- 1 Initialize
- 2 Main
- ▼ 3 Exploratory analysis
  - 3.1 Paths
  - 3.2 Annotations
  - 3.3 Parameters
  - 3.4 Loop of trials
  - 3.5 Behavioral data
  - 3.6 tag trials with sc
  - 3.7 Organize data
  - 3.8 Baseline fixation
  - 5.0 Dasellile lixation
  - 3.9 Align timestamp
  - 3.10 Timeseries me
  - **▼** 3.11 Plot
    - 3.11.1 Baseline p
    - 3.11.2 Baseline a
    - 3.12 extra
    - 3.13 Checking lengt
    - 3.14 Compare sd vs
    - 3.15 Count samples

# **▼** 1 Initialize

```
In [1]:
        from pupil apriltags import Detector, Detection
        from collections import defaultdict
        from typing import List, Dict, Tuple, Any
        from glob import glob
        import numpy as np
        import os
        import time
        import sys
        import cv2
        from math import atan2, degrees
        import platform
        import socket
        import matplotlib.pyplot as plt
        import math
        import pandas as pd
        import utils
        import multiprocessing
        from joblib import Parallel, delayed
        from numpy import save
        import pupil functions
        import decimal
        import pickle
        import extract diameter
        import operator
        import pupil filters
        import seaborn as sns
        from statsFuncs import mean confidence interval, no
        import diameter functions as ad
        %load_ext autoreload
        %autoreload 2
        executed in 753ms, finished 14:10:41 2020-07-10
```

# 2 Main

In [59]: time\_before\_imonset = -1 # seconds
max\_time=4
median\_pupil\_samples\_per\_sec = 70
times\_selected = np.linspace(time\_before\_imonset, r
executed in 11ms, finished 16:13:11 2020-07-10

# Contents 2 4

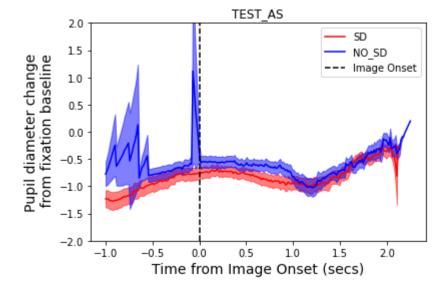
- 1 Initialize
- 2 Main
- ▼ 3 Exploratory analysis
  - 3.1 Paths
  - 3.2 Annotations
  - 3.3 Parameters
  - 3.4 Loop of trials
  - 3.5 Behavioral data
  - 3.6 tag trials with sc
  - 3.7 Organize data
  - 3.8 Baseline fixatior
  - 3.9 Align timestamp
  - 3.10 Timeseries me
  - **▼** 3.11 Plot
    - 3.11.1 Baseline p
    - 3.11.2 Baseline a
    - 3.12 extra
    - 3.13 Checking lengt
    - 3.14 Compare sd vs
    - 3.15 Count samples

```
Contents 2 &
  1 Initialize
   2 Main

▼ 3 Exploratory analysis
     3.1 Paths
     3.2 Annotations
     3.3 Parameters
     3.4 Loop of trials
     3.5 Behavioral data
     3.6 tag trials with sc
     3.7 Organize data
     3.8 Baseline fixation
     3.9 Align timestamp
     3.10 Timeseries me
  ▼ 3.11 Plot
      3.11.1 Baseline p
      3.11.2 Baseline a
     3.12 extra
     3.13 Checking lengt
     3.14 Compare sd vs
     3.15 Count samples
```

```
In [61]: havioral path = os.getcwd() + '/behavioral data/'
        r i in range(len(list_paths)):
           ad.main(behavioral path=behavioral path, EM path
         executed in 16m 42s, finished 16:41:13 2020-07-10
         /home/teresa/Documents/Naive_Spring_Eye_Recordings,
         riting.
         /home/teresa/Documents/Naive Spring Eye Recordings,
         92.81% of data excluded because < mininum confidence
         0.0% of data excluded because of pupil size is out
         Total of 3% of data kept
         /home/teresa/PycharmProjects/serialdependence radio
         A value is trying to be set on a copy of a slice f
         Try using .loc[row indexer,col indexer] = value in:
         See the caveats in the documentation: https://panda
         turning-a-view-versus-a-copy (https://pandas.pydata
         a-view-versus-a-copy)
           trial['TIMESTAMP CORRECTED'] = trial['timestamp'
         /home/teresa/PycharmProjects/serialdependence radio
         A value is trying to be set on a copy of a slice f
         Try using .loc[row indexer,col indexer] = value in:
         See the caveats in the documentation: https://panda
         turning-a-view-versus-a-copy (https://pandas.pydata
         a-view-versus-a-copy)
           trial['TIMESTAMP_CORRECTED_IMONSET'] = trial['tir
         Calculating Baseline Correction...
         Aligning timestamps...
         Block number: 1.0
         Block number: 2.0
         Block number: 3.0
         Calculating means per timestamp...
         /home/teresa/.local/lib/python3.8/site-packages/par
         verting a masked element to nan.
           values[indexer] = value
         Outputting plot...
```

