HW5_JonasSchweisthal_s4535561

December 21, 2020

1 Homework #5

Name: Jonas Schweisthal
Student number: s4535561

[1]:
```
from model import Model
from dmchunk import Chunk
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
import random
import math
```

[2]:
```
def noise(s):
    rand = random.uniform(0.001,0.999)
    return s * math.log((1 - rand)/rand)
```

[3]:
```
def time_to_pulses(time, t_0 = 0.011, a = 1.1, b = 0.015):
    pulses = 0
    pulse_duration = t_0
    while time >= pulse_duration:
        time = time - pulse_duration
        pulses += 1
        pulse_duration = a * pulse_duration + noise(b * a * pulse_duration)
    return pulses
```

[4]:
```
def pulses_to_time(pulses, t_0 = 0.011, a = 1.1, b = 0.015):
    time = 0
    pulse_duration = t_0
    while pulses > 0:
        time = time + pulse_duration
        pulses = pulses - 1
        pulse_duration = a * pulse_duration + noise(b * a * pulse_duration)
    return time
```

[5]:
```
# Perform Experiments:
def ready_set_go(n_participants, experiment):
    '''
```

```
        Simulates experiments 1 or 2 of Acerbi et al. (2012)

                Parameters:
                        a (int): number of participants conducting the␣
↪experiment
                        b (int[1 or 2]): number defining the selected experiemnt

                Returns:
                        df (pandas.DataFrame): DataFrame containing the results␣
↪of the experiment
    '''
    # number of subjects
    subjects = range(1,n_participants+1)
    if experiment == 1:
        # short, long
        conditions = ["Short Uniform", "Long Uniform"]
    elif experiment == 2:
         # medium uniform, medium peaked
        conditions = ["Medium Uniform", "Medium Peaked"]
    # defining dataframe
    df = pd.DataFrame(columns = ["Line", "Subj", "Cond", "Session", "Run",␣
↪"Trial", "Ts", "Tp", "Main"])
    main = False
    line = 0
    for subj in subjects:
        # shuffling order of conditions randomly per subject
        np.random.shuffle(conditions)
        # own condition and model per subject as there is probably a long time␣
↪between the two conditions
        for cond in conditions:
            m = Model()
            session = 1
            # set up for stopping if fractional change in mean squared timing␣
↪error between sessions less than 0.08
            change_error = 1
            while change_error >= 0.08:

                # between 5 and 6 runs per session a ~500 trials
                for run in np.arange(1, np.random.choice([5, 6])+1):
                    # between 84 and 96 trials per run
                    for trial in np.arange(1, np.random.randint(84, 97)):

                        line += 1
                        # educated guess of about 2 seconds preparation time␣
↪between trials
                        m.time += 2
```

```
                        # draw out of 6 discrete values of discrete uniform␣
↪distribution per condition
                        if cond == "Short Uniform":
                            ts = np.random.choice(np.linspace(0.45, 0.825, 6)).
↪round(3) # rounding just for computational rounding errors necessary
                        elif cond == "Long Uniform":
                            ts = np.random.choice(np.linspace(0.75, 1.125, 6)).
↪round(3)
                        elif cond == "Medium Uniform":
                            ts = np.random.choice(np.linspace(0.600, 0.975, 6)).
↪round(3)
                        elif cond == "Medium Peaked":
                            ts = np.random.choice(np.linspace(0.600, 0.975, 6),
                                                  p = [1/12, 7/12, 1/12, 1/12, 1/
↪12, 1/12]).round(3)
                        m.time += ts

                        # time to pulses
                        pulses = time_to_pulses(ts)
                        fact = Chunk(name = "pf" + str(pulses), slots ={"isa":
↪"pulses-fact", "pulses": pulses})
                        # adding encounter of the perceived interval as pulses␣
↪at the end time point of the presented interval
                        m.add_encounter(fact)
                        # flash time of 0.0185 seconds
                        m.time += 0.0185
                        # adding time of 250 ms for minimum waiting after flash
                        # 5ms time for storing encounter included here␣
↪(simultaneously)
                        m.time += 0.250

                        # retrieving blended trace
                        request = Chunk(name = "retrieve", slots = {"isa":␣
↪"pulses-fact"})
                        pulses_retrieved, latency = m.
↪retrieve_blended_trace(request, "pulses")
                        # m.time += latency is NOT added as discussed in␣
↪supervision session
                        # converting blended trace of retrieved pulses to␣
↪seconds
                        tp = pulses_to_time(pulses_retrieved)
                        # adding prodcution error for motoric mouseclicking of␣
↪retrieved intervall possible
                        # here no error is added because
                        # adding production time
```

```
                        m.time += tp

                        # random delay continuos random uniform distribution␣
↪till feedback
                        delay = np.random.uniform(0.45, 0.85)
                        m.time += delay
                        # adding time of feedback
                        m.time += 0.062
                        # adding time fixation cross disappearing
                        m.time += np.random.uniform(0.5, 0.75)
                        # adding time for blank screen
                        m.time += np.random.uniform(0.5, 0.75)
                        # new fixation cross signalling start of new trial

                        # store times in milliseconds in dataframe
                        df.loc[line-1] = [line, subj, cond, session, run,␣
↪trial, ts*1000, tp*1000, main]
                    # Subjects could take short breaks between runs, educated␣
↪guess with 1 minute assumed to be realistic
                    m.time += 300

                #checking if fractional change in mean squared timing error␣
↪between sessions less than 0.08
                if change_error >= 0.08 and session >1:
                    change_error = abs(1-(((df[df.Session ==␣
↪session]["Tp"]-df[df.Session == session]["Ts"])**2).mean()/
                                          ((df[df.Session == session-1]["Tp"]-df[df.
↪Session == session-1]["Ts"])**2).mean()))
                session += 1
            # set last two sessions per subject and block as Test (main = True)␣
↪
            df.loc[(df.Subj == subj) & (df.Cond == cond), 'Main'] = np.where(df.
↪loc[(df.Subj == subj) & (df.Cond == cond), 'Session'] >
                                                                                df.
↪loc[(df.Subj == subj) & (df.Cond == cond), 'Session'].max()-2,
                                                                                ␣
↪True, False)


    return df
```

