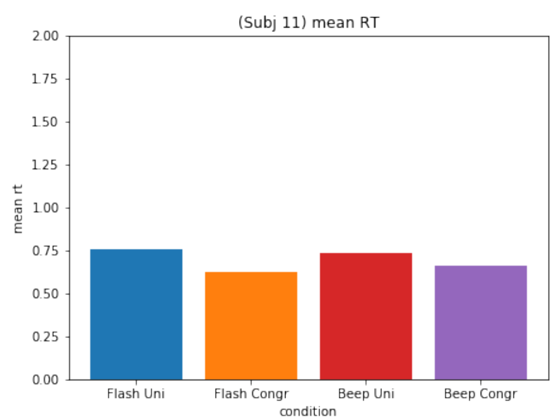

(Subj 9) % Correct
% accurate
0.0
0.2
0.4
0.6
0.8
1.0
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

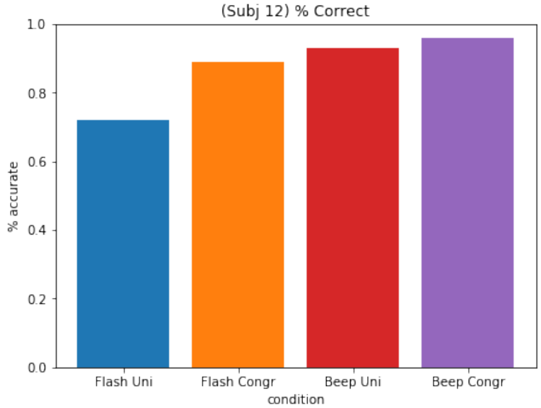
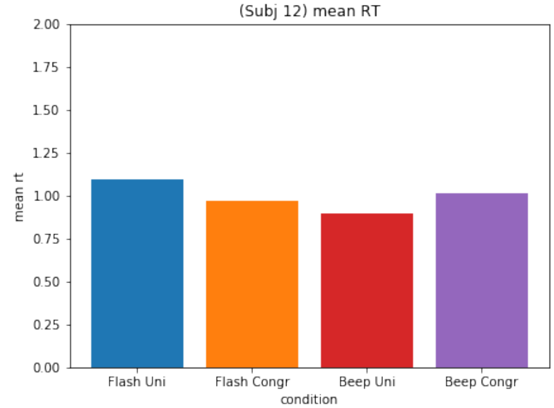
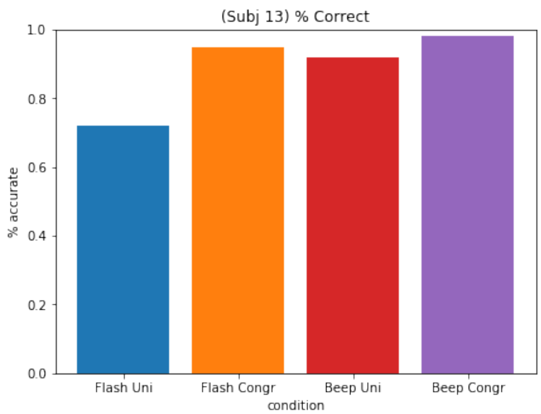
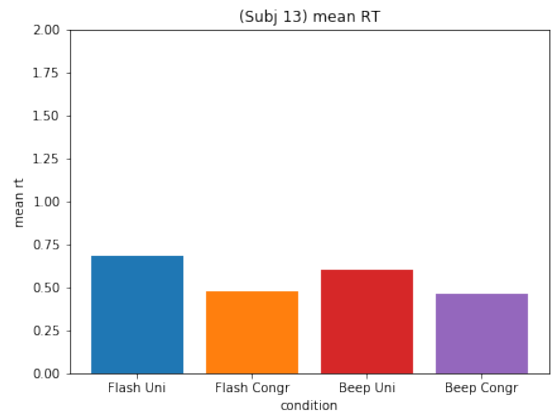
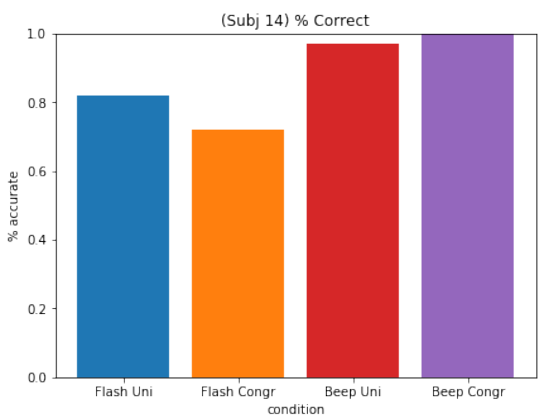
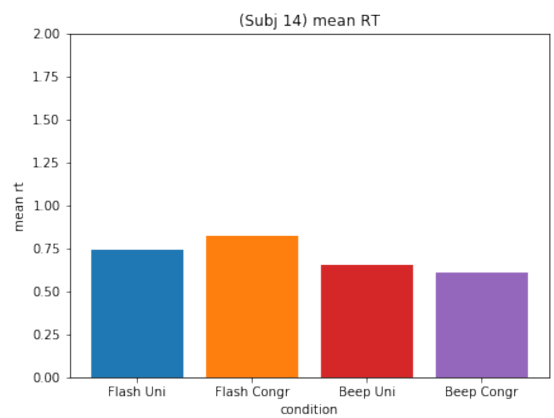

(Subj 9) mean RT
mean rt
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

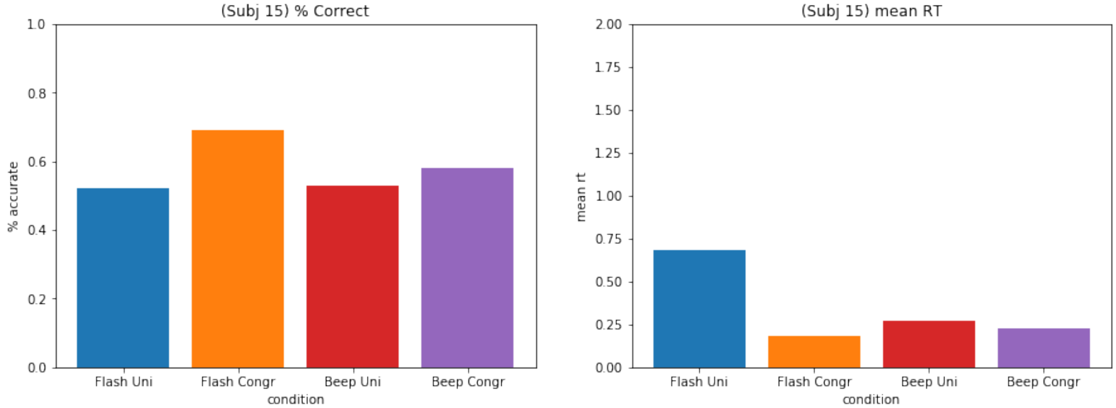

(Subj 10) % Correct
% accurate
0.0
0.2
0.4
0.6
0.8
1.0
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

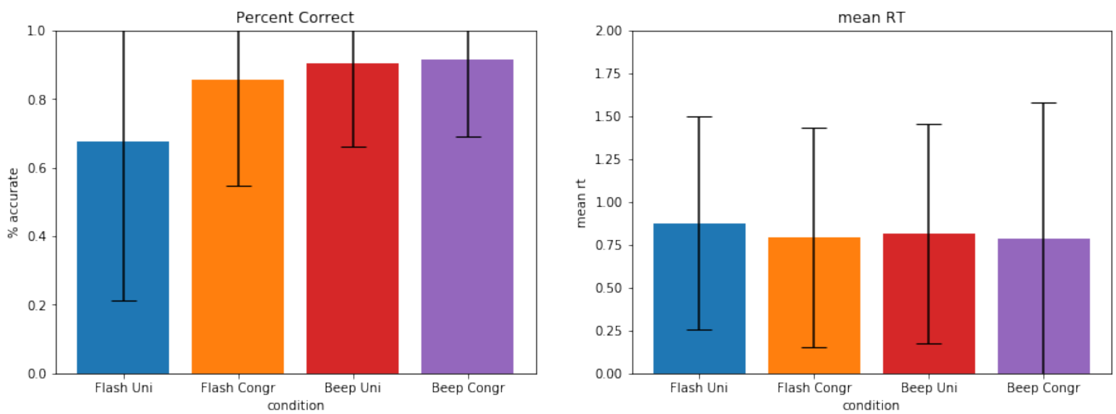

(Subj 10) mean RT
mean rt
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

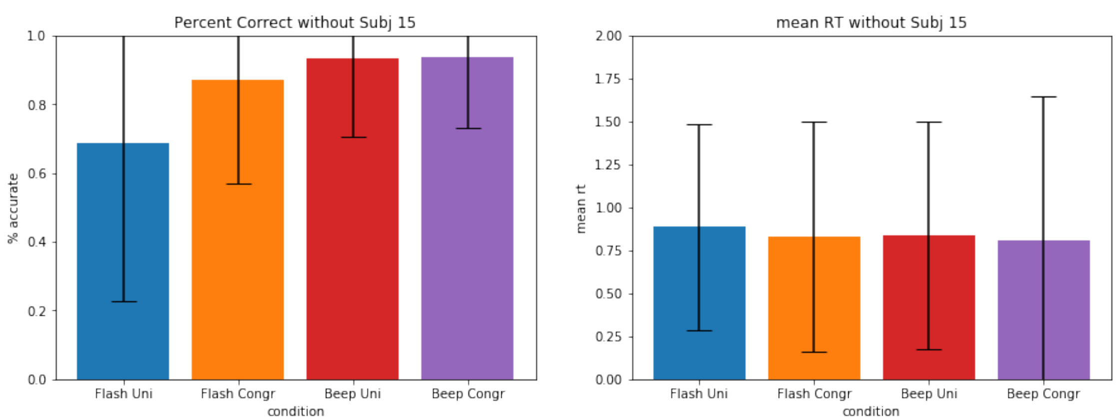

(Subj 11) % Correct
% accurate
0.0
0.2
0.4
0.6
0.8
1.0
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition


(Subj 11) mean RT
mean rt
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition


(Subj 12) % Correct
% accurate
0.0
0.2
0.4
0.6
0.8
1.0
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

(Subj 12) mean RT
mean rt
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

(Subj 13) % Correct
% accurate
0.0
0.2
0.4
0.6
0.8
1.0
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

(Subj 13) mean RT
mean rt
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

(Subj 14) % Correct
% accurate
0.0
0.2
0.4
0.6
0.8
1.0
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition

(Subj 14) mean RT
mean rt
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Flash Uni
Flash Congr
Beep Uni
Beep Congr
condition







[37]:
```
subject = 15

flashframe = droprow(flashframe, 0.05)
```

```
flashframe = dropsubj(flashframe, subject)
flashframe = droprow(flashframe, 10, False)
beepframe = droprow(beepframe, 0.05)
beepframe = dropsubj(beepframe, subject)
beepframe = droprow(beepframe, 10, False)

congrf = flashframe.loc[flashframe['flashpres'] == flashframe['beeppres']]
unif = flashframe.loc[flashframe['beeppres'] == 0]
congrb = beepframe.loc[beepframe['flashpres'] == beepframe['beeppres']]
unib = beepframe.loc[beepframe['flashpres'] == 0]
```

3 Pairwise t-tests

Conduct t-test between accuracy or rt across all subjects (1400 pairs in each test, 100 from each subject)

3.1 Comparing accuracy for flash trials (unisensory vs. bisensory)

[38]:
```
print("pvalue: " + str(stats.ttest_rel(unif["acc"][1:], congrf["acc"])[1]))
```

```
pvalue: 7.545208303580591e-33
```

3.2 Comparing accuracy for beep trials (unisensory vs. bisensory)

[39]:
```
print("pvalue: " + str(stats.ttest_rel(unib["acc"][3:], congrb["acc"])[1]))
```

```
pvalue: 0.4641157028835692
```

3.3 Comparing rt for flash trials (unisensory vs. bisensory)

[40]:
```
print("pvalue: " + str(stats.ttest_rel(unif["rt"][1:], congrf["rt"])[1]))
```

```
pvalue: 0.9112509628115936
```

3.4 Comparing rt for beep trials (unisensory vs. bisensory)

[41]:
```
print("pvalue: " + str(stats.ttest_rel(unib["rt"][3:], congrb["rt"])[1]))
```

```
pvalue: 0.08822721470776992
```

4 HDDM

[42]:
```
alldata = pd.concat([flashframe, beepframe])
alldata.columns = ['subj_idx', 'flashpres', 'beeppres', 'response', 'rt']
conditions = [(alldata['flashpres'] == 0) & (alldata['beeppres'] == 2),
              (alldata['flashpres'] == 0) & (alldata['beeppres'] == 3),
```

```
                (alldata['flashpres'] == 2) & (alldata['beeppres'] == 0),
                (alldata['flashpres'] == 3) & (alldata['beeppres'] == 0),
                (alldata['flashpres'] == 2) & (alldata['beeppres'] == 2),
                (alldata['flashpres'] == 3) & (alldata['beeppres'] == 3),]
choices = ['A2', 'A3', 'V2', 'V3', 'A2V2', 'A3V3']
alldata['stimName'] = np.select(conditions, choices)
```

[43]:
```
model_unif = formatmodeldata(unif, [(unif['flashpres'] == 2),␣
 ↪(unif['flashpres'] == 3)], ['F2', 'F3'])
model_unib = formatmodeldata(unib, [(unib['beeppres'] == 2), (unib['beeppres']␣
 ↪== 3)], ['B2', 'B3'])
model_congrf = formatmodeldata(congrf, [(congrf['flashpres'] == 2) &␣
 ↪(congrf['beeppres'] == 2),
                                        (congrf['flashpres'] == 3) &␣
 ↪(congrf['beeppres'] == 3)], ['F2B2', 'F3B3'])
model_congrb = formatmodeldata(congrb, [(congrb['flashpres'] == 2) &␣
 ↪(congrb['beeppres'] == 2),
                                        (congrb['flashpres'] == 3) &␣
 ↪(congrb['beeppres'] == 3)], ['F2B2', 'F3B3'])
```

[44]:
```
model_unif['type'] = 'u'
model_congrf['type'] = 'c'
model_f = pd.concat([model_unif, model_congrf], axis = 0)
model_unib['type'] = 'u'
model_congrb['type'] = 'c'
model_b = pd.concat([model_unib, model_congrb], axis = 0)
```

[45]:
```
# 0 means responded 2, 1 means responded 3
def stimcode(df, conditions, choices):
    dframe = df.copy()
    dframe['stimCode'] = np.select(conditions, choices)
    return(dframe)

stim_unif = stimcode(model_unif, [(model_unif['flashpres'] == 2) &␣
 ↪(model_unif['response'] == 0),
                                  (model_unif['flashpres'] == 2) &␣
 ↪(model_unif['response'] == 1),
                                  (model_unif['flashpres'] == 3) &␣
 ↪(model_unif['response'] == 0),
                                  (model_unif['flashpres'] == 3) &␣
 ↪(model_unif['response'] == 1)], [1, 0, 0, 1])
stim_congrf = stimcode(model_congrf, [(model_congrf['flashpres'] == 2) &␣
 ↪(model_congrf['response'] == 0),
                                      (model_congrf['flashpres'] == 2) &␣
 ↪(model_congrf['response'] == 1),
```

```
                                      (model_congrf['flashpres'] == 3) &␣
↪(model_congrf['response'] == 0),
                                      (model_congrf['flashpres'] == 3) &␣
↪(model_congrf['response'] == 1)], [1, 0, 0, 1])
stim_unib = stimcode(model_unib, [(model_unib['beeppres'] == 2) &␣
↪(model_unib['response'] == 0),
                                  (model_unib['beeppres'] == 2) &␣
↪(model_unib['response'] == 1),
                                  (model_unib['beeppres'] == 3) &␣
↪(model_unib['response'] == 0),
                                  (model_unib['beeppres'] == 3) &␣
↪(model_unib['response'] == 1)], [1, 0, 0, 1])
stim_congrb = stimcode(model_congrb, [(model_congrb['beeppres'] == 2) &␣
↪(model_congrb['response'] == 0),
                                      (model_congrb['beeppres'] == 2) &␣
↪(model_congrb['response'] == 1),
                                      (model_congrb['beeppres'] == 3) &␣
↪(model_congrb['response'] == 0),
                                      (model_congrb['beeppres'] == 3) &␣
↪(model_congrb['response'] == 1)], [1, 0, 0, 1])
```

[46]:

```
stim_f = pd.concat([stim_unif, stim_congrf], axis = 0)
stim_b = pd.concat([stim_unib, stim_congrb], axis = 0)
```

4.1 Accuracy-coded flash model (same threshold)

[64]:

```
flash_acc = hddm.HDDM(model_f, include=['a', 'v', 't', 'p_outlier'],␣
↪depends_on={'v': ['type'], 't': ['type']})
flash_acc.sample(7000, burn=500)
```

```
[-----------------100%-----------------] 7001 of 7000 complete in 706.6 sec
```

[64]:

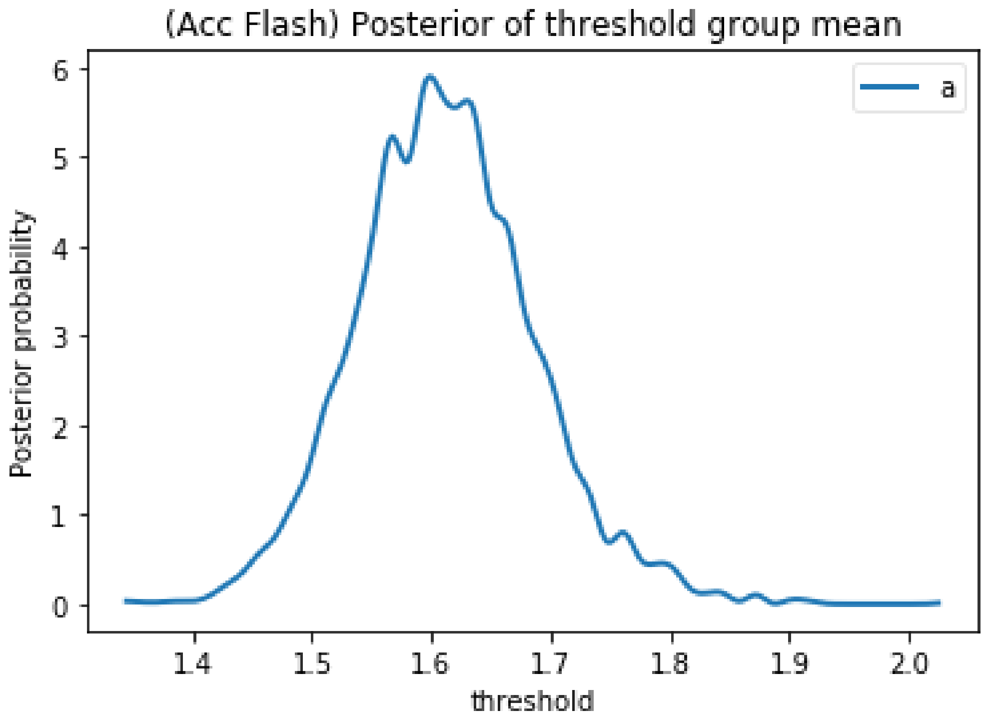
```
<pymc.MCMC.MCMC at 0x12692608>
```

[236]:

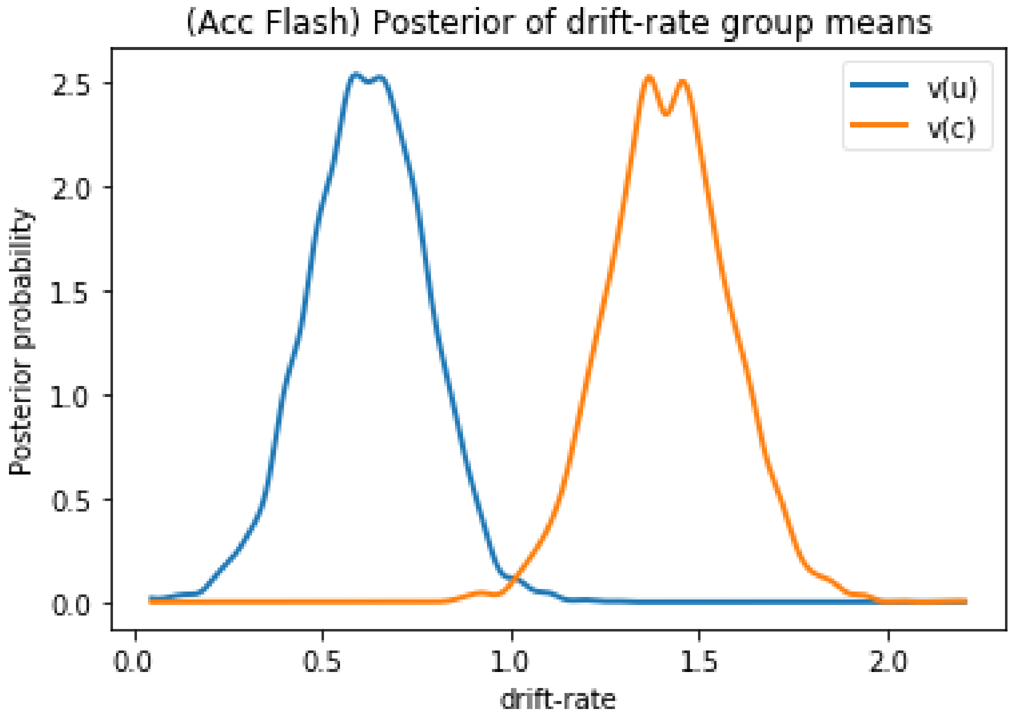
```
#flash_acc.print_stats()
#unif_acc.plot_posteriors()
```

[123]:

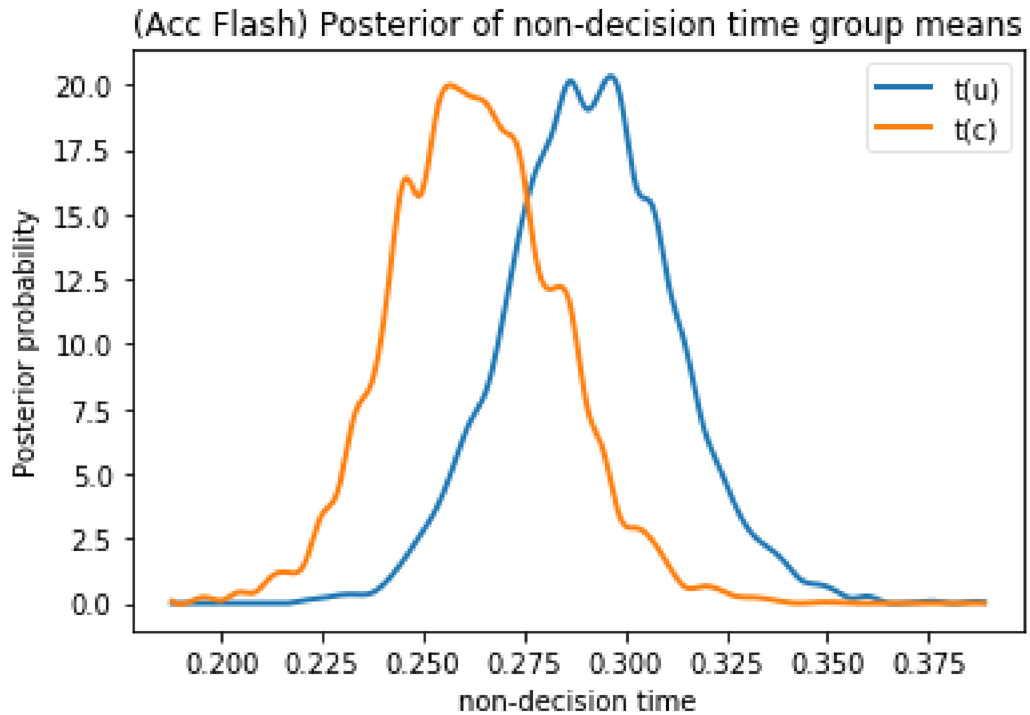
```
a = flash_acc.nodes_db.node['a']
hddm.analyze.plot_posterior_nodes([a])
plt.xlabel('threshold')
plt.ylabel('Posterior probability')
plt.title('(Acc Flash) Posterior of threshold group mean')
plt.show()
```



[124]:
```
v_u, v_c = flash_acc.nodes_db.node[['v(u)', 'v(c)']]
hddm.analyze.plot_posterior_nodes([v_u, v_c])
plt.xlabel('drift-rate')
plt.ylabel('Posterior probability')
plt.title('(Acc Flash) Posterior of drift-rate group means')
plt.show()
```




```
[125]: t_u, t_c = flash_acc.nodes_db.node[['t(u)', 't(c)']]
       hddm.analyze.plot_posterior_nodes([t_u, t_c])
       plt.xlabel('non-decision time')
       plt.ylabel('Posterior probability')
       plt.title('(Acc Flash) Posterior of non-decision time group means')
       plt.show()
```



4.2 Stimulus-coded flash models(same threshold)

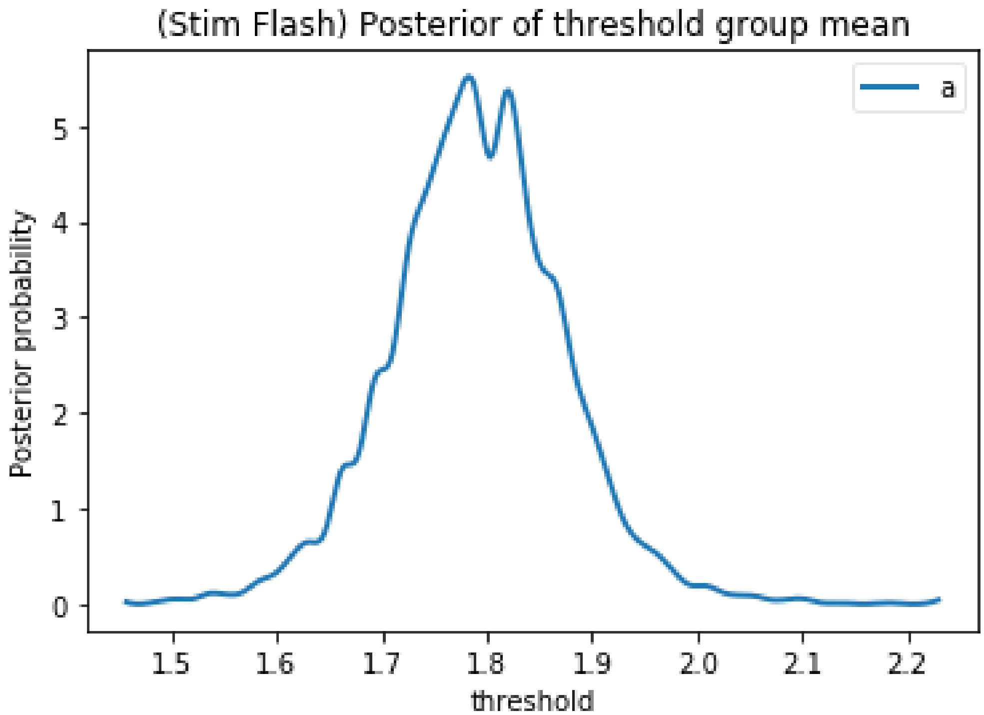
[86]:
```
flash_stim = hddm.HDDMStimCoding(stim_f, include='z', depends_on={'v':␣
 ↪['type'], 't': ['type'], 'z': ['type']}, stim_col='stimCode')
flash_stim.sample(7000, burn=500)
```

```
Setting model to be non-informative
Adding z to includes.
 [-----------------100%-----------------] 7001 of 7000 complete in 1030.1 sec
```

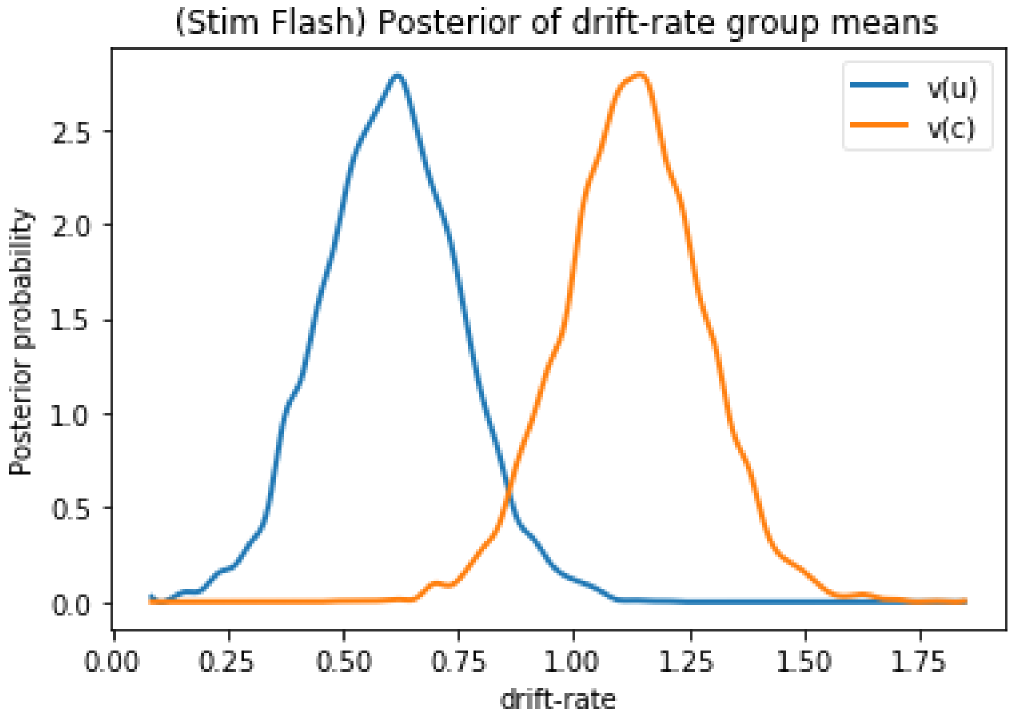
[86]: <pymc.MCMC.MCMC at 0x13ef5ac8>

[237]:
```
#flash_stim.print_stats()
```

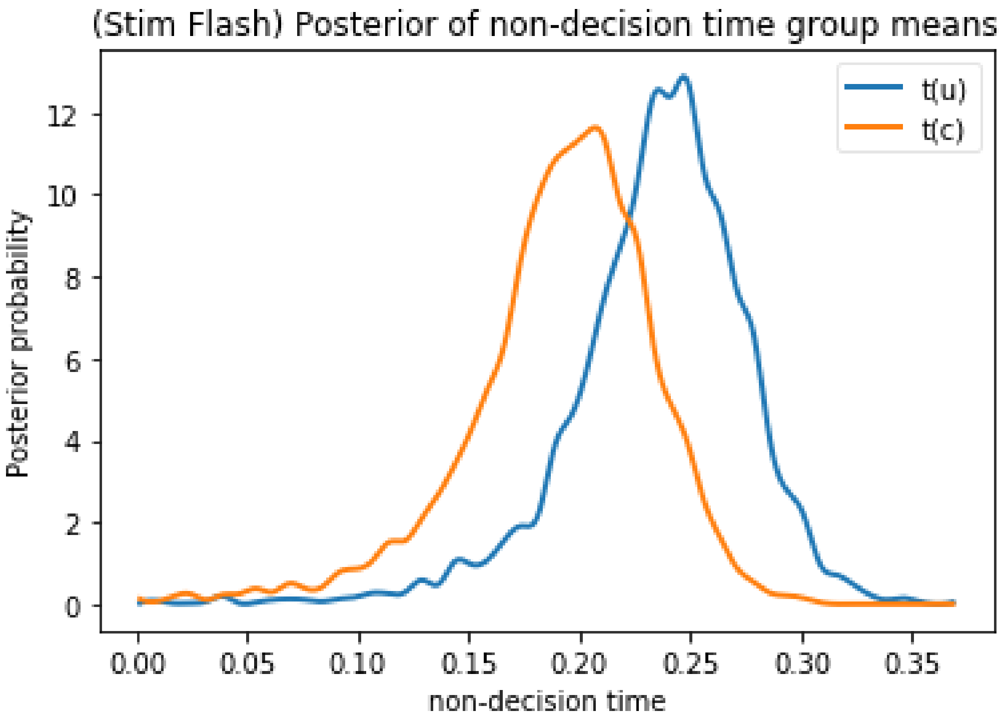
[88]:
```
a = flash_stim.nodes_db.node['a']
hddm.analyze.plot_posterior_nodes([a])
plt.xlabel('threshold')
plt.ylabel('Posterior probability')
plt.title('(Stim Flash) Posterior of threshold group mean')
plt.show()
```



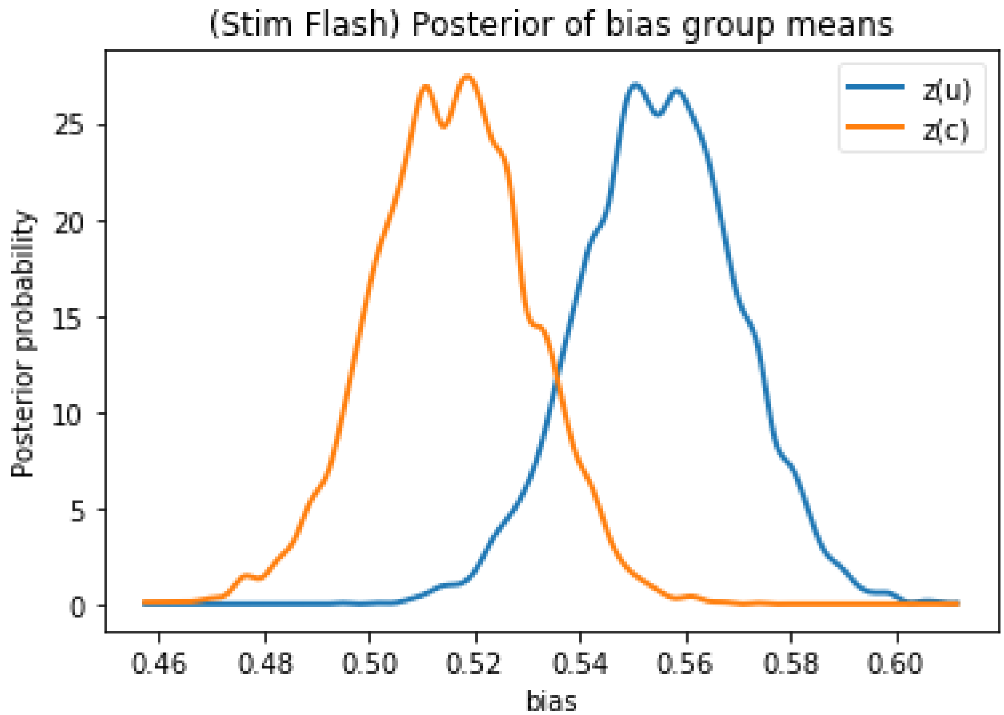
[89]:
```
v_u, v_c = flash_stim.nodes_db.node[['v(u)', 'v(c)']]
hddm.analyze.plot_posterior_nodes([v_u, v_c])
plt.xlabel('drift-rate')
plt.ylabel('Posterior probability')
plt.title('(Stim Flash) Posterior of drift-rate group means')
plt.show()
```