- 1 Initialize
- 2 Main
- ▼ 3 Exploratory analysis
  - 3.1 Paths
  - 3.2 Annotations
  - 3.3 Parameters
  - 3.4 Loop of trials
  - 3.5 Behavioral data
  - 3.6 tag trials with sc
  - 3.7 Organize data
  - 3.8 Baseline fixation
  - 3.9 Align timestamp
  - 3.10 Timeseries me
  - **▼** 3.11 Plot
    - 3.11.1 Baseline p
    - 3.11.2 Baseline a
    - 3.12 extra
    - 3.13 Checking lengt
    - 3.14 Compare sd vs
    - 3.15 Count samples



Done!

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings,
rwriting.

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings, 88.99% of data excluded because < mininum confidence 0.0% of data excluded because of pupil size is out Total of 3% of data kept

/home/teresa/PycharmProjects/serialdependence\_radional A value is trying to be set on a copy of a slice for try using .loc[row indexer, col indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/home/teresa/PycharmProjects/serialdependence\_radio
A value is trying to be set on a copy of a slice f
Try using .loc[row indexer,col indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED\_IMONSET'] = trial['tir

Calculating Baseline Correction...

Aligning timestamps...

Block number: 1.0

Block number: 2.0

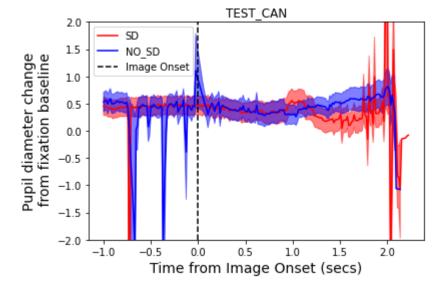
Block number: 3.0

Calculating means per timestamp...

/home/teresa/.local/lib/python3.8/site-packages/parverting a masked element to nan.

values[indexer] = value

- 1 Initialize
- 2 Main
- ▼ 3 Exploratory analysis
  - 3.1 Paths
  - 3.2 Annotations
  - 3.3 Parameters
  - 3.4 Loop of trials
  - 3.5 Behavioral data
  - 3.6 tag trials with sc
  - 3.7 Organize data
  - 3.8 Baseline fixation
  - 3.9 Align timestamp
  - 3.10 Timeseries me
  - **▼** 3.11 Plot
    - 3.11.1 Baseline p
    - 3.11.2 Baseline a
    - 3.12 extra
    - 3.13 Checking lengt
    - 3.14 Compare sd vs
    - 3.15 Count samples



Done!

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings,
riting.