[6]:
```
# Simulating experiments 1 and 2 with 4 and 6 participants as mentioned in the␣
↪paper
df_1 = ready_set_go(n_participants=4, experiment=1)
df_2 = ready_set_go(n_participants=6, experiment=2)
```

```
# changing Subject numbers for second experiment
df_2['Subj'] = df_2['Subj']+ df_1['Subj'].max()

# combining datasets and calculating Bias
df = df_1.append(df_2, ignore_index = True)
df["Bias"] = df["Tp"] - df["Ts"]
```

[7]:
```
# realistic numbers of sessions generated with algorithm and stopping rule
# in the paper described as between 3 and 6 sessions per condition and subject
df[df.Main == True].groupby(["Cond", "Subj"])['Session'].unique()
```

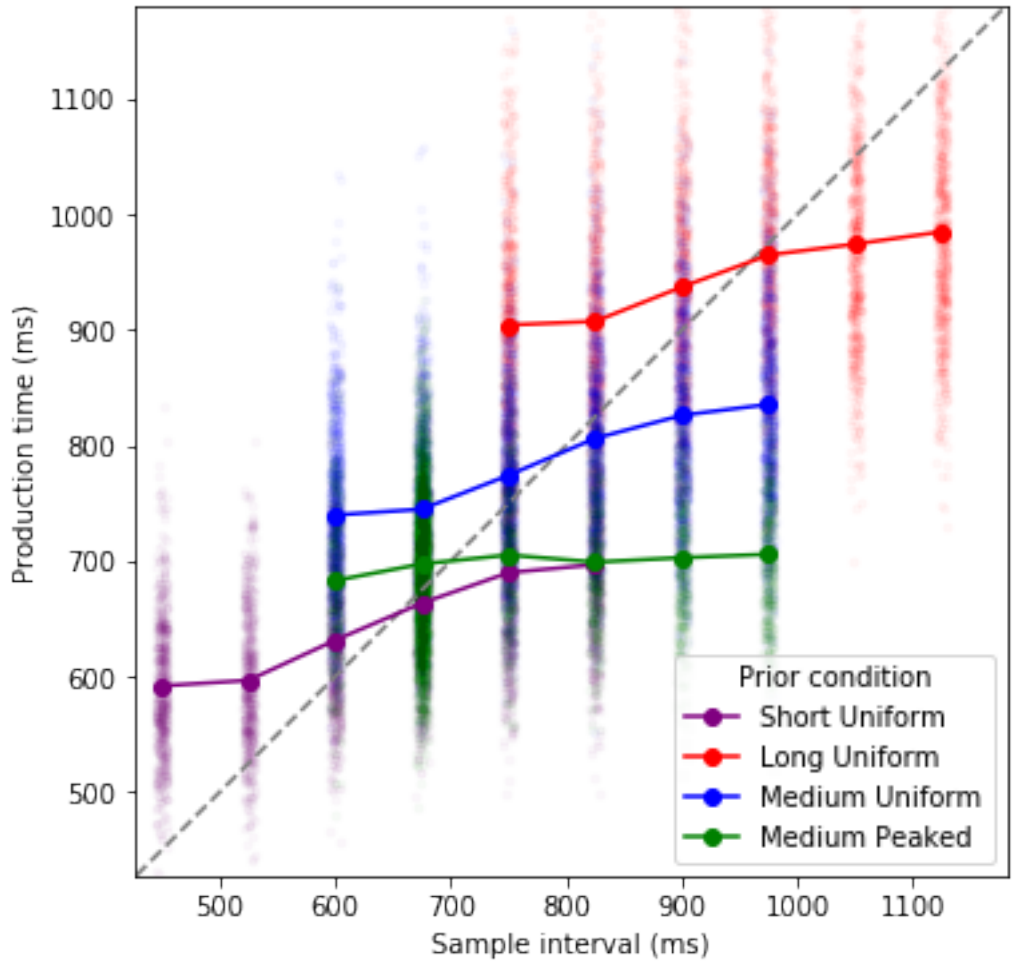
[7]:
```
Cond            Subj
Long Uniform    1       [2, 3]
                2       [2, 3]
                3       [3, 4]
                4       [3, 4]
Medium Peaked   5       [2, 3]
                6       [3, 4]
                7       [3, 4]
                8       [3, 4]
                9       [3, 4]
                10      [2, 3]
Medium Uniform  5       [3, 4]
                6       [3, 4]
                7       [3, 4]
                8       [3, 4]
                9       [3, 4]
                10      [2, 3]
Short Uniform   1       [2, 3]
                2       [5, 6]
                3       [3, 4]
                4       [3, 4]
Name: Session, dtype: object
```