[90]:
```
t_u, t_c = flash_stim.nodes_db.node[['t(u)', 't(c)']]
hddm.analyze.plot_posterior_nodes([t_u, t_c])
plt.xlabel('non-decision time')
plt.ylabel('Posterior probability')
plt.title('(Stim Flash) Posterior of non-decision time group means')
plt.show()
```



[91]:
```
z_u, z_c = flash_stim.nodes_db.node[['z(u)', 'z(c)']]
hddm.analyze.plot_posterior_nodes([z_u, z_c])
plt.xlabel('bias')
plt.ylabel('Posterior probability')
plt.title('(Stim Flash) Posterior of bias group means')
plt.show()
```



4.3 Posterior Predictive Check (Flash)

4.3.1 Accuracy-coded Flash

[93]:
```
fppc = hddm.utils.post_pred_gen(flash_acc)
```

```
[-------------------110%-------------------] 31 of 28 complete in 1290.7 sec
```

[98]:
```
fppc_compare = hddm.utils.post_pred_stats(model_f, fppc)
print(fppc_compare)
```

```
          observed      mean       std       SEM       MSE credible  \
stat
accuracy  0.778135  0.795677  0.124663  0.000308  0.015849     True
mean_ub   0.855433  0.820834  0.211357  0.001197  0.045869     True
std_ub    0.665953  0.420534  0.161049  0.060231  0.086168     True
10q_ub    0.389500  0.435356  0.093755  0.002103  0.010893     True
30q_ub    0.537021  0.554826  0.126206  0.000317  0.016245     True
50q_ub    0.665879  0.697958  0.171988  0.001029  0.030609     True
70q_ub    0.849032  0.911364  0.245902  0.003885  0.064353     True
90q_ub    1.449996  1.359270  0.413300  0.008231  0.179048     True
mean_lb  -1.085988 -0.823607  0.234260  0.068844  0.123721     True
std_lb    0.903215  0.388901  0.200062  0.264519  0.304544    False
10q_lb    0.444976  0.465511  0.110517  0.000422  0.012636     True
```

```
30q_lb    0.630831  0.577676  0.144925  0.002825  0.023829     True
50q_lb    0.812548  0.713187  0.197634  0.009873  0.048932     True
70q_lb    1.069355  0.912523  0.284419  0.024596  0.105490     True
90q_lb    1.941313  1.303862  0.482884  0.406344  0.639521     True

           quantile  mahalanobis
stat
accuracy  43.057144     0.140711
mean_ub   57.021427     0.163699
std_ub    92.535713     1.523876
10q_ub    34.835712     0.489111
30q_ub    45.942856     0.141079
50q_ub    44.128571     0.186518
70q_ub    42.200001     0.253482
90q_ub    60.085712     0.219516
mean_lb   13.965716     1.120041
std_lb    98.854797     2.570774
10q_lb    46.470757     0.185805
30q_lb    66.421783     0.366776
50q_lb    71.053009     0.502751
70q_lb    72.263039     0.551415
90q_lb    89.808411     1.320092
```

4.3.2 Stimulus-coded Flash

[52]:
```python
fppc2 = hddm.utils.post_pred_gen(flash_stim)
```

```
[-----------------105%------------------] 59 of 56 complete in 2478.1 sec
```

[55]:
```python
fppc_compare2 = hddm.utils.post_pred_stats(stim_f, fppc2)
print(fppc_compare2)
```

```
          observed      mean       std       SEM       MSE credible  \
stat
accuracy  0.778135  0.786028  0.128655  0.000062  0.016614     True
mean_ub   0.855433  0.920047  0.269142  0.004175  0.076612     True
std_ub    0.665953  0.523266  0.216317  0.020360  0.067152     True
10q_ub    0.389500  0.440812  0.129023  0.002633  0.019280     True
30q_ub    0.537021  0.588942  0.171498  0.002696  0.032107     True
50q_ub    0.665879  0.767402  0.229415  0.010307  0.062938     True
70q_ub    0.849032  1.032765  0.323504  0.033758  0.138412     True
90q_ub    1.449996  1.576562  0.532017  0.016019  0.299061     True
mean_lb  -1.085988 -0.926923  0.325185  0.025302  0.131047     True
std_lb    0.903215  0.453136  0.279067  0.202571  0.280450     True
10q_lb    0.444976  0.514913  0.209170  0.004891  0.048643     True
30q_lb    0.630831  0.646152  0.243953  0.000235  0.059748     True
50q_lb    0.812548  0.804650  0.301533  0.000062  0.090985     True
70q_lb    1.069355  1.033435  0.397583  0.001290  0.159362     True
```

```
90q_lb    1.941313  1.458242  0.619438  0.233358  0.617061     True

           quantile  mahalanobis
stat
accuracy  45.724998     0.061349
mean_ub   43.296429     0.240072
std_ub    76.703575     0.659621
10q_ub    39.071430     0.397696
30q_ub    41.453571     0.302749
50q_ub    35.639286     0.442528
70q_ub    30.303572     0.567945
90q_ub    43.842857     0.237899
mean_lb   27.836111     0.489151
std_lb    93.597183     1.612798
10q_lb    40.436157     0.334351
30q_lb    53.550186     0.062804
50q_lb    57.063660     0.026194
70q_lb    58.936047     0.090347
90q_lb    79.991188     0.779855
```

4.4 Parameter Recovery (Flash)

4.4.1 Accuracy-coded Flash

[232]:
```
fsyndata, fparam = hddm.generate.gen_rand_data(params={'u': {'a': 1.613684  ,␣
↪'v': 0.631853, 't': 0.291248},
                                                        'c': {'a': 1.613684  ,␣
↪'v': 1.411966, 't': 0.263438}},
                                                size = 200, subjs = 14)
```

[233]:
```
print(pd.DataFrame(data = fparam['u']).mean())
print(pd.DataFrame(data = fparam['c']).mean())
```

```
a    1.624109
t    0.296724
v    0.645254
dtype: float64
a    1.624109
t    0.268914
v    1.425367
dtype: float64
```

[234]:
```
fparamrec = hddm.HDDM(fsyndata, include=['a', 'v', 't', 'p_outlier'],␣
↪depends_on={'v': 'condition', 't': 'condition'})
fparamrec.sample(7000, burn=500)
```

```
 [-----------------100%-----------------] 7000 of 7000 complete in 865.2 sec
```

[234]: <pymc.MCMC.MCMC at 0x1be4b288>

[243]:
```
#fparamrec.print_stats()
```

a: 0.2% diff

v(c): 1.6% diff

v(u): 0.6% diff

t(c): 6.3% diff

t(u): 5.7% diff

4.4.2 Stim-coded Flash

[225]:
```
fsyndata2, fparam2 = hddm.generate.gen_rand_data(params={'u': {'a': 1.791961,␣
↪'v': 0.611159, 't': 0.234447, 'z': 0.554721},
                                                   'c': {'a': 1.791961,␣
↪'v': 1.125461, 't': 0.191573, 'z': 0.516007}},
                                            size = 100, subjs = 14)
```

[226]:
```
print(pd.DataFrame(data = fparam2['u']).mean())
print(pd.DataFrame(data = fparam2['c']).mean())
```

```
a    1.837094
t    0.224589
v    0.607973
z    0.558364
dtype: float64
a    1.837094
t    0.181715
v    1.122275
z    0.519650
dtype: float64
```

[227]:
```
fparamrec2 = hddm.HDDM(fsyndata2, include='z', depends_on={'v': 'condition',␣
↪'t': 'condition', 'z': 'condition'})
fparamrec2.sample(7000, burn=500)
```

```
[-----------------100%-----------------] 7000 of 7000 complete in 520.0 sec
```

[227]: <pymc.MCMC.MCMC at 0x15694f88>

[242]:
```
#fparamrec2.print_stats()
```

a: 0.7% diff

v(c): 4.4% diff

v(u): 4.9% diff

t(c): 0.5% diff

t(u): 3% diff

z(c): 7.6% diff

z(u): 4.9% diff

4.5 Accuracy-coded beep model (same threshold)

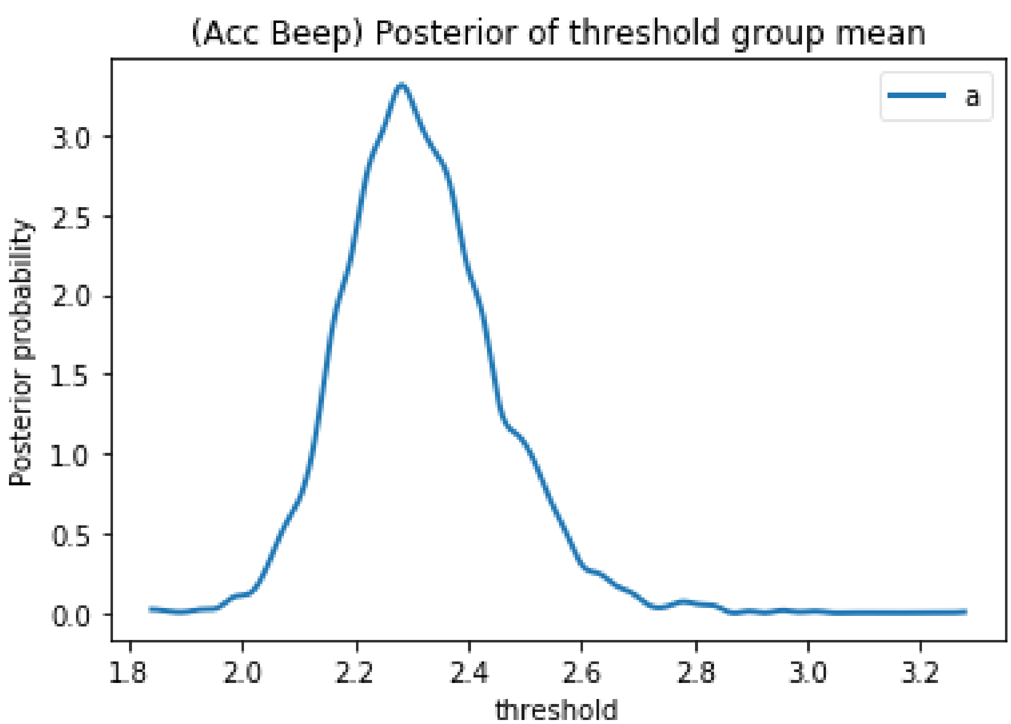
[138]:
```
beep_acc = hddm.HDDM(model_b, include=['a', 'v', 't', 'p_outlier'],␣
↪depends_on={'v': ['type'], 't': ['type']})
beep_acc.sample(7000, burn=500)
```

```
[-----------------100%-----------------] 7001 of 7000 complete in 462.8 sec
```

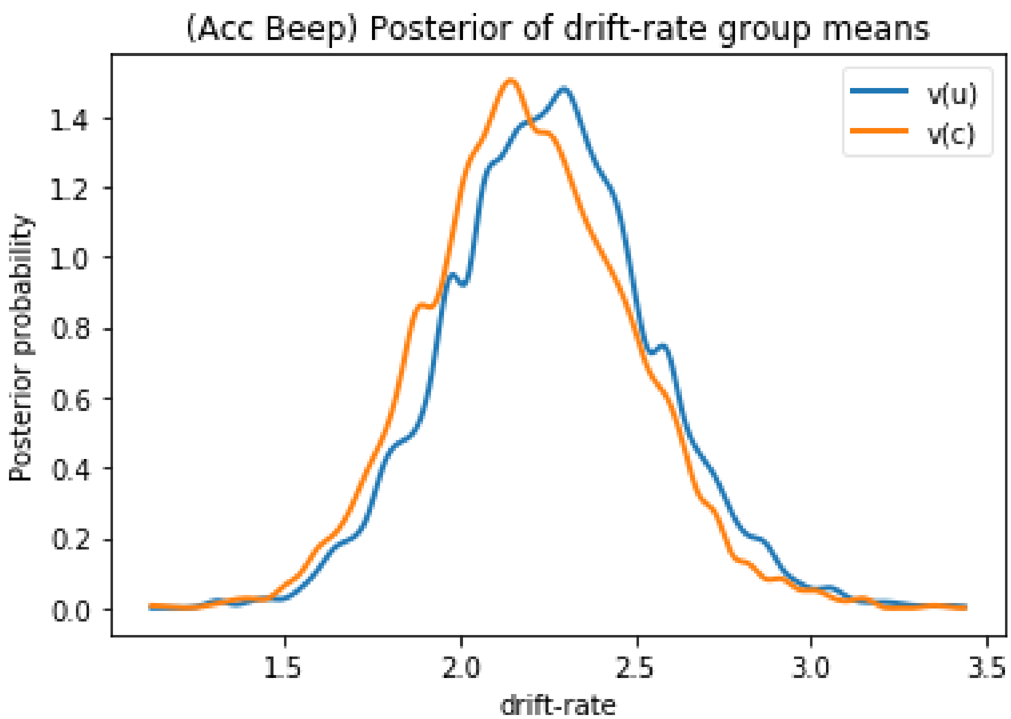
[138]:
```
<pymc.MCMC.MCMC at 0x1c44c508>
```

[238]:
```
#beep_acc.print_stats()
#unif_acc.plot_posteriors()
```

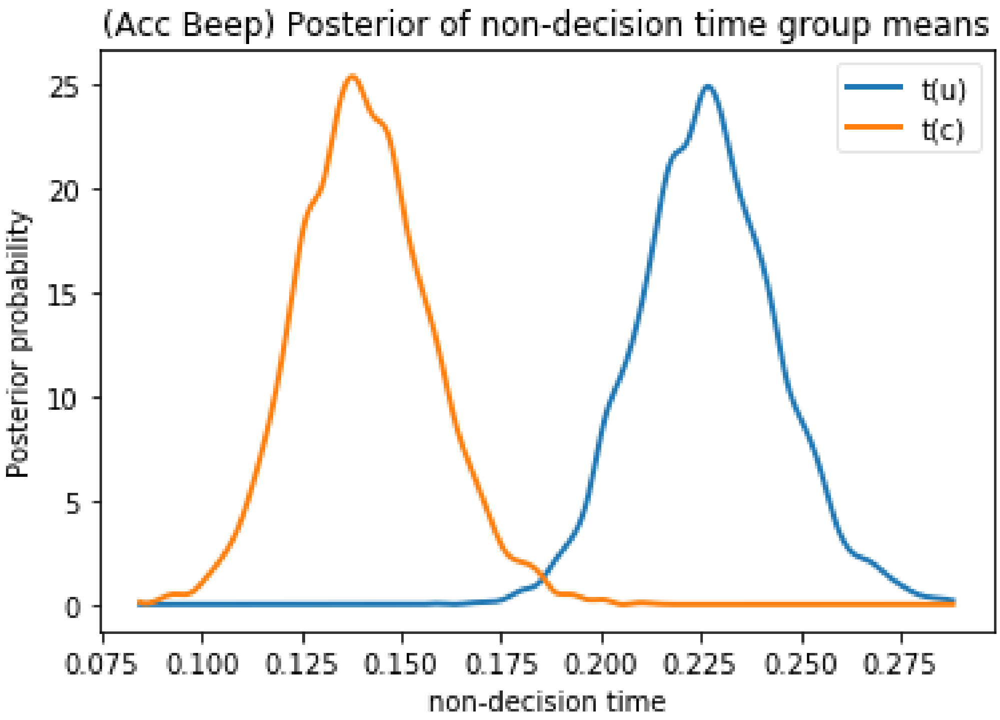
[140]:
```
a = beep_acc.nodes_db.node['a']
hddm.analyze.plot_posterior_nodes([a])
plt.xlabel('threshold')
plt.ylabel('Posterior probability')
plt.title('(Acc Beep) Posterior of threshold group mean')
plt.show()
```



[141]:
```
v_u, v_c = beep_acc.nodes_db.node[['v(u)', 'v(c)']]
hddm.analyze.plot_posterior_nodes([v_u, v_c])
plt.xlabel('drift-rate')
plt.ylabel('Posterior probability')
plt.title('(Acc Beep) Posterior of drift-rate group means')
plt.show()
```



[142]:
```
t_u, t_c = beep_acc.nodes_db.node[['t(u)', 't(c)']]
hddm.analyze.plot_posterior_nodes([t_u, t_c])
plt.xlabel('non-decision time')
plt.ylabel('Posterior probability')
plt.title('(Acc Beep) Posterior of non-decision time group means')
plt.show()
```