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings, 75.1% of data excluded because < mininum confidence 0.0% of data excluded because of pupil size is out Total of 15% of data kept

/home/teresa/PycharmProjects/serialdependence\_radional A value is trying to be set on a copy of a slice for Try using .loc[row indexer, col indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/home/teresa/PycharmProjects/serialdependence\_radio
A value is trying to be set on a copy of a slice f
Try using .loc[row indexer,col indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED\_IMONSET'] = trial['tir

Calculating Baseline Correction...

Aligning timestamps...

Block number: 1.0

Block number: 2.0

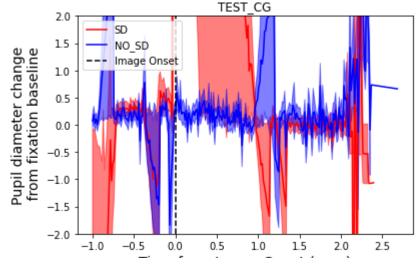
Block number: 3.0

Calculating means per timestamp...

/home/teresa/.local/lib/python3.8/site-packages/parnverting a masked element to nan.

values[indexer] = value

- 1 Initialize
- 2 Main
- ▼ 3 Exploratory analysis
  - 3.1 Paths
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  - 3.3 Parameters
  - 3.4 Loop of trials
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  - 3.6 tag trials with sc
  - 3.7 Organize data
  - 3.8 Baseline fixation
  - 3.9 Align timestamp
  - 3.10 Timeseries me
  - **▼** 3.11 Plot
    - 3.11.1 Baseline p
    - 3.11.2 Baseline a
    - 3.12 extra
    - 3.13 Checking lengt
    - 3.14 Compare sd vs
    - 3.15 Count samples



Done!

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings,
riting.

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings, 19.39% of data excluded because < mininum confidence 0.0% of data excluded because of pupil size is out Total of 65% of data kept

/home/teresa/PycharmProjects/serialdependence\_radional A value is trying to be set on a copy of a slice for Try using .loc[row indexer, col indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/home/teresa/PycharmProjects/serialdependence\_radio
A value is trying to be set on a copy of a slice f
Try using .loc[row indexer,col indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED\_IMONSET'] = trial['tir

Calculating Baseline Correction...

Aligning timestamps...

Block number: 1.0

Block Humber. 1.0

Block number: 2.0 Block number: 3.0

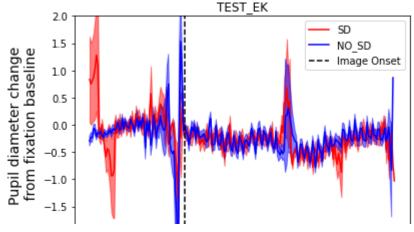
Calculating means per timestamp...

/home/teresa/.local/lib/python3.8/site-packages/par

verting a masked element to nan.

values[indexer] = value

- 1 Initialize
- 2 Main
- ▼ 3 Exploratory analysis
  - 3.1 Paths
  - 3.2 Annotations
  - 3.3 Parameters
  - 3.4 Loop of trials
  - 3.5 Behavioral data
  - 3.6 tag trials with sc
  - 3.7 Organize data
  - 3.8 Baseline fixation
  - 3.9 Align timestamp
  - 3.10 Timeseries me
  - **▼** 3.11 Plot
    - 3.11.1 Baseline p
    - 3.11.2 Baseline a
    - 3.12 extra
    - 3.13 Checking lengt
    - 3.14 Compare sd vs
    - 3.15 Count samples



Done!

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings,
riting.

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings, 57.14% of data excluded because < mininum confidence 0.0% of data excluded because of pupil size is out Total of 36% of data kept

/home/teresa/PycharmProjects/serialdependence\_radional A value is trying to be set on a copy of a slice for try using .loc[row\_indexer,col\_indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/home/teresa/PycharmProjects/serialdependence\_radio
A value is trying to be set on a copy of a slice f
Try using .loc[row indexer,col indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED\_IMONSET'] = trial['tir

Calculating Baseline Correction...