[18]:
```
# Plotting Production time per Condition of both experiments
# Remove training trials
dat = df[df['Main'] == True]

# Calculate mean Tp by condition
mean_tp = dat.groupby(['Cond', 'Ts'])['Tp'].mean().reset_index()


yrange = np.multiply((min(mean_tp['Ts']), max(mean_tp['Ts'])), [0.95, 1.05])

# Subset data for plotting

cond1 = mean_tp.loc[mean_tp['Cond'] == "Short Uniform"]
```

```
cond2 = mean_tp.loc[mean_tp['Cond'] == "Long Uniform"]
cond3 = mean_tp.loc[mean_tp['Cond'] == "Medium Uniform"]
cond4 = mean_tp.loc[mean_tp['Cond'] == "Medium Peaked"]

# Add jitter noise
jitter = dat.copy()
jitter['Ts'] = jitter['Ts'] + np.random.uniform(-5, 5, len(dat))
cond1_jitter = jitter.loc[jitter['Cond'] == "Short Uniform"]
cond2_jitter = jitter.loc[jitter['Cond'] == "Long Uniform"]
cond3_jitter = jitter.loc[jitter['Cond'] == "Medium Uniform"]
cond4_jitter = jitter.loc[jitter['Cond'] == "Medium Peaked"]

# Make plot
f, ax = plt.subplots(figsize = (6,6))

ax.set(xlim = yrange, ylim = yrange)
f.gca().set_aspect('equal', adjustable = 'box')

ax.set_xlabel('Sample interval (ms)')
ax.set_ylabel('Production time (ms)')

ax.plot(yrange, yrange, linestyle = '--', color ='gray')

ax.scatter(cond1_jitter['Ts'], cond1_jitter['Tp'], marker = '.', color =␣
↪'purple', alpha = 0.025, label = None)
ax.scatter(cond2_jitter['Ts'], cond2_jitter['Tp'], marker = '.', color = 'red',␣
↪alpha = 0.025, label = None)
ax.scatter(cond3_jitter['Ts'], cond3_jitter['Tp'], marker = '.', color =␣
↪'blue', alpha = 0.025, label = None)
ax.scatter(cond4_jitter['Ts'], cond4_jitter['Tp'], marker = '.', color =␣
↪'green', alpha = 0.025, label = None)

ax.plot(cond1['Ts'], cond1['Tp'], color = 'purple', marker = 'o', label =␣
↪"Short Uniform" )
ax.plot(cond2['Ts'], cond2['Tp'], color = 'red', marker = 'o', label = "Long␣
↪Uniform")
ax.plot(cond3['Ts'], cond3['Tp'], color = 'blue', marker = 'o', label = "Medium␣
↪Uniform" )
ax.plot(cond4['Ts'], cond4['Tp'], color = 'green', marker = 'o', label =␣
↪"Medium Peaked")
ax.legend(title = 'Prior condition', loc = 4)

f.savefig('plot1.png')
```

```
C:\Users\jonas\AppData\Roaming\Python\Python37\site-
packages\matplotlib\cbook\__init__.py:1402: FutureWarning: Support for multi-
dimensional indexing (e.g. `obj[:, None]`) is deprecated and will be removed in
```

```
a future version.  Convert to a numpy array before indexing instead.
  x[:, None]
C:\Users\jonas\AppData\Roaming\Python\Python37\site-
packages\matplotlib\axes\_base.py:276: FutureWarning: Support for multi-
dimensional indexing (e.g. `obj[:, None]`) is deprecated and will be removed in
a future version.  Convert to a numpy array before indexing instead.
  x = x[:, np.newaxis]
C:\Users\jonas\AppData\Roaming\Python\Python37\site-
packages\matplotlib\axes\_base.py:278: FutureWarning: Support for multi-
dimensional indexing (e.g. `obj[:, None]`) is deprecated and will be removed in
a future version.  Convert to a numpy array before indexing instead.
  y = y[:, np.newaxis]
```