4.6 Stim-coded beep model (same threshold)

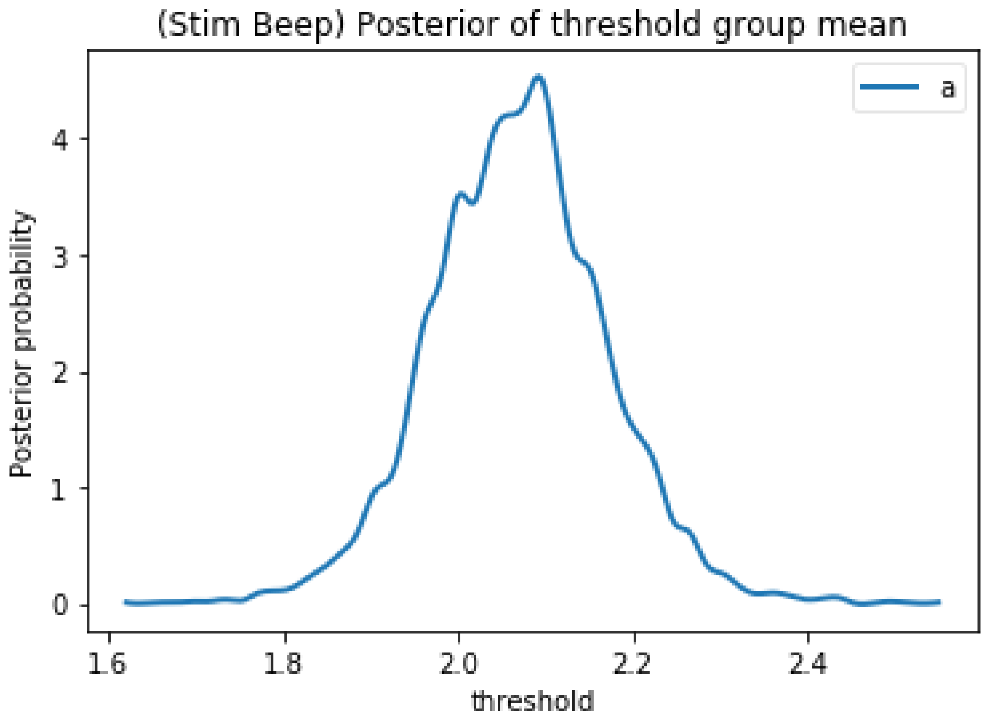
[92]:
```
beep_stim = hddm.HDDMStimCoding(stim_b, include='z', depends_on={'v': ['type'],␣
↪'t': ['type'], 'z': ['type']}, stim_col='stimCode')
beep_stim.sample(7000, burn=500)
```

```
Setting model to be non-informative
Adding z to includes.
 [-----------------100%-----------------] 7000 of 7000 complete in 932.9 sec
```

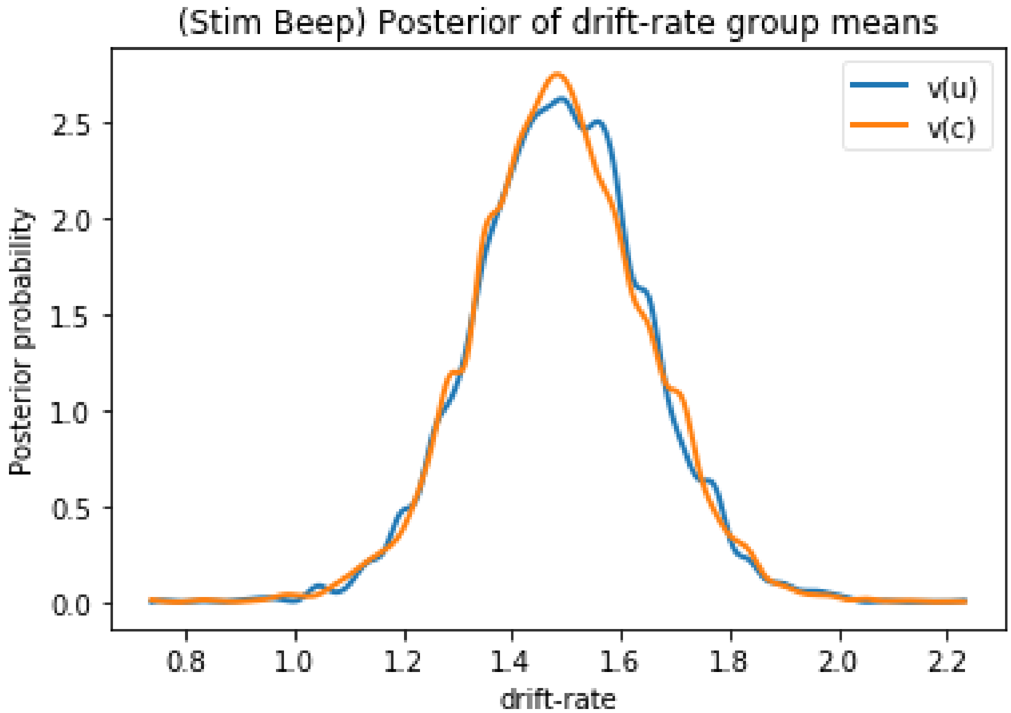
[92]: <pymc.MCMC.MCMC at 0x13b2e588>

[239]:
```
#beep_stim.print_stats()
```

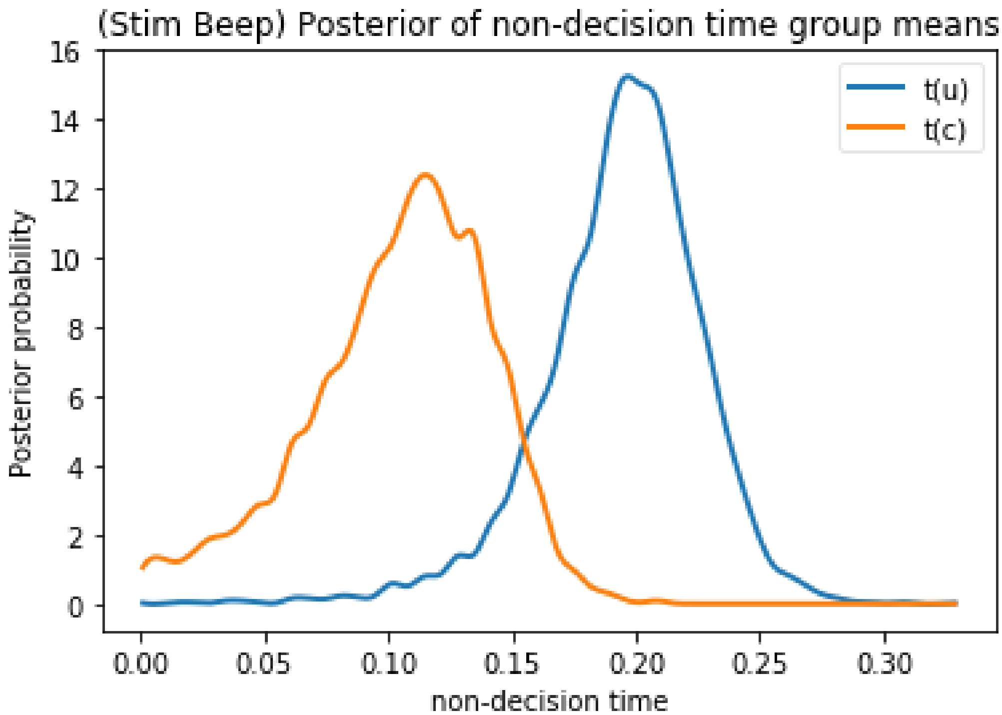
[104]:
```
a = beep_stim.nodes_db.node['a']
hddm.analyze.plot_posterior_nodes([a])
plt.xlabel('threshold')
plt.ylabel('Posterior probability')
plt.title('(Stim Beep) Posterior of threshold group mean')
plt.show()
```



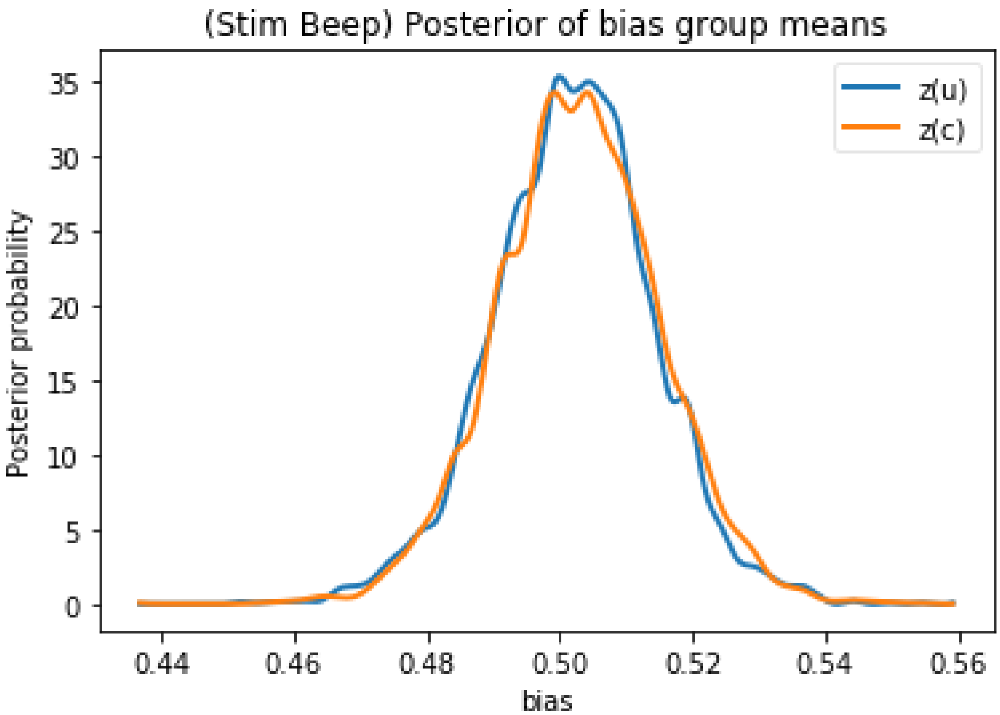
[105]:
```
v_u, v_c = beep_stim.nodes_db.node[['v(u)', 'v(c)']]
hddm.analyze.plot_posterior_nodes([v_u, v_c])
plt.xlabel('drift-rate')
plt.ylabel('Posterior probability')
plt.title('(Stim Beep) Posterior of drift-rate group means')
plt.show()
```



[106]:
```
t_u, t_c = beep_stim.nodes_db.node[['t(u)', 't(c)']]
hddm.analyze.plot_posterior_nodes([t_u, t_c])
plt.xlabel('non-decision time')
plt.ylabel('Posterior probability')
plt.title('(Stim Beep) Posterior of non-decision time group means')
plt.show()
```



[107]:
```
z_u, z_c = beep_stim.nodes_db.node[['z(u)', 'z(c)']]
hddm.analyze.plot_posterior_nodes([z_u, z_c])
plt.xlabel('bias')
plt.ylabel('Posterior probability')
plt.title('(Stim Beep) Posterior of bias group means')
plt.show()
```



4.7 Posterior Predictive Check (Beep)

4.7.1 Accuracy-coded beep

[94]:
```
bppc = hddm.utils.post_pred_gen(beep_acc)
```

```
[------------------110%------------------] 31 of 28 complete in 1335.7 sec
```

[97]:
```
bppc_compare = hddm.utils.post_pred_stats(model_b, bppc)
print(bppc_compare)
```

```
          observed      mean       std       SEM       MSE credible  \
stat
accuracy  0.778135  0.795291  0.123737  0.000294  0.015605     True
mean_ub   0.855433  0.821188  0.212542  0.001173  0.046347     True
std_ub    0.665953  0.420464  0.162188  0.060265  0.086570     True
10q_ub    0.389500  0.435782  0.094601  0.002142  0.011091     True
30q_ub    0.537021  0.555186  0.127195  0.000330  0.016509     True
50q_ub    0.665879  0.698644  0.172780  0.001074  0.030926     True
70q_ub    0.849032  0.912208  0.248106  0.003991  0.065548     True
90q_ub    1.449996  1.359244  0.414484  0.008236  0.180033     True
mean_lb  -1.085988 -0.822176  0.232183  0.069597  0.123506     True
std_lb    0.903215  0.389508  0.200447  0.263896  0.304074    False
10q_lb    0.444976  0.465194  0.112444  0.000409  0.013052     True
```

```
30q_lb    0.630831  0.576500  0.145448  0.002952  0.024107     True
50q_lb    0.812548  0.712482  0.196037  0.010013  0.048444     True
70q_lb    1.069355  0.909337  0.279303  0.025606  0.103616     True
90q_lb    1.941313  1.296496  0.475204  0.415790  0.641609     True

           quantile  mahalanobis
stat
accuracy  43.264286     0.138651
mean_ub   57.435715     0.161124
std_ub    92.264282     1.513615
10q_ub    34.871429     0.489237
30q_ub    46.342857     0.142809
50q_ub    44.178570     0.189636
70q_ub    42.564285     0.254631
90q_ub    59.964287     0.218952
mean_lb   13.328535     1.136223
std_lb    98.661392     2.562812
10q_lb    47.225620     0.179798
30q_lb    66.326019     0.373539
50q_lb    70.939186     0.510446
70q_lb    72.990288     0.572921
90q_lb    90.262688     1.356927
```

4.7.2 Stim-coded Beep

[108]:
```
bppc2 = hddm.utils.post_pred_gen(beep_stim)
```

```
[------------------105%------------------] 59 of 56 complete in 3179.1 sec
```

[109]:
```
bppc_compare2 = hddm.utils.post_pred_stats(stim_b, bppc2)
print(bppc_compare2)
```

```
          observed      mean       std       SEM       MSE credible  \
stat
accuracy  0.936003  0.932646  0.071991  0.000011  0.005194     True
mean_ub   0.811824  0.850116  0.267236  0.001466  0.072882     True
std_ub    0.705276  0.482211  0.240484  0.049758  0.107591     True
10q_ub    0.364230  0.400436  0.098640  0.001311  0.011041     True
30q_ub    0.491178  0.546768  0.144118  0.003090  0.023860     True
50q_ub    0.613278  0.715256  0.212955  0.010399  0.055749     True
70q_ub    0.787827  0.959066  0.323825  0.029323  0.134185     True
90q_ub    1.393924  1.459930  0.569839  0.004357  0.329074     True
mean_lb  -1.516434 -0.878211  0.420975  0.407328  0.584548     True
std_lb    1.449590  0.314117  0.352153  1.289299  1.413310    False
10q_lb    0.498767  0.597810  0.318249  0.009809  0.111092     True
30q_lb    0.745144  0.695967  0.338326  0.002418  0.116883     True
50q_lb    1.002491  0.809195  0.393327  0.037363  0.192070     True
70q_lb    1.601099  0.966624  0.500046  0.402558  0.652604     True
```

```
90q_lb    2.775234  1.217269  0.747572  2.427255  2.986119     True

           quantile  mahalanobis
stat
accuracy  36.125000     0.046624
mean_ub   49.400002     0.143288
std_ub    83.960716     0.927567
10q_ub    35.507141     0.367053
30q_ub    37.871429     0.385725
50q_ub    36.742859     0.478871
70q_ub    36.121429     0.528803
90q_ub    53.042858     0.115833
mean_lb    7.566568     1.516059
std_lb    98.847160     3.224373
10q_lb    45.713425     0.311211
30q_lb    67.393639     0.145353
50q_lb    76.009811     0.491439
70q_lb    89.577148     1.268832
90q_lb    95.672562     2.084033
```

4.8 Parameter Recovery (Beep)

4.8.1 Accuracy-coded beep

[203]:
```
bsyndata, bparam = hddm.generate.gen_rand_data(params={'u': {'a': 2.334434, 'v':
↪ 2.270080, 't': 0.225199},
                                                       'c': {'a': 2.334434, 'v':
↪ 2.208667, 't': 0.140507}},
                                               size = 100, subjs = 14)
```

[204]:
```
print(pd.DataFrame(data = bparam['u']).mean())
print(pd.DataFrame(data = bparam['c']).mean())
```

```
a    2.341762
t    0.234906
v    2.298922
dtype: float64
a    2.341762
t    0.150214
v    2.237509
dtype: float64
```

[205]:
```
bparamrec = hddm.HDDM(bsyndata, include=['a', 'v', 't', 'p_outlier'],␣
↪depends_on={'v': 'condition', 't': 'condition'})
bparamrec.sample(7000, burn=500)
```

```
[-----------------100%-----------------] 7000 of 7000 complete in 627.4 sec
```

[205]: <pymc.MCMC.MCMC at 0x1d977e08>

[240]:
```
#bparamrec.print_stats()
```

a: 6% diff

v(c): 5% diff

v(u): 4% diff

t(c): 4.2% diff

t(u): 2.2% diff

4.8.2 Stim-coded beep

[219]:
```
bsyndata2, bparam2 = hddm.generate.gen_rand_data(params={'u': {'a': 2.069617,␣
↪'v': 1.490287, 't': 0.193942, 'z': 0.502049},
                                                        'c': {'a': 2.069617,␣
↪'v': 1.488529, 't': 0.105678, 'z': 0.502745}},
                                              size = 100, subjs = 14)
```