Aligning timestamps...

Block number: 1.0

Block number: 2.0

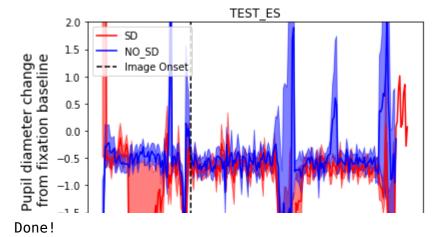
Block number: 3.0

Calculating means per timestamp...

/home/teresa/.local/lib/python3.8/site-packages/parverting a masked element to nan.

values[indexer] = value

- 1 Initialize
- 2 Main
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  - 3.6 tag trials with sc
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  - 3.8 Baseline fixation
  - 3.9 Align timestamp
  - 3.10 Timeseries me
  - **▼** 3.11 Plot
    - 3.11.1 Baseline p
    - 3.11.2 Baseline a
    - 3.12 extra
    - 3.13 Checking lengt
    - 3.14 Compare sd vs
    - 3.15 Count samples



/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings,
riting.

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings, 90.82% of data excluded because < mininum confidence.0.0% of data excluded because of pupil size is out Total of 3% of data kept

/home/teresa/PycharmProjects/serialdependence\_radional A value is trying to be set on a copy of a slice for try using .loc[row\_indexer,col\_indexer] = value in:

See the caveats in the documentation: https://pandaeturning-a-view-versus-a-copy (https://pandas.pydag-a-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/home/teresa/PycharmProjects/serialdependence\_radio
A value is trying to be set on a copy of a slice f
Try using .loc[row\_indexer,col\_indexer] = value in:

See the caveats in the documentation: https://pandaeturning-a-view-versus-a-copy (https://pandas.pydag-a-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED\_IMONSET'] = trial['tir

Calculating Baseline Correction...

Aligning timestamps...

Block number: 1.0

Block number: 2.0

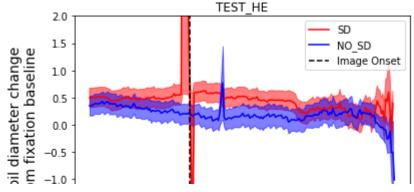
Block number: 3.0

Calculating means per timestamp...

/home/teresa/.local/lib/python3.8/site-packages/parverting a masked element to nan.

values[indexer] = value

- 1 Initialize
- 2 Main
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  - 3.7 Organize data
  - 3.8 Baseline fixation
  - 3.9 Align timestamp
  - 3.10 Timeseries me
  - **▼** 3.11 Plot
    - 3.11.1 Baseline p
    - 3.11.2 Baseline a
    - 3.12 extra
    - 3.13 Checking lengt
    - 3.14 Compare sd vs
    - 3.15 Count samples



Done!

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings, 33.4% of data excluded because < mininum confidence 0.0% of data excluded because of pupil size is out Total of 57% of data kept

/home/teresa/PycharmProjects/serialdependence\_radio A value is trying to be set on a copy of a slice f Try using .loc[row\_indexer,col\_indexer] = value in:

See the caveats in the documentation: https://pandaeturning-a-view-versus-a-copy (https://pandas.pydag-a-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/home/teresa/PycharmProjects/serialdependence\_radio
A value is trying to be set on a copy of a slice f
Try using .loc[row indexer,col indexer] = value in:

See the caveats in the documentation: https://pandaeturning-a-view-versus-a-copy (https://pandas.pydag-a-view-versus-a-copy)

trial['TIMESTAMP CORRECTED IMONSET'] = trial['tir

Calculating Baseline Correction...

Aligning timestamps...

Block number: 1.0

Block number: 2.0

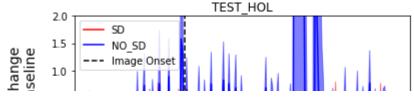
Block number: 3.0

Calculating means per timestamp...