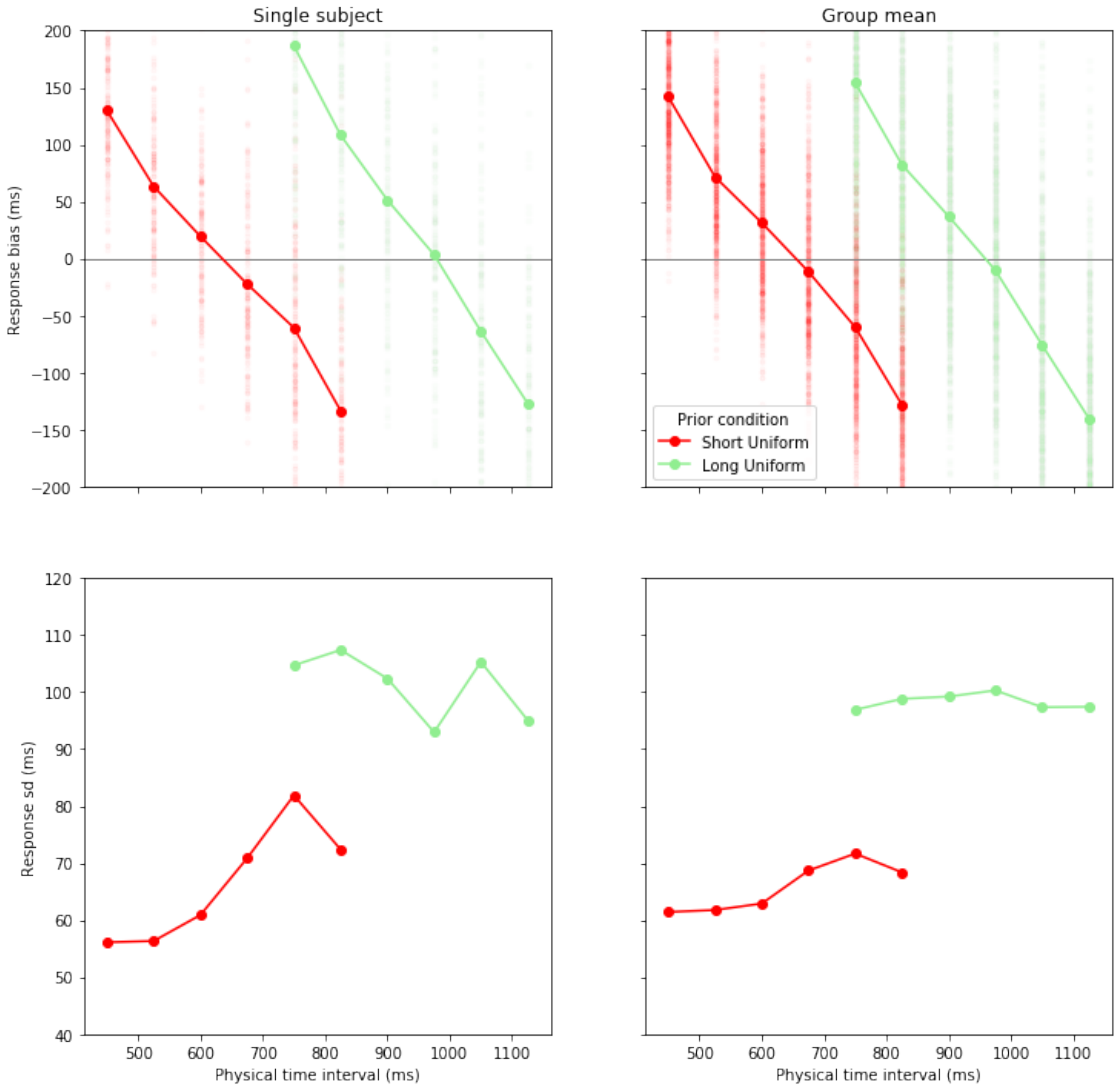
[16]:
```
# Plotting Experiment1:

# Remove training trials
dat = df[df['Main'] == True]
```

```
# Calculate mean Tp by condition
# mean_bias = dat.groupby(['Cond', 'Ts'])['Bias'].mean().reset_index()
mean_bias = dat.groupby(['Cond', 'Ts'])[['Tp', 'Bias']].agg({'Tp': 'std',␣
↪'Bias': 'mean'}).reset_index().rename({'Tp':'Std'}, axis = 1)

yrange = np.multiply((min(mean_bias['Bias']), max(mean_bias['Bias'])), [0.9, 1.
↪1])

# Subset data for plotting

cond1 = mean_bias.loc[mean_bias['Cond'] == "Short Uniform"]
cond2 = mean_bias.loc[mean_bias['Cond'] == "Long Uniform"]
cond3 = mean_bias.loc[mean_bias['Cond'] == "Medium Uniform"]
cond4 = mean_bias.loc[mean_bias['Cond'] == "Medium Peaked"]

# Add jitter noise
jitter = dat.copy()
jitter['Bias'] = jitter['Bias'] + np.random.uniform(-5, 5, len(dat))
cond1_jitter = jitter.loc[jitter['Cond'] == "Short Uniform"]
cond2_jitter = jitter.loc[jitter['Cond'] == "Long Uniform"]
cond3_jitter = jitter.loc[jitter['Cond'] == "Medium Uniform"]
cond4_jitter = jitter.loc[jitter['Cond'] == "Medium Peaked"]

# Make plot
# f, ax = plt.subplots(figsize = (6,6))
f, ax = plt.subplots(2, 2, sharex='all', sharey = 'row', figsize = (12, 12))

# Plot 1 Group Bias right
ax[0, 1].set_title("Group mean")
ax[0, 1].set(ylim = (-200, 200))
ax[0,1].axhline(linewidth=1, color='gray')

ax[0, 1].scatter(cond1_jitter['Ts'], cond1_jitter['Bias'], marker = '.', color␣
↪= 'red', alpha = 0.025, label = None)
ax[0, 1].scatter(cond2_jitter['Ts'], cond2_jitter['Bias'], marker = '.', color␣
↪= 'lightgreen', alpha = 0.025, label = None)

ax[0, 1].plot(cond1['Ts'], cond1['Bias'], color = 'red', marker = 'o', label =␣
↪"Short Uniform" )
ax[0, 1].plot(cond2['Ts'], cond2['Bias'], color = 'lightgreen', marker = 'o',␣
↪label = "Long Uniform")

ax[0, 1].legend(title = 'Prior condition', loc = 'best')

# Plot 2 Group Std right
```

```
ax[1, 1].set(ylim = (40, 120))
ax[1, 1].set_xlabel('Physical time interval (ms)')
# ax[1, 0].scatter(cond1_jitter['Ts'], cond1_jitter['Std'], marker = '.', color␣
 ↪= 'red', alpha = 0.025, label = None)
# ax[1, 0].scatter(cond2_jitter['Ts'], cond2_jitter['Std'], marker = '.', color␣
 ↪= 'green', alpha = 0.025, label = None)

ax[1, 1].plot(cond1['Ts'], cond1['Std'], color = 'red', marker = 'o', label =␣
 ↪"Short Uniform" )
ax[1, 1].plot(cond2['Ts'], cond2['Std'], color = 'lightgreen', marker = 'o',␣
 ↪label = "Long Uniform")
## selecting one representative subject:
subject = np.random.choice(dat[(dat.Cond.str.startswith('Long'))|(dat.Cond.str.
 ↪startswith('Short'))].Subj.unique(), replace = False)

dat_subj = dat[dat.Subj==subject]

# Calculate mean Tp by condition
mean_bias = dat_subj.groupby(['Cond', 'Ts'])[['Tp', 'Bias']].agg({'Tp': 'std',␣
 ↪'Bias': 'mean'}).reset_index().rename({'Tp':'Std'}, axis = 1)