[220]:
```
print(pd.DataFrame(data = bparam2['u']).mean())
print(pd.DataFrame(data = bparam2['c']).mean())
```

```
a    2.048299
t    0.179535
v    1.506936
z    0.502954
dtype: float64
a    2.048299
t    0.091271
v    1.505178
z    0.503650
dtype: float64
```

[221]:
```
bparamrec2 = hddm.HDDM(bsyndata2, include='z', depends_on={'v': 'condition',␣
↪'t': 'condition', 'z': 'condition'})
bparamrec2.sample(7000, burn=500)
```

```
[-----------------100%-----------------] 7000 of 7000 complete in 554.8 sec
```

[221]: <pymc.MCMC.MCMC at 0x1cca35c8>

[241]:
```
#bparamrec2.print_stats()
```

a: 2.9% diff

v(c): 1.3% diff

v(u): 3.1% diff

t(c): 2.6% diff

t(u): 4.6% diff

z(c): 0.1% diff

z(u): 3.4% diff

5 Old models

5.1 Vary by unisensory/congruent and 2/3 flashes

[79]:
```
flash_acc2 = hddm.HDDM(model_f, include=['a', 'v', 't', 'p_outlier'],␣
↪depends_on={'v': ['type', 'stimName'], 't': ['type', 'stimName']})
flash_acc2.sample(7000, burn=500)
```

```
[-----------------100%-----------------] 7000 of 7000 complete in 637.8 sec
```

[79]:
```
<pymc.MCMC.MCMC at 0xf292508>
```

[80]:
```
flash_acc2.print_stats()
```

```
                     mean       std      2.5q       25q       50q       75q
97.5q    mc err
a                    1.703131  0.094190  1.530280  1.639464  1.697672  1.761284
1.901385  0.001469
a_std                0.332672  0.083625  0.210828  0.274489  0.318305  0.375153
0.528948  0.001774
a_subj.1.0           2.126073  0.111639  1.921076  2.047733  2.119805  2.197454
2.366489  0.002548
a_subj.2.0           1.929853  0.083002  1.773527  1.872145  1.926948  1.984221
2.102571  0.001499
a_subj.3.0           1.370059  0.080798  1.217519  1.313481  1.367761  1.423700
1.535422  0.002702
a_subj.4.0           1.762512  0.076686  1.618694  1.710062  1.759930  1.812207
1.921942  0.001561
a_subj.5.0           2.014737  0.100214  1.826708  1.946206  2.011284  2.079095
2.220786  0.002287
a_subj.6.0           1.897676  0.090718  1.726116  1.833759  1.895433  1.957566
2.081776  0.002217
a_subj.7.0           1.797476  0.076027  1.651538  1.745684  1.796250  1.846571
1.949046  0.001456
a_subj.8.0           1.767115  0.087504  1.607313  1.707641  1.762420  1.822363
1.951339  0.002069
a_subj.9.0           1.669924  0.083466  1.517118  1.613791  1.665925  1.722909
1.847919  0.001895
a_subj.10.0          1.457410  0.061149  1.339764  1.415938  1.456000  1.497789
1.582080  0.001066
a_subj.11.0          1.479797  0.069802  1.347976  1.431515  1.476716  1.526695
```

```
1.620347  0.001739
a_subj.12.0          1.885744  0.084993  1.722940  1.825896  1.883773  1.942518
2.056429  0.001884
a_subj.13.0          1.195035  0.057542  1.087805  1.155540  1.193101  1.231286
1.315027  0.001449
a_subj.14.0          1.353144  0.057489  1.245363  1.313928  1.351000  1.391348
1.467483  0.001237
v(F2.u)              1.494937  0.222454  1.062617  1.346450  1.492322  1.643884
1.934029  0.003159
v(F2B2.c)            1.688371  0.224197  1.253256  1.539682  1.691136  1.841905
2.115356  0.003095
v(F3.u)              0.045267  0.218616 -0.377797 -0.098900  0.046728  0.190628
0.473211  0.003131
v(F3B3.c)            1.381033  0.219836  0.952557  1.233932  1.379925  1.529210
1.815185  0.003384
v_std                0.785695  0.091018  0.631182  0.720355  0.778062  0.841808
0.985722  0.001652
v_subj(F2.u).1.0     1.791088  0.245952  1.323929  1.622795  1.787030  1.953186
2.284822  0.003876
v_subj(F2.u).2.0     1.415907  0.324740  0.886194  1.190557  1.382394  1.600796
2.165621  0.006107
v_subj(F2.u).3.0     2.454285  0.382551  1.779885  2.180782  2.431272  2.696799
3.285285  0.012826
v_subj(F2.u).4.0     1.680079  0.257754  1.202198  1.506614  1.671116  1.846410
2.226233  0.004111
v_subj(F2.u).5.0     1.679786  0.270738  1.172990  1.491413  1.667890  1.858646
2.228154  0.004343
v_subj(F2.u).6.0     1.900964  0.274231  1.365483  1.717105  1.895940  2.084607
2.457578  0.004021
v_subj(F2.u).7.0     0.374583  0.176664  0.028313  0.253202  0.373266  0.490902
0.725659  0.002248
v_subj(F2.u).8.0     1.910819  0.242978  1.449043  1.744699  1.902148  2.068233
2.398528  0.003894
v_subj(F2.u).9.0     0.962165  0.209249  0.558814  0.821088  0.957700  1.101137
1.389291  0.003002
v_subj(F2.u).10.0    1.020761  0.236070  0.565951  0.861565  1.015817  1.173871
1.506485  0.002793
v_subj(F2.u).11.0    0.987405  0.224661  0.556725  0.836058  0.984521  1.136052
1.439612  0.003114
v_subj(F2.u).12.0    1.624489  0.245835  1.164161  1.456344  1.616962  1.782584
2.128738  0.004120
v_subj(F2.u).13.0    1.034362  0.259785  0.532462  0.856947  1.032518  1.207058
1.547801  0.003273
v_subj(F2.u).14.0    2.089395  0.288869  1.547844  1.892228  2.075910  2.280109
2.688023  0.003460
v_subj(F2B2.c).1.0   1.775213  0.220152  1.355856  1.623176  1.773779  1.923284
2.216342  0.003399
v_subj(F2B2.c).2.0   1.042014  0.176387  0.702100  0.922350  1.039170  1.159746
```

```
1.395972  0.002435
v_subj(F2B2.c).3.0   2.408063  0.317338  1.805596  2.190204  2.403986  2.617487
3.035470  0.006062
v_subj(F2B2.c).4.0   1.476786  0.271546  0.980598  1.291539  1.459855  1.648788
2.047625  0.004339
v_subj(F2B2.c).5.0   0.390170  0.166736  0.072057  0.274605  0.387164  0.501703
0.720491  0.002399
v_subj(F2B2.c).6.0   2.186184  0.259288  1.690618  2.005355  2.178081  2.363893
2.700845  0.003809
v_subj(F2B2.c).7.0   2.372313  0.281823  1.838738  2.178951  2.366496  2.560045
2.949571  0.004506
v_subj(F2B2.c).8.0   2.092975  0.289976  1.535654  1.896840  2.087619  2.287865
2.671945  0.004747
v_subj(F2B2.c).9.0   2.021724  0.274009  1.493622  1.830625  2.021145  2.205974
2.575110  0.004783
v_subj(F2B2.c).10.0  1.947925  0.261527  1.442880  1.767317  1.950288  2.124570
2.455489  0.003909
v_subj(F2B2.c).11.0  0.603682  0.239748  0.148025  0.439399  0.598292  0.760236
1.087123  0.003289
v_subj(F2B2.c).12.0  1.067804  0.186807  0.721934  0.938170  1.062266  1.196041
1.439117  0.002637
v_subj(F2B2.c).13.0  3.272848  0.402126  2.487043  3.000300  3.271409  3.542469
4.065071  0.007634
v_subj(F2B2.c).14.0  0.973261  0.257180  0.486741  0.797817  0.969059  1.143457
1.498589  0.003134
v_subj(F3.u).1.0    -0.102106  0.149802 -0.401986 -0.200861 -0.099766  0.000542
0.189186  0.001980
v_subj(F3.u).2.0    -0.003176  0.174626 -0.348734 -0.121748 -0.000141  0.112803
0.333824  0.002201
v_subj(F3.u).3.0     0.097053  0.229522 -0.359107 -0.054140  0.096423  0.249324
0.546411  0.002751
v_subj(F3.u).4.0    -1.114127  0.205494 -1.517831 -1.251091 -1.114956 -0.974541
-0.716366  0.002760
v_subj(F3.u).5.0    -0.999000  0.230377 -1.484223 -1.147113 -0.987997 -0.837809
-0.579240  0.003141
v_subj(F3.u).6.0    -0.176220  0.157453 -0.487297 -0.281698 -0.173802 -0.070900
0.132041  0.002151
v_subj(F3.u).7.0     0.555704  0.181409  0.201394  0.432270  0.556236  0.677763
0.917622  0.002392
v_subj(F3.u).8.0    -0.278334  0.179904 -0.632178 -0.400840 -0.274541 -0.157453
0.067143  0.002049
v_subj(F3.u).9.0     0.810895  0.197845  0.419092  0.677078  0.812857  0.944731
1.193710  0.002410
v_subj(F3.u).10.0   -0.107170  0.218972 -0.540682 -0.253848 -0.107777  0.042504
0.325927  0.002785
v_subj(F3.u).11.0    0.489869  0.219306  0.071026  0.339730  0.483356  0.634568
0.932026  0.003036
v_subj(F3.u).12.0   -0.064180  0.168061 -0.392793 -0.181238 -0.063934  0.050259
```

```
0.261992  0.002181
v_subj(F3.u).13.0    0.694383  0.259479  0.191190  0.516443  0.690310  0.869516
1.205787  0.003301
v_subj(F3.u).14.0    0.667461  0.230912  0.222327  0.508916  0.666780  0.826373
1.124936  0.002879
v_subj(F3B3.c).1.0   0.733384  0.163135  0.422423  0.624922  0.729170  0.839174
1.066779  0.002292
v_subj(F3B3.c).2.0   0.940209  0.175544  0.607668  0.817119  0.937060  1.057751
1.290277  0.002247
v_subj(F3B3.c).3.0   3.488109  0.374220  2.777142  3.235404  3.489140  3.738365
4.243236  0.006441
v_subj(F3B3.c).4.0  -0.208418  0.174685 -0.545825 -0.328337 -0.209467 -0.088100
0.129925  0.002226
v_subj(F3B3.c).5.0   1.142618  0.192507  0.785217  1.011090  1.139473  1.267443
1.541374  0.002444
v_subj(F3B3.c).6.0   0.497713  0.176277  0.161342  0.377653  0.494366  0.615700
0.853244  0.002311
v_subj(F3B3.c).7.0   1.028845  0.219839  0.617169  0.878333  1.020836  1.173558
1.474706  0.002548
v_subj(F3B3.c).8.0   1.916087  0.252424  1.435825  1.743374  1.911536  2.083141
2.428047  0.004043
v_subj(F3B3.c).9.0   2.081718  0.263563  1.558854  1.906400  2.082221  2.258613
2.605832  0.004239
v_subj(F3B3.c).10.0  1.207946  0.225696  0.766918  1.053596  1.204900  1.361751
1.658085  0.003068
v_subj(F3B3.c).11.0  2.103807  0.300426  1.511541  1.896916  2.103589  2.306273
2.696354  0.004950
v_subj(F3B3.c).12.0  1.428175  0.266866  0.932238  1.246358  1.412090  1.599932
1.982448  0.004163
v_subj(F3B3.c).13.0  2.107665  0.328011  1.460808  1.887254  2.111360  2.330525
2.733649  0.004438
v_subj(F3B3.c).14.0  0.793566  0.222829  0.353348  0.644043  0.792555  0.941598
1.229701  0.002922
t(F2.u)              0.337972  0.023156  0.292001  0.322684  0.338017  0.353109
0.384080  0.000383
t(F2B2.c)            0.272447  0.023341  0.226461  0.256909  0.272440  0.287828
0.317893  0.000396
t(F3.u)              0.245006  0.022780  0.200019  0.230315  0.245038  0.259838
0.290513  0.000359
t(F3B3.c)            0.253459  0.022489  0.209107  0.239077  0.253411  0.268436
0.296808  0.000359
t_std                0.085402  0.010664  0.067358  0.077870  0.084365  0.092047
0.109070  0.000231
t_subj(F2.u).1.0     0.354593  0.026394  0.295593  0.338205  0.356928  0.373023
0.400361  0.000453
t_subj(F2.u).2.0     0.333169  0.035134  0.263819  0.308325  0.333434  0.359768
0.395085  0.000648
t_subj(F2.u).3.0     0.322796  0.034637  0.274609  0.294383  0.306398  0.356609
```

```
0.389416  0.001819
t_subj(F2.u).4.0     0.333084  0.021043  0.286823  0.320006  0.334836  0.347885
0.369259  0.000342
t_subj(F2.u).5.0     0.352623  0.027705  0.292216  0.335131  0.354854  0.371957
0.400242  0.000488
t_subj(F2.u).6.0     0.314943  0.020690  0.269852  0.301838  0.316558  0.329677
0.350327  0.000379
t_subj(F2.u).7.0     0.282725  0.060164  0.194380  0.236918  0.261430  0.342270
0.392908  0.001843
t_subj(F2.u).8.0     0.311808  0.023756  0.267889  0.297180  0.310160  0.323531
0.362682  0.000418
t_subj(F2.u).9.0     0.290823  0.023628  0.242898  0.276565  0.291812  0.305331
0.338776  0.000415
t_subj(F2.u).10.0    0.225067  0.016561  0.188233  0.215159  0.226606  0.236436
0.253610  0.000229
t_subj(F2.u).11.0    0.286910  0.017338  0.247544  0.276953  0.288959  0.299132
0.315317  0.000331
t_subj(F2.u).12.0    0.386861  0.026867  0.326645  0.370548  0.388870  0.405717
0.433085  0.000459
t_subj(F2.u).13.0    0.359984  0.020034  0.322154  0.344861  0.358256  0.377147
0.392878  0.000390
t_subj(F2.u).14.0    0.446764  0.012796  0.418218  0.439079  0.448155  0.455751
0.467882  0.000207
t_subj(F2B2.c).1.0   0.345535  0.029568  0.279025  0.327800  0.348059  0.366747
0.395114  0.000577
t_subj(F2B2.c).2.0   0.250383  0.028040  0.190338  0.232767  0.252914  0.269921
0.297956  0.000421
t_subj(F2B2.c).3.0   0.229925  0.015381  0.203253  0.221633  0.229198  0.236364
0.278680  0.000497
t_subj(F2B2.c).4.0   0.166115  0.029794  0.121971  0.150238  0.162745  0.174569
0.261842  0.000706
t_subj(F2B2.c).5.0   0.290574  0.037809  0.207985  0.266136  0.293741  0.317948
0.353847  0.000654
t_subj(F2B2.c).6.0   0.254640  0.020872  0.209831  0.241612  0.256510  0.269310
0.290359  0.000395
t_subj(F2B2.c).7.0   0.318824  0.022972  0.275612  0.304976  0.317690  0.330752
0.370329  0.000396
t_subj(F2B2.c).8.0   0.207649  0.019512  0.164606  0.195650  0.208884  0.221064
0.241878  0.000330
t_subj(F2B2.c).9.0   0.187439  0.036872  0.098435  0.169266  0.199213  0.213540
0.233262  0.000871
t_subj(F2B2.c).10.0  0.210908  0.015112  0.178105  0.201704  0.211815  0.221398
0.237171  0.000214
t_subj(F2B2.c).11.0  0.259773  0.041019  0.142184  0.241325  0.260629  0.290725
0.321841  0.000895
t_subj(F2B2.c).12.0  0.243574  0.026248  0.186634  0.227469  0.245691  0.261625
0.288722  0.000417
t_subj(F2B2.c).13.0  0.312735  0.014731  0.265545  0.308875  0.315571  0.321338
```

```
0.330198  0.000457
t_subj(F2B2.c).14.0  0.534848  0.018623  0.492796  0.523465  0.536817  0.548252
0.564953  0.000325
t_subj(F3.u).1.0     0.395820  0.056830  0.270938  0.361192  0.402036  0.436473
0.488929  0.001073
t_subj(F3.u).2.0     0.175648  0.029408  0.112338  0.157052  0.177870  0.196351
0.228120  0.000413
t_subj(F3.u).3.0     0.168805  0.017903  0.128206  0.157911  0.170511  0.181664
0.198473  0.000410
t_subj(F3.u).4.0     0.140622  0.019264  0.098876  0.128654  0.142247  0.153997
0.173702  0.000337
t_subj(F3.u).5.0     0.287115  0.038175  0.204106  0.262323  0.291267  0.314918
0.351427  0.000743
t_subj(F3.u).6.0     0.324130  0.037135  0.241903  0.302107  0.328030  0.350195
0.385898  0.000624
t_subj(F3.u).7.0     0.194163  0.026710  0.140042  0.178117  0.194938  0.210150
0.247018  0.000350
t_subj(F3.u).8.0     0.205211  0.026658  0.148366  0.188928  0.207004  0.223379
0.251855  0.000462
t_subj(F3.u).9.0     0.158850  0.046563  0.084591  0.124160  0.151768  0.188082
0.260712  0.000932
t_subj(F3.u).10.0    0.154043  0.018575  0.115319  0.142683  0.154886  0.165426
0.186666  0.000294
t_subj(F3.u).11.0    0.279316  0.035260  0.204555  0.254069  0.287862  0.304566
0.335372  0.000710
t_subj(F3.u).12.0    0.301790  0.037054  0.218477  0.279118  0.305666  0.328597
0.363699  0.000664
t_subj(F3.u).13.0    0.305956  0.014655  0.272199  0.297073  0.307559  0.316463
0.330266  0.000269
t_subj(F3.u).14.0    0.372483  0.019004  0.328671  0.361007  0.374158  0.386198
0.403816  0.000361
t_subj(F3B3.c).1.0   0.405023  0.046459  0.300974  0.377574  0.409828  0.438276
0.482267  0.000815
t_subj(F3B3.c).2.0   0.278803  0.033141  0.205689  0.258793  0.281069  0.302267
0.335837  0.000523
t_subj(F3B3.c).3.0   0.196234  0.010368  0.173686  0.189913  0.197051  0.203524
0.214262  0.000231
t_subj(F3B3.c).4.0   0.215115  0.027924  0.155072  0.197390  0.217436  0.234521
0.263700  0.000415
t_subj(F3B3.c).5.0   0.273685  0.031039  0.205041  0.254553  0.276476  0.295515
0.326891  0.000534
t_subj(F3B3.c).6.0   0.381820  0.039073  0.294870  0.357734  0.386212  0.410434
0.445758  0.000719
t_subj(F3B3.c).7.0   0.145395  0.026904  0.098405  0.128478  0.143329  0.158523
0.206943  0.000437
t_subj(F3B3.c).8.0   0.236793  0.019564  0.194699  0.224807  0.238467  0.250056
0.271261  0.000316
t_subj(F3B3.c).9.0   0.198561  0.018659  0.157710  0.186804  0.200467  0.211697
```

```
0.230876  0.000352
t_subj(F3B3.c).10.0  0.186079  0.015953  0.151188  0.176424  0.187547  0.197486
0.212982  0.000258
t_subj(F3B3.c).11.0  0.234266  0.028027  0.166474  0.222631  0.242417  0.254108
0.270158  0.000754
t_subj(F3B3.c).12.0  0.155514  0.022147  0.107430  0.142154  0.157099  0.170180
0.195185  0.000335
t_subj(F3B3.c).13.0  0.227365  0.015884  0.181238  0.222142  0.230555  0.236958
0.248665  0.000392
t_subj(F3B3.c).14.0  0.414098  0.017182  0.375782  0.403619  0.415834  0.426321
0.442461  0.000281
p_outlier            0.061777  0.006721  0.049003  0.057137  0.061611  0.066211
0.075648  0.000121
DIC: 4127.815383
deviance: 4024.368381
pD: 103.447001
```