/home/teresa/.local/lib/python3.8/site-packages/parverting a masked element to nan.

values[indexer] = value

- 1 Initialize
- 2 Main
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    - 3.11.1 Baseline p
    - 3.11.2 Baseline a
    - 3.12 extra
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    - 3.15 Count samples



Done!

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings, 56.56% of data excluded because < mininum confidence 0.0% of data excluded because of pupil size is out Total of 41% of data kept

/home/teresa/PycharmProjects/serialdependence\_radional A value is trying to be set on a copy of a slice for try using .loc[row indexer, col indexer] = value in:

See the caveats in the documentation: https://pandaeturning-a-view-versus-a-copy (https://pandas.pydag-a-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/home/teresa/PycharmProjects/serialdependence\_radio
A value is trying to be set on a copy of a slice f
Try using .loc[row\_indexer,col\_indexer] = value in:

See the caveats in the documentation: https://pandaeturning-a-view-versus-a-copy (https://pandas.pydag-a-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED IMONSET'] = trial['tir

Calculating Baseline Correction...

Aligning timestamps...

Block number: 1.0

Block number: 2.0

Block number: 3.0

Calculating means per timestamp...

/home/teresa/.local/lib/python3.8/site-packages/parverting a masked element to nan.

values[indexer] = value

#### TEST HY

#### Done!

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings, 19.14% of data excluded because < mininum confidence 0.0% of data excluded because of pupil size is out Total of 66% of data kept

/home/teresa/PycharmProjects/serialdependence\_radio A value is trying to be set on a copy of a slice f Try using .loc[row\_indexer,col\_indexer] = value in:

See the caveats in the documentation: https://pandaeturning-a-view-versus-a-copy (https://pandas.pydag-a-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/home/teresa/PycharmProjects/serialdependence\_radio
A value is trying to be set on a copy of a slice f
Try using .loc[row\_indexer,col\_indexer] = value in:

See the caveats in the documentation: https://pandaeturning-a-view-versus-a-copy (https://pandas.pydag-a-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED\_IMONSET'] = trial['tir

Calculating Baseline Correction...

Aligning timestamps...

Block number: 1.0

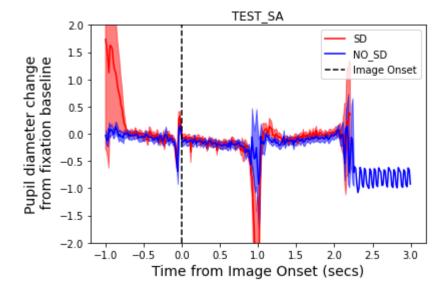
Block number: 2.0 Block number: 3.0

Calculating means per timestamp...

/home/teresa/.local/lib/python3.8/site-packages/parverting a masked element to nan.

values[indexer] = value

Outputting plot...



Done!

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3.9 Align timestamp

3.10 Timeseries me

**▼** 3.11 Plot

3.11.1 Baseline p

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3.12 extra

3.13 Checking lengt

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  - 3.9 Align timestamp
  - 3.10 Timeseries me
  - **▼** 3.11 Plot
    - 3.11.1 Baseline p
    - 3.11.2 Baseline a
    - 3.12 extra
    - 3.13 Checking lengt
    - 3.14 Compare sd vs
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```
In [62]:
```

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings,
rwriting.

/home/teresa/Documents/Naive\_Spring\_Eye\_Recordings, 11.93% of data excluded because < mininum confidence 0.0% of data excluded because of pupil size is out Total of 81% of data kept

/home/teresa/PycharmProjects/serialdependence\_radio A value is trying to be set on a copy of a slice f Try using .loc[row indexer,col indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/home/teresa/PycharmProjects/serialdependence\_radio
A value is trying to be set on a copy of a slice f
Try using .loc[row indexer,col indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED\_IMONSET'] = trial['tir