# Subset data for plotting

cond1 = mean_bias.loc[mean_bias['Cond'] == "Short Uniform"]
cond2 = mean_bias.loc[mean_bias['Cond'] == "Long Uniform"]
cond3 = mean_bias.loc[mean_bias['Cond'] == "Medium Uniform"]
cond4 = mean_bias.loc[mean_bias['Cond'] == "Medium Peaked"]

# Add jitter noise
jitter = dat_subj.copy()
jitter['Bias'] = jitter['Bias'] + np.random.uniform(-5, 5, len(dat_subj))
cond1_jitter = jitter.loc[jitter['Cond'] == "Short Uniform"]
cond2_jitter = jitter.loc[jitter['Cond'] == "Long Uniform"]
cond3_jitter = jitter.loc[jitter['Cond'] == "Medium Uniform"]
cond4_jitter = jitter.loc[jitter['Cond'] == "Medium Peaked"]

# Plot 3 Individual bias left
ax[0, 0].set_title("Single subject")
ax[0, 0].set_ylabel('Response bias (ms)')
ax[0,0].axhline(linewidth=1, color='gray')

ax[0, 0].scatter(cond1_jitter['Ts'], cond1_jitter['Bias'], marker = '.', color␣
 ↪= 'red', alpha = 0.025, label = None)
ax[0, 0].scatter(cond2_jitter['Ts'], cond2_jitter['Bias'], marker = '.', color␣
 ↪= 'lightgreen', alpha = 0.025, label = None)
```

```
ax[0, 0].plot(cond1['Ts'], cond1['Bias'], color = 'red', marker = 'o', label =␣
 ↪"Short Uniform" )
ax[0, 0].plot(cond2['Ts'], cond2['Bias'], color = 'lightgreen', marker = 'o',␣
 ↪label = "Long Uniform")

# Plot 4 Individual Std left
# f.gca().set_aspect('equal', adjustable = 'box')

ax[1, 0].set_xlabel('Physical time interval (ms)')
ax[1, 0].set_ylabel('Response sd (ms)')
# ax[1, 0].scatter(cond1_jitter['Ts'], cond1_jitter['Std'], marker = '.', color␣
 ↪= 'red', alpha = 0.025, label = None)
# ax[1, 0].scatter(cond2_jitter['Ts'], cond2_jitter['Std'], marker = '.', color␣
 ↪= 'green', alpha = 0.025, label = None)

ax[1, 0].plot(cond1['Ts'], cond1['Std'], color = 'red', marker = 'o', label =␣
 ↪"Short Uniform" )
ax[1, 0].plot(cond2['Ts'], cond2['Std'], color = 'lightgreen', marker = 'o',␣
 ↪label = "Long Uniform")

f.savefig('plot3.png')
```

```
C:\Users\jonas\AppData\Roaming\Python\Python37\site-
packages\matplotlib\cbook\__init__.py:1402: FutureWarning: Support for multi-
dimensional indexing (e.g. `obj[:, None]`) is deprecated and will be removed in
a future version.  Convert to a numpy array before indexing instead.
  x[:, None]
C:\Users\jonas\AppData\Roaming\Python\Python37\site-
packages\matplotlib\axes\_base.py:276: FutureWarning: Support for multi-
dimensional indexing (e.g. `obj[:, None]`) is deprecated and will be removed in
a future version.  Convert to a numpy array before indexing instead.
  x = x[:, np.newaxis]
C:\Users\jonas\AppData\Roaming\Python\Python37\site-
packages\matplotlib\axes\_base.py:278: FutureWarning: Support for multi-
dimensional indexing (e.g. `obj[:, None]`) is deprecated and will be removed in
a future version.  Convert to a numpy array before indexing instead.
  y = y[:, np.newaxis]
```