[90]:
```python
fppc2 = hddm.utils.post_pred_gen(flash_acc2)
```

```
 [------------------105%------------------] 59 of 56 complete in 2396.0 sec
```

[93]:
```python
fppc_compare2 = hddm.utils.post_pred_stats(model_f, fppc2)
print(fppc_compare2)
```

```
          observed      mean       std           SEM       MSE credible  \
stat
accuracy  0.778135  0.785527  0.226781  5.464787e-05  0.051484     True
mean_ub   0.855433  0.824403  0.255163  9.629046e-04  0.066071     True
std_ub    0.665953  0.400850  0.206955  7.027969e-02  0.113110     True
10q_ub    0.389500  0.454602  0.121276  4.238339e-03  0.018946     True
30q_ub    0.537021  0.571205  0.157151  1.168506e-03  0.025865     True
50q_ub    0.665879  0.709956  0.212699  1.942770e-03  0.047184     True
70q_ub    0.849032  0.913406  0.304318  4.144056e-03  0.096754     True
90q_ub    1.449996  1.326561  0.502026  1.523606e-02  0.267267     True
mean_lb  -1.085988 -0.842109  0.300749  5.947689e-02  0.149927     True
std_lb    0.903215  0.342147  0.269634  3.147972e-01  0.387500     True
10q_lb    0.444976  0.530092  0.199483  7.244650e-03  0.047038     True
30q_lb    0.630831  0.630779  0.218292  2.665745e-09  0.047652     True
50q_lb    0.812548  0.751508  0.265273  3.725880e-03  0.074095     True
70q_lb    1.069355  0.924992  0.359859  2.084076e-02  0.150339     True
90q_lb    1.941313  1.245801  0.595332  4.837368e-01  0.838157     True

           quantile  mahalanobis
stat
accuracy  34.903572     0.032597
mean_ub   60.636475     0.121611
std_ub    88.942070     1.280973
10q_ub    34.077435     0.536812
```

```
30q_ub     45.674690      0.217520
50q_ub     47.117653      0.207226
70q_ub     47.931995      0.211536
90q_ub     67.558395      0.245872
mean_lb    19.544052      0.810904
std_lb     96.323120      2.080852
10q_lb     36.938969      0.426680
30q_lb     57.389378      0.000237
50q_lb     65.716774      0.230103
70q_lb     70.596848      0.401166
90q_lb     86.780655      1.168275
```

[25]:
```
beep_acc2 = hddm.HDDM(model_b, include=['a', 'v', 't', 'p_outlier'],␣
↪depends_on={'v': ['type', 'stimName'], 't': ['type', 'stimName']})
beep_acc2.sample(7000, burn=500)
```

```
[-----------------100%-----------------] 7001 of 7000 complete in 683.9 sec
```

[25]: <pymc.MCMC.MCMC at 0xeafab08>

[26]:
```
beep_acc2.print_stats()
```

```
                         mean       std      2.5q       25q       50q       75q
97.5q    mc err
a                    2.200595  0.112022  1.995613  2.124570  2.194940  2.269042
2.445599  0.004953
a_std                0.319009  0.093885  0.173661  0.254210  0.305648  0.369765
0.544017  0.003129
a_subj.1.0           2.768557  0.188990  2.422729  2.636831  2.759288  2.891783
3.157849  0.007411
a_subj.2.0           2.054795  0.105359  1.864433  1.980444  2.051144  2.123073
2.274486  0.003036
a_subj.3.0           1.912661  0.176501  1.618852  1.787960  1.893891  2.017807
2.307200  0.008070
a_subj.4.0           2.050665  0.085349  1.888219  1.992570  2.048839  2.105857
2.227876  0.002016
a_subj.5.0           2.351929  0.096149  2.170049  2.285556  2.349899  2.415424
2.549821  0.002015
a_subj.6.0           2.492803  0.221884  2.088632  2.338092  2.478854  2.635888
2.949100  0.011300
a_subj.7.0           2.344883  0.151087  2.073811  2.240539  2.336642  2.440902
2.666535  0.005262
a_subj.8.0           2.361951  0.188030  2.024547  2.232530  2.348641  2.480665
2.764160  0.007983
a_subj.9.0           1.826101  0.126608  1.596566  1.737772  1.818479  1.905132
2.099215  0.004794
a_subj.10.0          2.125233  0.135788  1.874520  2.032122  2.120963  2.212756
2.402341  0.004736
```

```
a_subj.11.0          2.084367  0.196256  1.775346  1.944216  2.061759  2.198148
2.543063  0.009105
a_subj.12.0          2.203708  0.146494  1.936297  2.104657  2.197142  2.294501
2.517608  0.005220
a_subj.13.0          2.062655  0.260609  1.658989  1.878995  2.022884  2.206967
2.697036  0.016488
a_subj.14.0          2.158433  0.247053  1.704638  1.983378  2.151203  2.322653
2.666018  0.014973
v(B2.u)              2.379831  0.262642  1.867569  2.205030  2.379488  2.549808
2.905734  0.005582
v(B3.u)              1.983993  0.265149  1.475744  1.808094  1.981813  2.159414
2.520455  0.005987
v(F2B2.c)            2.124873  0.266930  1.609824  1.949547  2.120941  2.299291
2.656506  0.005970
v(F3B3.c)            2.154142  0.261513  1.650046  1.978858  2.153054  2.324745
2.668915  0.005262
v_std                0.914271  0.112800  0.719630  0.835719  0.907812  0.982180
1.162654  0.004064
v_subj(B2.u).1.0     2.030476  0.234213  1.575268  1.872434  2.028293  2.184038
2.493684  0.004919
v_subj(B2.u).2.0     1.782162  0.243705  1.320327  1.615510  1.779313  1.947215
2.266959  0.003874
v_subj(B2.u).3.0     2.739577  0.323776  2.133150  2.524351  2.728305  2.952729
3.401709  0.008785
v_subj(B2.u).4.0     1.515039  0.278804  1.039738  1.319098  1.493951  1.689245
2.126656  0.004600
v_subj(B2.u).5.0     1.123937  0.175715  0.798337  1.000278  1.117748  1.240019
1.484486  0.002232
v_subj(B2.u).6.0     2.490738  0.283802  1.911980  2.297704  2.493926  2.676725
3.050657  0.009409
v_subj(B2.u).7.0     2.582624  0.328989  2.003159  2.345692  2.553991  2.788984
3.280092  0.006746
v_subj(B2.u).8.0     2.751531  0.312529  2.134146  2.536596  2.749744  2.960462
3.376736  0.008131
v_subj(B2.u).9.0     2.546271  0.285357  1.997164  2.355817  2.540418  2.727015
3.128564  0.005373
v_subj(B2.u).10.0    1.714519  0.257181  1.237858  1.530738  1.703594  1.884156
2.240610  0.004479
v_subj(B2.u).11.0    2.115087  0.262243  1.625271  1.936601  2.106841  2.283942
2.663003  0.007203
v_subj(B2.u).12.0    2.616752  0.344714  1.969972  2.375995  2.613833  2.846855
3.312322  0.006469
v_subj(B2.u).13.0    3.461610  0.448797  2.646100  3.149792  3.442959  3.747112
4.403520  0.019602
v_subj(B2.u).14.0    3.975823  0.517707  2.981629  3.619858  3.970942  4.325807
5.010059  0.019886
v_subj(B3.u).1.0     2.175007  0.227116  1.749529  2.018820  2.172960  2.325700
2.624856  0.004887
```

```
v_subj(B3.u).2.0      1.307756  0.221065  0.899649  1.155614  1.299871  1.448400
1.769415  0.003074
v_subj(B3.u).3.0      2.672389  0.371976  1.976774  2.413916  2.659249  2.919241
3.431117  0.011993
v_subj(B3.u).4.0      0.004844  0.153343 -0.302394 -0.096066  0.006781  0.105961
0.299703  0.001917
v_subj(B3.u).5.0      0.647708  0.156656  0.352908  0.539233  0.643596  0.750611
0.971039  0.001989
v_subj(B3.u).6.0      2.162595  0.249926  1.692799  1.991454  2.153366  2.332797
2.664480  0.007252
v_subj(B3.u).7.0      1.622514  0.228181  1.174192  1.465885  1.621754  1.778979
2.064666  0.004623
v_subj(B3.u).8.0      2.551517  0.308387  1.943304  2.336643  2.553891  2.764076
3.155147  0.008526
v_subj(B3.u).9.0      2.121450  0.352740  1.481466  1.873110  2.107375  2.347627
2.862450  0.007783
v_subj(B3.u).10.0     2.852584  0.320739  2.221704  2.638755  2.851885  3.063423
3.495368  0.006482
v_subj(B3.u).11.0     2.083596  0.314091  1.515466  1.871403  2.064364  2.284022
2.755957  0.010377
v_subj(B3.u).12.0     1.537845  0.264214  1.058812  1.358699  1.526806  1.705929
2.093498  0.004320
v_subj(B3.u).13.0     2.428884  0.520775  1.519740  2.050633  2.379678  2.767893
3.530657  0.026918
v_subj(B3.u).14.0     3.581351  0.376775  2.854499  3.325904  3.578302  3.832204
4.327337  0.014494
v_subj(F2B2.c).1.0    1.850736  0.292143  1.357018  1.649610  1.815564  2.020903
2.515170  0.006406
v_subj(F2B2.c).2.0    1.434073  0.204795  1.047231  1.297815  1.430166  1.567013
1.848651  0.002827
v_subj(F2B2.c).3.0    2.232878  0.373735  1.533997  1.972769  2.222524  2.478999
3.002347  0.011237
v_subj(F2B2.c).4.0    1.508430  0.197730  1.130609  1.367781  1.504746  1.640711
1.908174  0.002935
v_subj(F2B2.c).5.0    0.289978  0.140911  0.016754  0.196594  0.290390  0.386292
0.567108  0.001816
v_subj(F2B2.c).6.0    2.833519  0.298016  2.254429  2.632028  2.828526  3.029051
3.432901  0.008677
v_subj(F2B2.c).7.0    2.486274  0.273517  1.965223  2.300254  2.482570  2.664892
3.031858  0.005368
v_subj(F2B2.c).8.0    2.268053  0.246393  1.793588  2.101638  2.266513  2.432229
2.755228  0.006226
v_subj(F2B2.c).9.0    2.571722  0.318785  1.973505  2.349257  2.560357  2.776827
3.236307  0.006966
v_subj(F2B2.c).10.0   2.060674  0.312755  1.461770  1.847112  2.057614  2.270816
2.674804  0.005827
v_subj(F2B2.c).11.0   2.270295  0.407643  1.532494  1.981924  2.258010  2.544806
3.103610  0.012695
```

```
v_subj(F2B2.c).12.0  1.687802  0.231273  1.244772  1.530916  1.682665  1.838431
2.147291  0.003608
v_subj(F2B2.c).13.0  3.044084  0.393601  2.339949  2.771016  3.024547  3.292927
3.895022  0.015656
v_subj(F2B2.c).14.0  3.167143  0.389423  2.425724  2.900643  3.156455  3.429920
3.938027  0.014527
v_subj(F3B3.c).1.0   1.374408  0.189440  1.019564  1.245776  1.369444  1.495906
1.760639  0.003881
v_subj(F3B3.c).2.0   1.255954  0.217379  0.848433  1.106283  1.248314  1.400611
1.697147  0.003223
v_subj(F3B3.c).3.0   3.075878  0.355947  2.372965  2.843158  3.076543  3.311743
3.776089  0.009554
v_subj(F3B3.c).4.0   0.281494  0.165569 -0.041643  0.170556  0.280086  0.392157
0.610694  0.001970
v_subj(F3B3.c).5.0   1.245627  0.223756  0.850231  1.089972  1.234164  1.386179
1.725681  0.003079
v_subj(F3B3.c).6.0   2.442472  0.279994  1.902146  2.254623  2.435455  2.622269
3.012875  0.006868
v_subj(F3B3.c).7.0   2.255794  0.258008  1.759209  2.083691  2.251155  2.424197
2.764482  0.005173
v_subj(F3B3.c).8.0   2.527722  0.300666  1.970213  2.319475  2.518900  2.721866
3.138426  0.007882
v_subj(F3B3.c).9.0   2.175403  0.252776  1.685883  2.004118  2.172284  2.340761
2.681647  0.005425
v_subj(F3B3.c).10.0  2.493809  0.277481  1.980531  2.298914  2.485918  2.685604
3.052989  0.004948
v_subj(F3B3.c).11.0  2.976187  0.317585  2.385231  2.752057  2.967663  3.183039
3.620926  0.008202
v_subj(F3B3.c).12.0  1.292383  0.183688  0.950033  1.163967  1.288016  1.414718
1.676597  0.002942
v_subj(F3B3.c).13.0  3.613947  0.427880  2.808010  3.316127  3.605727  3.897426
4.476694  0.017604
v_subj(F3B3.c).14.0  3.200944  0.361630  2.496531  2.957404  3.196316  3.443434
3.916078  0.014693
t(B2.u)              0.237894  0.017045  0.205165  0.226399  0.237806  0.249034
0.271823  0.000541
t(B3.u)              0.240558  0.017674  0.205994  0.228669  0.240393  0.252500
0.275718  0.000534
t(F2B2.c)            0.159293  0.017112  0.126409  0.147717  0.158761  0.170710
0.194324  0.000576
t(F3B3.c)            0.149293  0.017181  0.115323  0.137636  0.149508  0.160934
0.182576  0.000579
t_std                0.054784  0.009273  0.038367  0.048344  0.054041  0.060674
0.074308  0.000347
t_subj(B2.u).1.0     0.223710  0.032290  0.156033  0.202409  0.224743  0.246225
0.284253  0.000856
t_subj(B2.u).2.0     0.255101  0.025516  0.202148  0.238783  0.256511  0.273679
0.300313  0.000506
```

```
t_subj(B2.u).3.0      0.220863  0.024248  0.175697  0.205379  0.219354  0.233930
0.272824  0.000708
t_subj(B2.u).4.0      0.284319  0.035936  0.193259  0.265172  0.288208  0.309037
0.340950  0.000748
t_subj(B2.u).5.0      0.255602  0.034047  0.183631  0.233150  0.256919  0.279496
0.317226  0.000630
t_subj(B2.u).6.0      0.192273  0.024625  0.141558  0.176234  0.193124  0.209818
0.237512  0.000771
t_subj(B2.u).7.0      0.213393  0.023539  0.164906  0.198501  0.214314  0.229166
0.257118  0.000550
t_subj(B2.u).8.0      0.222997  0.022862  0.173801  0.208273  0.224619  0.239331
0.262832  0.000606
t_subj(B2.u).9.0      0.159497  0.017034  0.123210  0.148505  0.160870  0.171429
0.189246  0.000471
t_subj(B2.u).10.0     0.178784  0.027187  0.127569  0.161002  0.177476  0.194563
0.239552  0.000586
t_subj(B2.u).11.0     0.245751  0.025668  0.194190  0.229462  0.246476  0.262214
0.296482  0.000771
t_subj(B2.u).12.0     0.287064  0.029018  0.225596  0.268328  0.288871  0.307646
0.339167  0.000781
t_subj(B2.u).13.0     0.280882  0.022594  0.230864  0.267297  0.283179  0.296705
0.319034  0.001032
t_subj(B2.u).14.0     0.278934  0.029079  0.226507  0.258282  0.275145  0.301597
0.335026  0.001236
t_subj(B3.u).1.0      0.258845  0.037384  0.189201  0.234496  0.256509  0.280933
0.340508  0.000984
t_subj(B3.u).2.0      0.212726  0.025641  0.157321  0.196276  0.214084  0.230730
0.258850  0.000511
t_subj(B3.u).3.0      0.213438  0.019883  0.169219  0.201211  0.214834  0.227907
0.246799  0.000626
t_subj(B3.u).4.0      0.259888  0.035590  0.185631  0.236999  0.261244  0.285285
0.324199  0.000639
t_subj(B3.u).5.0      0.264396  0.041535  0.184686  0.236815  0.264006  0.290312
0.349499  0.000742
t_subj(B3.u).6.0      0.291172  0.033208  0.221677  0.269031  0.293155  0.314740
0.350382  0.001122
t_subj(B3.u).7.0      0.208521  0.027568  0.151665  0.190315  0.209790  0.227868
0.259596  0.000555
t_subj(B3.u).8.0      0.234506  0.025875  0.181022  0.217817  0.236239  0.252858
0.280351  0.000736
t_subj(B3.u).9.0      0.166509  0.031494  0.115109  0.143108  0.161323  0.186678
0.235722  0.000831
t_subj(B3.u).10.0     0.170249  0.026870  0.120217  0.149801  0.170592  0.191048
0.218343  0.000626
t_subj(B3.u).11.0     0.250698  0.026177  0.194390  0.234734  0.252740  0.269008
0.296277  0.000798
t_subj(B3.u).12.0     0.324313  0.042698  0.234170  0.295714  0.327257  0.355896
0.400425  0.001196
```

```
t_subj(B3.u).13.0    0.244046  0.024399  0.191844  0.227995  0.245749  0.261306
0.287536  0.000894
t_subj(B3.u).14.0    0.247762  0.024058  0.197975  0.232037  0.249053  0.265234
0.290514  0.001158
t_subj(F2B2.c).1.0   0.198923  0.045408  0.108885  0.167586  0.199523  0.231000
0.286976  0.001290
t_subj(F2B2.c).2.0   0.177521  0.031099  0.112980  0.156981  0.179223  0.199087
0.233389  0.000711
t_subj(F2B2.c).3.0   0.107145  0.022525  0.063434  0.093106  0.106671  0.120016
0.157892  0.000616
t_subj(F2B2.c).4.0   0.163436  0.034690  0.102943  0.139489  0.158588  0.186326
0.234794  0.000638
t_subj(F2B2.c).5.0   0.156943  0.037551  0.082087  0.131430  0.156990  0.182598
0.229316  0.000671
t_subj(F2B2.c).6.0   0.139441  0.026630  0.085827  0.121555  0.139854  0.157622
0.190310  0.000987
t_subj(F2B2.c).7.0   0.139227  0.025118  0.088796  0.123116  0.139728  0.155058
0.190930  0.000586
t_subj(F2B2.c).8.0   0.107977  0.022977  0.061297  0.092632  0.108600  0.124226
0.150573  0.000631
t_subj(F2B2.c).9.0   0.108206  0.016581  0.071980  0.097887  0.109369  0.119905
0.137492  0.000421
t_subj(F2B2.c).10.0  0.099938  0.021706  0.056086  0.085348  0.100488  0.115391
0.139641  0.000494
t_subj(F2B2.c).11.0  0.184374  0.028806  0.122358  0.165777  0.186263  0.204684
0.235225  0.000830
t_subj(F2B2.c).12.0  0.206558  0.036754  0.130764  0.181884  0.208409  0.232909
0.271441  0.000943
t_subj(F2B2.c).13.0  0.162284  0.029601  0.104811  0.142266  0.159816  0.183741
0.217074  0.001303
t_subj(F2B2.c).14.0  0.199239  0.025883  0.143714  0.183077  0.200438  0.217905
0.244597  0.001156
t_subj(F3B3.c).1.0   0.163480  0.042511  0.080505  0.134377  0.163832  0.192952
0.247336  0.001092
t_subj(F3B3.c).2.0   0.161518  0.029485  0.099960  0.142090  0.163371  0.182334
0.213509  0.000610
t_subj(F3B3.c).3.0   0.133675  0.019644  0.091329  0.121240  0.135502  0.147613
0.167406  0.000700
t_subj(F3B3.c).4.0   0.144147  0.045359  0.067824  0.109912  0.137132  0.179084
0.235100  0.000921
t_subj(F3B3.c).5.0   0.108790  0.026667  0.054864  0.090712  0.110096  0.127246
0.157597  0.000455
t_subj(F3B3.c).6.0   0.280640  0.041018  0.191873  0.255179  0.283167  0.310248
0.351471  0.001571
t_subj(F3B3.c).7.0   0.091257  0.021903  0.048923  0.076786  0.091496  0.105080
0.133423  0.000534
t_subj(F3B3.c).8.0   0.139249  0.025318  0.085975  0.122855  0.140837  0.157103
0.183796  0.000718
```

```
t_subj(F3B3.c).9.0   0.083598  0.017232  0.046777  0.072201  0.084789  0.096069
0.114059  0.000471
t_subj(F3B3.c).10.0  0.092490  0.020686  0.048358  0.078985  0.093480  0.107188
0.129499  0.000525
t_subj(F3B3.c).11.0  0.229531  0.026050  0.169833  0.214347  0.232483  0.248348
0.271678  0.000908
t_subj(F3B3.c).12.0  0.196688  0.038899  0.116362  0.170411  0.199284  0.224917
0.266308  0.001108
t_subj(F3B3.c).13.0  0.154018  0.022068  0.105077  0.141083  0.156381  0.169865
0.190820  0.001080
t_subj(F3B3.c).14.0  0.125139  0.021904  0.080021  0.110674  0.126175  0.140431
0.165338  0.001021
p_outlier            0.063786  0.006448  0.051679  0.059240  0.063724  0.068051
0.076849  0.000157
DIC: 2491.671527
deviance: 2391.565590
pD: 100.105937
```