```
Calculating Baseline Correction...
Aligning timestamps...
Block number: 1.0
Block number: 2.0
Block number: 3.0
Calculating means per timestamp...
Outputting plot...
```

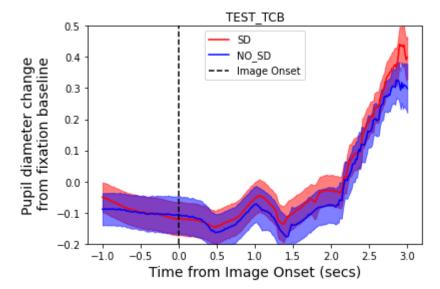
/home/teresa/.local/lib/python3.8/site-packages/parverting a masked element to nan.

values[indexer] = value

```
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```

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  - 3.9 Align timestamp
  - 3.10 Timeseries me
  - **▼** 3.11 Plot
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Done!

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  - 3.10 Timeseries me
  - **▼** 3.11 Plot
    - 3.11.1 Baseline p
    - 3.11.2 Baseline a
    - 3.12 extra
    - 3.13 Checking lengt
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    - 3.15 Count samples

In [51]: ad.main(behavioral\_path=behavioral\_path, EM\_path =

executed in 2m 3s, finished 15:32:57 2020-07-08

/Users/teresa/Dropbox/Naive\_Spring\_Eye\_Recordings\_ overwriting.

/Users/teresa/Dropbox/Naive\_Spring\_Eye\_Recordings\_ 88.99% of data excluded because < mininum confidence 0.0% of data excluded because of pupil size is out Total of 3% of data kept

/Users/teresa/PycharmProjects/serialdependence\_rad: A value is trying to be set on a copy of a slice f Try using .loc[row indexer,col indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/Users/teresa/PycharmProjects/serialdependence\_rad:
A value is trying to be set on a copy of a slice f
Try using .loc[row\_indexer,col\_indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED\_IMONSET'] = trial['tir

Calculating Baseline Correction...

Aligning timestamps...

Block number: 1.0

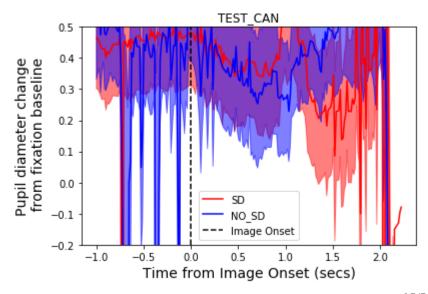
Block number: 2.0

Block number: 3.0

Calculating means per timestamp...

/opt/anaconda3/lib/python3.7/site-packages/pandas/
ng a masked element to nan.

values[indexer] = value



#### Done!

# 1 Initialize 2 Main ▼ 3 Exploratory analysis 3.1 Paths 3.2 Annotations 3.3 Parameters 3.4 Loop of trials 3.5 Behavioral data 3.6 tag trials with sc 3.7 Organize data 3.8 Baseline fixatior 3.9 Align timestamp 3.10 Timeseries me **▼** 3.11 Plot 3.11.1 Baseline p 3.11.2 Baseline a 3.12 extra 3.13 Checking lengt 3.14 Compare sd vs 3.15 Count samples

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In [52]: ad.main(behavioral\_path=behavioral\_path, EM\_path =

executed in 4m 4s, finished 15:52:06 2020-07-08

/Users/teresa/Dropbox/Naive\_Spring\_Eye\_Recordings\_ erwriting.

/Users/teresa/Dropbox/Naive\_Spring\_Eye\_Recordings\_ 75.1% of data excluded because < mininum confidence 0.0% of data excluded because of pupil size is out Total of 15% of data kept

/Users/teresa/PycharmProjects/serialdependence\_rad: A value is trying to be set on a copy of a slice f Try using .loc[row\_indexer,col\_indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/Users/teresa/PycharmProjects/serialdependence\_rad:
A value is trying to be set on a copy of a slice f
Try using .loc[row\_indexer,col\_indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED\_IMONSET'] = trial['tir

Calculating Baseline Correction...