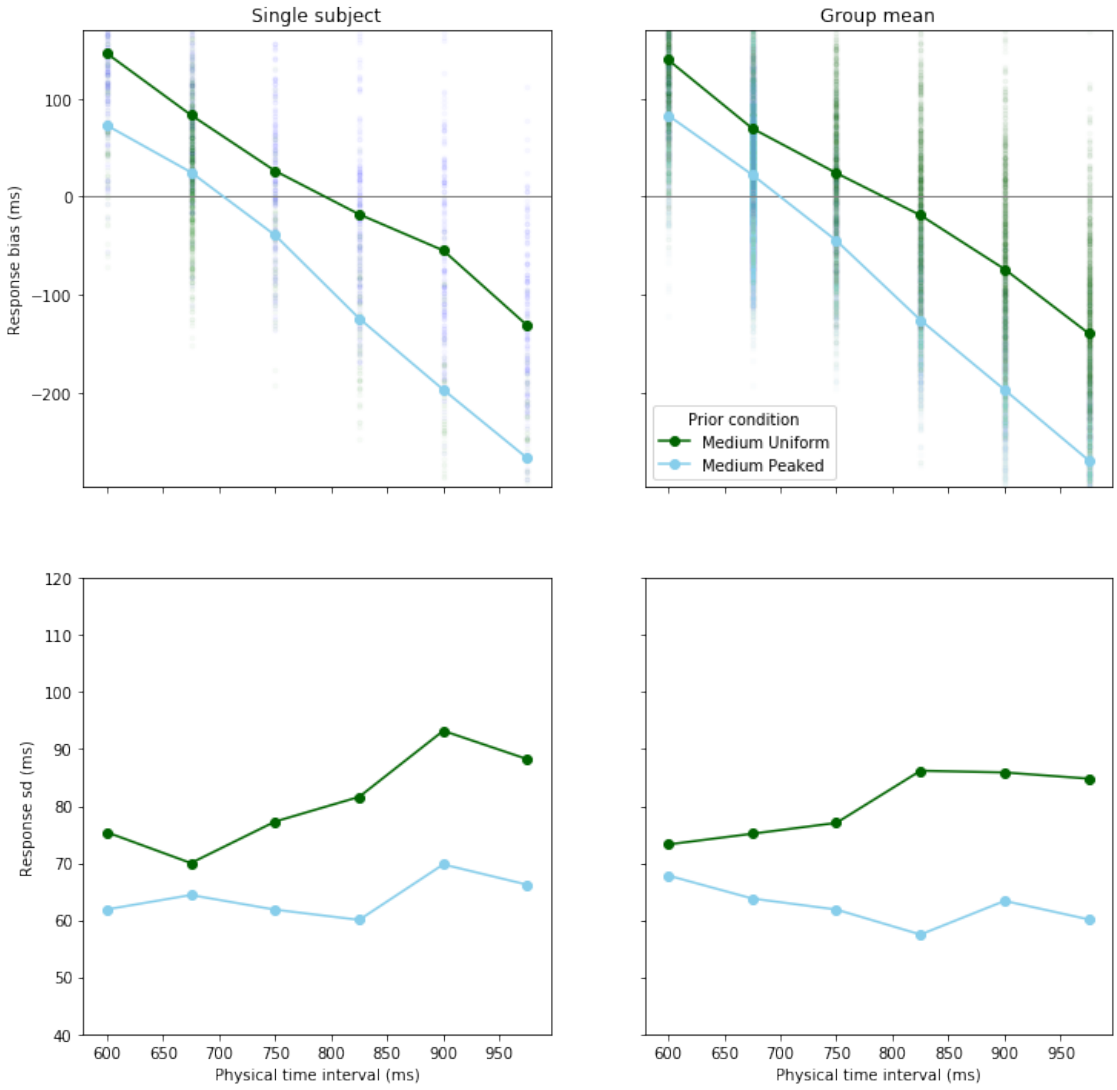
[17]:
```
# Plotting Experiment 2:

# Remove training trials
dat = df[df['Main'] == True]

# Calculate mean Tp by condition
# mean_bias = dat.groupby(['Cond', 'Ts'])['Bias'].mean().reset_index()
mean_bias = dat.groupby(['Cond', 'Ts'])[['Tp', 'Bias']].agg({'Tp': 'std',␣
↪'Bias': 'mean'}).reset_index().rename({'Tp':'Std'}, axis = 1)

yrange = np.multiply((min(mean_bias['Bias']), max(mean_bias['Bias'])), [1.1, 1.
↪1])
```

```
# Subset data for plotting

cond1 = mean_bias.loc[mean_bias['Cond'] == "Short Uniform"]
cond2 = mean_bias.loc[mean_bias['Cond'] == "Long Uniform"]
cond3 = mean_bias.loc[mean_bias['Cond'] == "Medium Uniform"]
cond4 = mean_bias.loc[mean_bias['Cond'] == "Medium Peaked"]

# Add jitter noise
jitter = dat.copy()
jitter['Bias'] = jitter['Bias'] + np.random.uniform(-5, 5, len(dat))
cond1_jitter = jitter.loc[jitter['Cond'] == "Short Uniform"]
cond2_jitter = jitter.loc[jitter['Cond'] == "Long Uniform"]
cond3_jitter = jitter.loc[jitter['Cond'] == "Medium Uniform"]
cond4_jitter = jitter.loc[jitter['Cond'] == "Medium Peaked"]

# Make plot
# f, ax = plt.subplots(figsize = (6,6))
f, ax = plt.subplots(2, 2, sharex='all', sharey='row', figsize = (12, 12))

# Plot 1 Group Bias right
ax[0, 1].set_title("Group mean")
ax[0, 1].set(ylim = yrange)
ax[0,1].axhline(linewidth=1, color='gray')


ax[0, 1].scatter(cond3_jitter['Ts'], cond3_jitter['Bias'], marker = '.', color␣
 ↪= 'darkgreen', alpha = 0.025, label = None)
ax[0, 1].scatter(cond4_jitter['Ts'], cond4_jitter['Bias'], marker = '.', color␣
 ↪= 'skyblue', alpha = 0.025, label = None)

ax[0, 1].plot(cond3['Ts'], cond3['Bias'], color = 'darkgreen', marker = 'o',␣
 ↪label = "Medium Uniform" )
ax[0, 1].plot(cond4['Ts'], cond4['Bias'], color = 'skyblue', marker = 'o',␣
 ↪label = "Medium Peaked")


ax[0, 1].legend(title = 'Prior condition', loc = 'best')

# Plot 2 Group Std right
ax[1, 1].set_xlabel('Physical time interval (ms)')