[27]:
```python
bppc2 = hddm.utils.post_pred_gen(beep_acc2)
```

```
 [------------------105%------------------] 59 of 56 complete in 2853.8 sec
```

[29]:
```python
bppc_compare2 = hddm.utils.post_pred_stats(model_b, bppc2)
print(bppc_compare2)
```

```
          observed      mean       std       SEM       MSE credible  \
stat
accuracy  0.936003  0.958033  0.098906  0.000485  0.010268     True
mean_ub   0.811824  0.747368  0.257363  0.004155  0.070390     True
std_ub    0.705276  0.354193  0.215075  0.123259  0.169517     True
10q_ub    0.364230  0.409418  0.100310  0.002042  0.012104     True
30q_ub    0.491178  0.525384  0.142563  0.001170  0.021494     True
50q_ub    0.613278  0.653432  0.203826  0.001612  0.043157     True
70q_ub    0.787827  0.833393  0.303793  0.002076  0.094366     True
90q_ub    1.393924  1.197600  0.526981  0.038543  0.316252     True
mean_lb  -1.516434 -0.882663  0.422287  0.401666  0.579992     True
std_lb    1.449590  0.273431  0.354659  1.383349  1.509132    False
10q_lb    0.498767  0.637923  0.314918  0.019364  0.118538     True
30q_lb    0.745144  0.722800  0.329991  0.000499  0.109393     True
50q_lb    1.002491  0.820873  0.383301  0.032985  0.179905     True
70q_lb    1.601099  0.958393  0.494539  0.413071  0.657639     True
90q_lb    2.775234  1.183012  0.765211  2.535173  3.120721     True

           quantile  mahalanobis
stat
accuracy  13.864285     0.222742
mean_ub   67.278572     0.250449
std_ub    92.471428     1.632377
```

```
10q_ub     34.642857     0.450480
30q_ub     46.939285     0.239934
50q_ub     51.017857     0.196997
70q_ub     54.457142     0.149990
90q_ub     73.796425     0.372545
mean_lb     7.665729     1.500807
std_lb     99.212532     3.316311
10q_lb     35.516273     0.441879
30q_lb     62.073120     0.067710
50q_lb     73.700279     0.473827
70q_lb     88.975494     1.299608
90q_lb     95.636803     2.080763
```

5.2 Vary by unisensory/congruent and 2/3 flashes, add back bound sep

[14]:
```
flash_acc3 = hddm.HDDM(model_f, include=['a', 'v', 't', 'p_outlier'],␣
 ↪depends_on={'a': ['type', 'stimName'], 'v': ['type', 'stimName'], 't':␣
 ↪['type', 'stimName']})
flash_acc3.sample(7000, burn=500)
```

```
[-----------------100%-----------------] 7000 of 7000 complete in 724.6 sec
```

[14]:
```
<pymc.MCMC.MCMC at 0xcfac308>
```

[15]:
```
flash_acc3.print_stats()
```

```
                          mean       std      2.5q       25q       50q       75q
97.5q    mc err
a(F2.u)               1.811840  0.111500  1.592404  1.738819  1.811359  1.884319
2.036660  0.002694
a(F2B2.c)             2.047023  0.133524  1.795251  1.955991  2.044066  2.136802
2.317286  0.004606
a(F3.u)               1.571487  0.098330  1.381276  1.505106  1.571307  1.635536
1.766772  0.001651
a(F3B3.c)             1.817476  0.114147  1.595926  1.740297  1.817382  1.891872
2.049284  0.002872
a_std                 0.363458  0.053674  0.271009  0.325430  0.359145  0.396405
0.481025  0.001880
a_subj(F2.u).1.0      2.125704  0.269858  1.697706  1.939081  2.091427  2.273391
2.754127  0.008309
a_subj(F2.u).2.0      1.588058  0.140934  1.330326  1.488942  1.580923  1.679989
1.885886  0.003216
a_subj(F2.u).3.0      1.993313  0.296428  1.482574  1.783737  1.966249  2.174361
2.642914  0.011429
a_subj(F2.u).4.0      1.899771  0.202962  1.543799  1.757544  1.885581  2.026179
2.341874  0.005158
a_subj(F2.u).5.0      1.928476  0.219483  1.561097  1.778511  1.906297  2.052814
2.423505  0.006433
```

```
a_subj(F2.u).6.0      2.270875  0.303635  1.779842  2.056071  2.237309  2.439544
2.966361  0.009628
a_subj(F2.u).7.0      1.741431  0.138933  1.488102  1.645600  1.736205  1.831682
2.029386  0.004057
a_subj(F2.u).8.0      2.094501  0.290902  1.631832  1.890702  2.053983  2.260236
2.774708  0.009412
a_subj(F2.u).9.0      1.591242  0.123013  1.359720  1.506303  1.587821  1.671914
1.843391  0.002662
a_subj(F2.u).10.0     1.632125  0.140878  1.373153  1.534558  1.626236  1.723160
1.929562  0.002592
a_subj(F2.u).11.0     1.530812  0.120085  1.311845  1.447047  1.526063  1.609199
1.789131  0.002201
a_subj(F2.u).12.0     1.895002  0.211443  1.533890  1.746612  1.876749  2.023261
2.362626  0.006344
a_subj(F2.u).13.0     1.322179  0.104102  1.134571  1.249550  1.318030  1.387516
1.543369  0.001789
a_subj(F2.u).14.0     1.680376  0.220713  1.326399  1.525199  1.655535  1.806229
2.193771  0.006836
a_subj(F2B2.c).1.0    2.395194  0.292561  1.892703  2.189705  2.373194  2.576234
3.051768  0.008649
a_subj(F2B2.c).2.0    2.512026  0.243793  2.096795  2.336317  2.494638  2.664726
3.041088  0.005708
a_subj(F2B2.c).3.0    2.067472  0.304529  1.549942  1.846526  2.043791  2.261054
2.743262  0.012148
a_subj(F2B2.c).4.0    2.157639  0.274850  1.729692  1.958341  2.121714  2.314699
2.790202  0.009287
a_subj(F2B2.c).5.0    1.957623  0.156144  1.663555  1.849298  1.953841  2.059006
2.282709  0.003312
a_subj(F2B2.c).6.0    2.185877  0.289761  1.680238  1.981023  2.162826  2.370016
2.816734  0.011022
a_subj(F2B2.c).7.0    2.251825  0.316612  1.717378  2.019323  2.223553  2.450865
2.941242  0.010226
a_subj(F2B2.c).8.0    2.190264  0.294782  1.686542  1.981996  2.165787  2.370061
2.842787  0.009342
a_subj(F2B2.c).9.0    2.152655  0.240920  1.698725  1.990952  2.148150  2.307164
2.640203  0.007244
a_subj(F2B2.c).10.0   1.832496  0.256615  1.411164  1.653789  1.804374  1.982129
2.416144  0.009040
a_subj(F2B2.c).11.0   1.554503  0.158121  1.266141  1.439492  1.547123  1.663573
1.873990  0.004815
a_subj(F2B2.c).12.0   2.442875  0.232809  2.028489  2.279278  2.430909  2.586602
2.933538  0.005210
a_subj(F2B2.c).13.0   2.105604  0.300913  1.550533  1.899277  2.087060  2.296889
2.754544  0.011982
a_subj(F2B2.c).14.0   1.300094  0.113945  1.095060  1.221190  1.294762  1.371048
1.546037  0.002375
a_subj(F3.u).1.0      1.856273  0.149471  1.580917  1.755156  1.847590  1.948177
2.176755  0.003054
```