ax[1, 1].set(ylim = (40, 120))

# ax[1, 1].scatter(cond3_jitter['Ts'], cond3_jitter['Std'], marker = '.', color␣
 ↪= 'blue', alpha = 0.025, label = None)
# ax[1, 1].scatter(cond4_jitter['Ts'], cond4_jitter['Std'], marker = '.', color␣
 ↪= 'green', alpha = 0.025, label = None)
```

```
ax[1, 1].plot(cond3['Ts'], cond3['Std'], color = 'darkgreen', marker = 'o',␣
 ↪label = "Medium Uniform" )
ax[1, 1].plot(cond4['Ts'], cond4['Std'], color = 'skyblue', marker = 'o', label␣
 ↪= "Medium Peaked")

## selecting on represntative subject:
subject = np.random.choice(dat[dat.Cond.str.startswith('Medium')].Subj.
 ↪unique(), replace = False)


dat_subj = dat[dat.Subj==subject]

# Calculate mean Tp by condition
# mean_bias = dat.groupby(['Cond', 'Ts'])['Bias'].mean().reset_index()
mean_bias = dat_subj.groupby(['Cond', 'Ts'])[['Tp', 'Bias']].agg({'Tp': 'std',␣
 ↪'Bias': 'mean'}).reset_index().rename({'Tp':'Std'}, axis = 1)


# Subset data for plotting

cond1 = mean_bias.loc[mean_bias['Cond'] == "Short Uniform"]
cond2 = mean_bias.loc[mean_bias['Cond'] == "Long Uniform"]
cond3 = mean_bias.loc[mean_bias['Cond'] == "Medium Uniform"]
cond4 = mean_bias.loc[mean_bias['Cond'] == "Medium Peaked"]

# Add jitter noise
jitter = dat_subj.copy()
jitter['Bias'] = jitter['Bias'] + np.random.uniform(-5, 5, len(dat_subj))
cond1_jitter = jitter.loc[jitter['Cond'] == "Short Uniform"]
cond2_jitter = jitter.loc[jitter['Cond'] == "Long Uniform"]
cond3_jitter = jitter.loc[jitter['Cond'] == "Medium Uniform"]
cond4_jitter = jitter.loc[jitter['Cond'] == "Medium Peaked"]

# Plot 3 Individual bias left
ax[0, 0].set_title("Single subject")
ax[0, 0].set_ylabel('Response bias (ms)')
ax[0,0].axhline(linewidth=1, color='gray')

ax[0, 0].scatter(cond3_jitter['Ts'], cond3_jitter['Bias'], marker = '.', color␣
 ↪= 'blue', alpha = 0.025, label = None)
ax[0, 0].scatter(cond4_jitter['Ts'], cond4_jitter['Bias'], marker = '.', color␣
 ↪= 'green', alpha = 0.025, label = None)

ax[0, 0].plot(cond3['Ts'], cond3['Bias'], color = 'darkgreen', marker = 'o',␣
 ↪label = "Medium Uniform" )
```

```
ax[0, 0].plot(cond4['Ts'], cond4['Bias'], color = 'skyblue', marker = 'o',␣
 ↪label = "Medium Peaked")

# Plot 4 Individual Std left

ax[1, 0].set_xlabel('Physical time interval (ms)')
ax[1, 0].set_ylabel('Response sd (ms)')

# ax[1, 0].scatter(cond3_jitter['Std'], cond3_jitter['Bias'], marker = '.',␣
 ↪color = 'blue', alpha = 0.025, label = None)
# ax[1, 0].scatter(cond4_jitter['Std'], cond4_jitter['Bias'], marker = '.',␣
 ↪color = 'green', alpha = 0.025, label = None)

ax[1, 0].plot(cond3['Ts'], cond3['Std'], color = 'darkgreen', marker = 'o',␣
 ↪label = "Medium Uniform" )
ax[1, 0].plot(cond4['Ts'], cond4['Std'], color = 'skyblue', marker = 'o', label␣
 ↪= "Medium Peaked")
f.savefig('plot4.png')
```

```
C:\Users\jonas\AppData\Roaming\Python\Python37\site-
packages\matplotlib\cbook\__init__.py:1402: FutureWarning: Support for multi-
dimensional indexing (e.g. `obj[:, None]`) is deprecated and will be removed in
a future version.  Convert to a numpy array before indexing instead.
  x[:, None]
C:\Users\jonas\AppData\Roaming\Python\Python37\site-
packages\matplotlib\axes\_base.py:276: FutureWarning: Support for multi-
dimensional indexing (e.g. `obj[:, None]`) is deprecated and will be removed in
a future version.  Convert to a numpy array before indexing instead.
  x = x[:, np.newaxis]
C:\Users\jonas\AppData\Roaming\Python\Python37\site-
packages\matplotlib\axes\_base.py:278: FutureWarning: Support for multi-
dimensional indexing (e.g. `obj[:, None]`) is deprecated and will be removed in
a future version.  Convert to a numpy array before indexing instead.
  y = y[:, np.newaxis]
```


Single subject
Group mean
Response bias (ms)
100
0
−100
−200
Prior condition
Medium Uniform
Medium Peaked
Response sd (ms)
120
110
100
90
80
70
60
50
40
600
650
700
750
800
850
900
950
Physical time interval (ms)