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a_subj(F3.u).2.0      1.572090  0.118886  1.342072  1.491520  1.570450  1.651586
1.810376  0.002198
a_subj(F3.u).3.0      1.209894  0.089607  1.041477  1.147399  1.205910  1.268036
1.396518  0.001502
a_subj(F3.u).4.0      1.707909  0.133935  1.468865  1.614128  1.699816  1.793238
1.993701  0.002646
a_subj(F3.u).5.0      1.654492  0.166630  1.361919  1.538213  1.643424  1.759692
2.011705  0.003752
a_subj(F3.u).6.0      1.789888  0.126598  1.554995  1.701604  1.786147  1.873347
2.048783  0.002273
a_subj(F3.u).7.0      1.660112  0.114639  1.451198  1.581639  1.654256  1.732415
1.899582  0.001875
a_subj(F3.u).8.0      1.599852  0.110718  1.395958  1.521392  1.594349  1.671454
1.832111  0.001914
a_subj(F3.u).9.0      1.671816  0.129317  1.422790  1.583511  1.668833  1.757776
1.930929  0.002575
a_subj(F3.u).10.0     1.286242  0.094367  1.105060  1.223787  1.285062  1.347383
1.478978  0.002148
a_subj(F3.u).11.0     1.401812  0.108534  1.200986  1.325446  1.396783  1.470850
1.628430  0.002225
a_subj(F3.u).12.0     1.657091  0.120584  1.429234  1.573306  1.652719  1.735235
1.903212  0.002033
a_subj(F3.u).13.0     1.147607  0.090483  0.980961  1.085856  1.145007  1.205170
1.336333  0.001873
a_subj(F3.u).14.0     1.316788  0.099232  1.139392  1.247984  1.310847  1.379233
1.533364  0.002017
a_subj(F3B3.c).1.0    2.182519  0.171289  1.882589  2.060641  2.172200  2.289423
2.546111  0.003478
a_subj(F3B3.c).2.0    2.293562  0.202241  1.934869  2.154302  2.279668  2.420768
2.727450  0.004549
a_subj(F3B3.c).3.0    1.527395  0.246896  1.102836  1.346296  1.505634  1.685837
2.067504  0.010729
a_subj(F3B3.c).4.0    1.684699  0.116520  1.462451  1.604558  1.681076  1.762607
1.916548  0.002171
a_subj(F3B3.c).5.0    2.448028  0.238328  2.025297  2.280414  2.431497  2.596735
2.960594  0.005049
a_subj(F3B3.c).6.0    1.807240  0.138999  1.549970  1.711166  1.798123  1.895579
2.103802  0.002889
a_subj(F3B3.c).7.0    1.973927  0.150303  1.700520  1.870644  1.967231  2.068752
2.286864  0.003050
a_subj(F3B3.c).8.0    1.895044  0.224795  1.522398  1.733737  1.870632  2.029743
2.403558  0.006480
a_subj(F3B3.c).9.0    1.753224  0.202945  1.412571  1.605905  1.736862  1.881673
2.181513  0.005905
a_subj(F3B3.c).10.0   1.583944  0.130995  1.349967  1.492768  1.574213  1.668543
1.854984  0.002953
a_subj(F3B3.c).11.0   2.068404  0.281094  1.567871  1.871380  2.047546  2.242108
2.682322  0.009770
```

a_subj(F3B3.c).12.0	1.765113	0.161748	1.482792	1.653353	1.755108	1.865193	2.121972	0.003435
a_subj(F3B3.c).13.0	1.223071	0.143507	0.990469	1.122178	1.206125	1.305877	1.551644	0.004236
a_subj(F3B3.c).14.0	1.481960	0.116886	1.273465	1.399612	1.475415	1.556292	1.727273	0.002569
v(F2.u)	1.607810	0.259096	1.109693	1.433049	1.605806	1.780225	2.117544	0.004332
v(F2B2.c)	1.939921	0.267298	1.422926	1.761630	1.938284	2.118885	2.472726	0.004608
v(F3.u)	0.039954	0.249112	-0.437526	-0.128191	0.036825	0.204764	0.540652	0.003594
v(F3B3.c)	1.461651	0.252516	0.954812	1.296856	1.461708	1.626153	1.959012	0.003581
v_std	0.906819	0.109813	0.718736	0.828791	0.898841	0.974811	1.150438	0.002498
v_subj(F2.u).1.0	1.809497	0.301440	1.253536	1.602103	1.795358	2.007811	2.438602	0.007783
v_subj(F2.u).2.0	1.306536	0.287745	0.798310	1.103761	1.289908	1.487416	1.916211	0.004707
v_subj(F2.u).3.0	3.070924	0.432920	2.263822	2.771667	3.060189	3.346455	3.974212	0.012506
v_subj(F2.u).4.0	1.759200	0.287619	1.225281	1.563025	1.750054	1.937198	2.368975	0.004998
v_subj(F2.u).5.0	1.657542	0.291819	1.131951	1.458322	1.639936	1.833461	2.286985	0.005809
v_subj(F2.u).6.0	2.184587	0.355794	1.527340	1.938880	2.173643	2.409565	2.924324	0.008550
v_subj(F2.u).7.0	0.363128	0.175230	0.021465	0.246013	0.360398	0.482852	0.714771	0.002301
v_subj(F2.u).8.0	2.203770	0.345578	1.593566	1.955583	2.181501	2.429402	2.942068	0.009004
v_subj(F2.u).9.0	0.942905	0.215472	0.525737	0.799500	0.942204	1.080293	1.380341	0.002941
v_subj(F2.u).10.0	1.033479	0.236935	0.584848	0.869267	1.030374	1.192707	1.508730	0.003115
v_subj(F2.u).11.0	1.002862	0.229360	0.561780	0.846317	0.999592	1.156135	1.464559	0.002925
v_subj(F2.u).12.0	1.646750	0.267985	1.154014	1.460589	1.634510	1.818994	2.205892	0.004081
v_subj(F2.u).13.0	1.085022	0.262316	0.568841	0.909751	1.083075	1.258299	1.604056	0.003794
v_subj(F2.u).14.0	2.434255	0.371170	1.735247	2.181487	2.421786	2.670871	3.195692	0.008072
v_subj(F2B2.c).1.0	1.897130	0.252976	1.424473	1.724512	1.888933	2.064720	2.408578	0.005053
v_subj(F2B2.c).2.0	1.223853	0.206182	0.832265	1.084786	1.222484	1.361140	1.636408	0.003256

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v_subj(F2B2.c).3.0   3.237680  0.457885  2.340258  2.927188  3.244245  3.547602
4.133691  0.014571
v_subj(F2B2.c).4.0   1.810469  0.385182  1.143352  1.532741  1.786927  2.057766
2.641853  0.010935
v_subj(F2B2.c).5.0   0.392139  0.169410  0.072189  0.277846  0.388000  0.505385
0.732939  0.001957
v_subj(F2B2.c).6.0   2.389165  0.321969  1.792045  2.167298  2.382837  2.604375
3.054854  0.007950
v_subj(F2B2.c).7.0   2.714728  0.340073  2.057849  2.484419  2.706495  2.943385
3.407068  0.008581
v_subj(F2B2.c).8.0   2.444658  0.380188  1.715955  2.188937  2.433728  2.698329
3.205828  0.008752
v_subj(F2B2.c).9.0   2.179872  0.282071  1.645601  1.987059  2.168546  2.368995
2.747800  0.005353
v_subj(F2B2.c).10.0  2.277502  0.352965  1.610903  2.039771  2.264444  2.504579
3.022447  0.009258
v_subj(F2B2.c).11.0  0.556345  0.235886  0.115447  0.393142  0.544692  0.708158
1.057610  0.004038
v_subj(F2B2.c).12.0  1.243167  0.206582  0.861645  1.099129  1.238620  1.377065
1.661113  0.003402
v_subj(F2B2.c).13.0  3.866183  0.481259  2.959947  3.532969  3.855023  4.188524
4.852989  0.014649
v_subj(F2B2.c).14.0  0.971340  0.263730  0.464196  0.792773  0.963679  1.145741
1.521581  0.003323
v_subj(F3.u).1.0    -0.116675  0.163591 -0.436871 -0.222941 -0.116197 -0.008002
0.203512  0.002080
v_subj(F3.u).2.0    -0.028242  0.196154 -0.421784 -0.156016 -0.025255  0.103680
0.355163  0.002526
v_subj(F3.u).3.0     0.108721  0.243121 -0.377315 -0.055473  0.105993  0.271341
0.583956  0.002774
v_subj(F3.u).4.0    -1.107379  0.212548 -1.539677 -1.249698 -1.101324 -0.960480
-0.705840  0.003126
v_subj(F3.u).5.0    -1.028660  0.243768 -1.525140 -1.195445 -1.018384 -0.855454
-0.581755  0.003064
v_subj(F3.u).6.0    -0.176060  0.167267 -0.511825 -0.286371 -0.177327 -0.064924
0.152008  0.002084
v_subj(F3.u).7.0     0.538378  0.185268  0.174597  0.414847  0.537790  0.661924
0.905613  0.002325
v_subj(F3.u).8.0    -0.271679  0.185660 -0.643383 -0.396526 -0.268664 -0.144453
0.083636  0.002377
v_subj(F3.u).9.0     0.832060  0.207097  0.441081  0.692603  0.829778  0.968470
1.248951  0.002952
v_subj(F3.u).10.0   -0.111991  0.228450 -0.564952 -0.266011 -0.107790  0.045521
0.326487  0.003454
v_subj(F3.u).11.0    0.502300  0.223914  0.062708  0.354296  0.500837  0.649420
0.951670  0.003100
v_subj(F3.u).12.0   -0.078696  0.177741 -0.431054 -0.195148 -0.078982  0.036942
0.272124  0.002019
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v_subj(F3.u).13.0     0.707362  0.268211  0.197752  0.526285  0.707449  0.892040
1.241987  0.003102
v_subj(F3.u).14.0     0.675027  0.234469  0.209884  0.514571  0.674137  0.834805
1.146353  0.002832
v_subj(F3B3.c).1.0    0.745009  0.169661  0.436500  0.627287  0.739773  0.857989
1.090516  0.002037
v_subj(F3B3.c).2.0    0.999750  0.180550  0.660583  0.874916  0.996768  1.118507
1.370350  0.002330
v_subj(F3B3.c).3.0    3.789839  0.487015  2.847520  3.461970  3.780446  4.119000
4.755955  0.015555
v_subj(F3B3.c).4.0   -0.222933  0.177152 -0.560445 -0.342905 -0.222776 -0.103894
0.127657  0.002117
v_subj(F3B3.c).5.0    1.261784  0.208418  0.878509  1.117822  1.252826  1.397866
1.703967  0.003098
v_subj(F3B3.c).6.0    0.490223  0.176859  0.147016  0.369731  0.488200  0.609175
0.841076  0.002349
v_subj(F3B3.c).7.0    1.093013  0.234751  0.669246  0.933029  1.080564  1.237509
1.601134  0.003165
v_subj(F3B3.c).8.0    2.031190  0.311426  1.460345  1.820227  2.019011  2.226233
2.686919  0.006824
v_subj(F3B3.c).9.0    2.149143  0.299800  1.553366  1.948638  2.147273  2.345953
2.742423  0.005211
v_subj(F3B3.c).10.0   1.271963  0.228888  0.839680  1.114806  1.266066  1.424006
1.738168  0.003534
v_subj(F3B3.c).11.0   2.480354  0.353023  1.793971  2.239654  2.473902  2.718286
3.204529  0.008834
v_subj(F3B3.c).12.0   1.369936  0.271362  0.865930  1.187751  1.356541  1.541114
1.946907  0.004221
v_subj(F3B3.c).13.0   2.155722  0.360674  1.469284  1.906211  2.152254  2.395099
2.886209  0.005285
v_subj(F3B3.c).14.0   0.802196  0.222604  0.365506  0.650409  0.796873  0.947974
1.251560  0.003025
t(F2.u)               0.333217  0.025898  0.282260  0.316116  0.333020  0.350559
0.384360  0.000495
t(F2B2.c)             0.225572  0.028486  0.169227  0.206810  0.225646  0.244723
0.280538  0.000765
t(F3.u)               0.271420  0.025947  0.220505  0.254311  0.271697  0.288945
0.322524  0.000436
t(F3B3.c)             0.239599  0.025466  0.189481  0.222428  0.239517  0.256807
0.289402  0.000494
t_std                 0.095697  0.011885  0.075301  0.087210  0.094702  0.103043
0.121646  0.000295
t_subj(F2.u).1.0      0.355991  0.033336  0.280462  0.335927  0.359719  0.379643
0.411274  0.000804
t_subj(F2.u).2.0      0.385839  0.035374  0.305061  0.364554  0.393971  0.411805
0.435841  0.000802
t_subj(F2.u).3.0      0.267182  0.028218  0.212910  0.250938  0.267057  0.281522
0.343996  0.000929
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t_subj(F2.u).4.0	0.319119	0.030106	0.249386	0.301295	0.322113	0.340673	0.368934	0.000727
t_subj(F2.u).5.0	0.363004	0.033926	0.285936	0.343416	0.366519	0.386867	0.416879	0.000922
t_subj(F2.u).6.0	0.287166	0.032153	0.215202	0.267053	0.290472	0.310222	0.340158	0.000891
t_subj(F2.u).7.0	0.297088	0.069675	0.190692	0.238543	0.271557	0.365352	0.413013	0.003019
t_subj(F2.u).8.0	0.288911	0.031227	0.223712	0.269928	0.290354	0.307844	0.349930	0.000840
t_subj(F2.u).9.0	0.299194	0.028470	0.244299	0.282519	0.298858	0.313684	0.363572	0.000615
t_subj(F2.u).10.0	0.207040	0.023019	0.155187	0.193245	0.209399	0.222991	0.245262	0.000444
t_subj(F2.u).11.0	0.280336	0.021555	0.230654	0.267389	0.283064	0.295741	0.315289	0.000424
t_subj(F2.u).12.0	0.386215	0.037749	0.300179	0.364088	0.390100	0.414333	0.447911	0.001082
t_subj(F2.u).13.0	0.345746	0.022779	0.301661	0.330419	0.344502	0.362206	0.388086	0.000397
t_subj(F2.u).14.0	0.421028	0.024236	0.364663	0.406944	0.424398	0.438382	0.458607	0.000690
t_subj(F2B2.c).1.0	0.312340	0.046791	0.207107	0.283699	0.316772	0.345860	0.389976	0.001256
t_subj(F2B2.c).2.0	0.179935	0.043857	0.087898	0.150552	0.181830	0.211791	0.257862	0.000953
t_subj(F2B2.c).3.0	0.185408	0.024775	0.131526	0.170050	0.188430	0.202795	0.226402	0.000851
t_subj(F2B2.c).4.0	0.129516	0.029123	0.069326	0.111212	0.130961	0.148767	0.179040	0.000721
t_subj(F2B2.c).5.0	0.295128	0.045422	0.190661	0.268010	0.299941	0.328163	0.369143	0.000907
t_subj(F2B2.c).6.0	0.226216	0.035594	0.147843	0.203700	0.229292	0.251849	0.286900	0.001208
t_subj(F2B2.c).7.0	0.279147	0.037349	0.188780	0.259031	0.282908	0.303464	0.341990	0.001061
t_subj(F2B2.c).8.0	0.177004	0.030439	0.109100	0.158209	0.179530	0.199047	0.228752	0.000844
t_subj(F2B2.c).9.0	0.100357	0.040702	0.040869	0.072754	0.091834	0.119912	0.203349	0.001197
t_subj(F2B2.c).10.0	0.180305	0.026724	0.120220	0.163743	0.182779	0.199585	0.224002	0.000825
t_subj(F2B2.c).11.0	0.216743	0.076057	0.057609	0.149174	0.239523	0.271584	0.323645	0.002615
t_subj(F2B2.c).12.0	0.174116	0.041241	0.089811	0.147059	0.176268	0.202978	0.248744	0.000780
t_subj(F2B2.c).13.0	0.213837	0.026257	0.163237	0.198276	0.213817	0.227882	0.273290	0.000922

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t_subj(F2B2.c).14.0  0.542504  0.021166  0.493505  0.530648  0.545329  0.557675
0.575482  0.000414
t_subj(F3.u).1.0     0.463342  0.048454  0.352057  0.435830  0.469564  0.497567
0.539047  0.001001
t_subj(F3.u).2.0     0.223696  0.030040  0.166457  0.206943  0.223842  0.238656
0.310519  0.000843
t_subj(F3.u).3.0     0.186015  0.015046  0.152685  0.176987  0.187577  0.196998
0.210138  0.000261
t_subj(F3.u).4.0     0.146020  0.020375  0.103069  0.133582  0.147603  0.159714
0.180714  0.000386
t_subj(F3.u).5.0     0.347843  0.034016  0.267807  0.328945  0.352809  0.372224
0.398999  0.000760
t_subj(F3.u).6.0     0.345153  0.035669  0.266847  0.324784  0.348496  0.370129
0.404900  0.000588
t_subj(F3.u).7.0     0.213632  0.033198  0.154816  0.194343  0.212171  0.227597
0.301797  0.000576
t_subj(F3.u).8.0     0.228166  0.028120  0.171032  0.212342  0.228918  0.243779
0.290001  0.000479
t_subj(F3.u).9.0     0.169798  0.054076  0.084520  0.128918  0.158264  0.208114
0.273342  0.001177
t_subj(F3.u).10.0    0.177415  0.029110  0.134220  0.160625  0.171640  0.183206
0.249829  0.001080
t_subj(F3.u).11.0    0.296908  0.033548  0.215326  0.283594  0.302856  0.316839
0.353775  0.000699
t_subj(F3.u).12.0    0.344972  0.032453  0.274278  0.326056  0.348496  0.366380
0.401282  0.000532
t_subj(F3.u).13.0    0.311817  0.015555  0.276110  0.302998  0.313869  0.322906
0.336529  0.000318
t_subj(F3.u).14.0    0.378094  0.021116  0.327830  0.365989  0.380864  0.393114
0.411729  0.000452
t_subj(F3B3.c).1.0   0.396995  0.052916  0.276968  0.365247  0.403565  0.435051
0.482988  0.001109
t_subj(F3B3.c).2.0   0.220084  0.048017  0.119671  0.187853  0.223190  0.254474
0.302686  0.001135
t_subj(F3B3.c).3.0   0.187247  0.018500  0.146120  0.175643  0.189151  0.200547
0.217594  0.000743
t_subj(F3B3.c).4.0   0.223558  0.030641  0.157341  0.205335  0.225729  0.244563
0.276957  0.000562
t_subj(F3B3.c).5.0   0.219622  0.046194  0.119593  0.189696  0.223019  0.252572
0.298387  0.000904
t_subj(F3B3.c).6.0   0.400287  0.039502  0.309820  0.377896  0.406040  0.428201
0.461163  0.000779
t_subj(F3B3.c).7.0   0.123122  0.028760  0.065252  0.104784  0.123281  0.140849
0.183831  0.000576
t_subj(F3B3.c).8.0   0.225292  0.027353  0.165300  0.208008  0.228368  0.245011
0.270494  0.000715
t_subj(F3B3.c).9.0   0.189400  0.027267  0.130629  0.172541  0.191359  0.208984
0.235507  0.000778
```

```
t_subj(F3B3.c).10.0  0.172214  0.022121  0.122425  0.158381  0.174715  0.188274
0.208505  0.000474
t_subj(F3B3.c).11.0  0.166444  0.036650  0.098869  0.142796  0.163326  0.186069
0.245450  0.001055
t_subj(F3B3.c).12.0  0.162948  0.024976  0.107157  0.147960  0.165158  0.179946
0.206180  0.000499
t_subj(F3B3.c).13.0  0.222599  0.024589  0.160613  0.215884  0.229050  0.238073
0.258241  0.000780
t_subj(F3B3.c).14.0  0.396410  0.026342  0.335996  0.381383  0.399752  0.415319
0.437578  0.000575
p_outlier            0.063434  0.006922  0.050382  0.058582  0.063370  0.067946
0.077692  0.000130
DIC: 4068.273330
deviance: 3933.856793
pD: 134.416537
```