Aligning timestamps...

Block number: 1.0

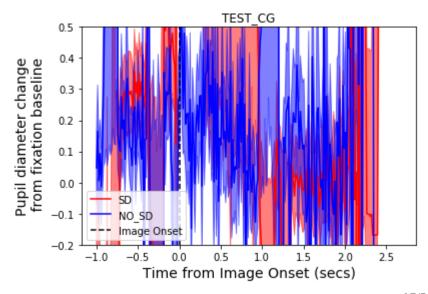
Block number: 2.0

Block number: 3.0

Calculating means per timestamp...

/opt/anaconda3/lib/python3.7/site-packages/pandas/
ng a masked element to nan.

values[indexer] = value



#### Done!

# 1 Initialize 2 Main ▼ 3 Exploratory analysis 3.1 Paths 3.2 Annotations 3.3 Parameters 3.4 Loop of trials 3.5 Behavioral data 3.6 tag trials with sc 3.7 Organize data 3.8 Baseline fixatior 3.9 Align timestamp 3.10 Timeseries me **▼** 3.11 Plot 3.11.1 Baseline p 3.11.2 Baseline a 3.12 extra 3.13 Checking lengt 3.14 Compare sd vs 3.15 Count samples

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    - 3.12 extra
    - 3.13 Checking lengt
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    - 3.15 Count samples

In [53]: ad.main(behavioral\_path=behavioral\_path, EM\_path =

executed in 2m 9s, finished 15:57:48 2020-07-08

/Users/teresa/Dropbox/Naive\_Spring\_Eye\_Recordings\_ erwriting.

/Users/teresa/Dropbox/Naive\_Spring\_Eye\_Recordings\_ 90.82% of data excluded because < mininum confidence 0.0% of data excluded because of pupil size is out Total of 3% of data kept

/Users/teresa/PycharmProjects/serialdependence\_rad: A value is trying to be set on a copy of a slice f Try using .loc[row\_indexer,col\_indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/Users/teresa/PycharmProjects/serialdependence\_rad:
A value is trying to be set on a copy of a slice f
Try using .loc[row\_indexer,col\_indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED\_IMONSET'] = trial['tir

Calculating Baseline Correction...

Aligning timestamps...

Block number: 1.0

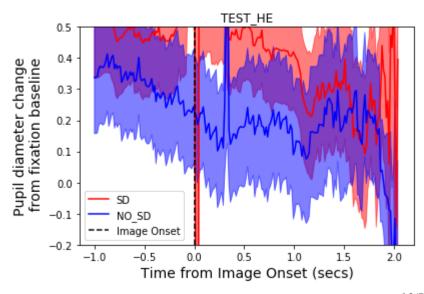
Block number: 2.0

Block number: 3.0

Calculating means per timestamp...

/opt/anaconda3/lib/python3.7/site-packages/pandas/
ng a masked element to nan.

values[indexer] = value



Done!

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# 3 Exploratory analysis

# ▼ 3.1 Paths

```
In [46]: datapath = os.getcwd() + '/behavioral_data/'

if platform.system() == 'Darwin':
        EM_path = '/Users/teresa/Dropbox/Naive_Spring_I
elif platform.system() == 'Linux':
        EM_path = '/home/teresa/Documents/Naive_Spring_
executed in 13ms, finished 15:54:19 2020-07-10
In [47]: behavioral data = nd_road_csy/datapath + 'EK_VM_out
```

```
In [47]: behavioral_data = pd.read_csv(datapath + 'EK_VM_out
# cut file just to have the 255 rows of data
behavioral_data = behavioral_data.iloc[range(255)]
# annotation_data = pd.read_csv(datapath + 'pl_msg:
timestamp_path = EM_path + 'world_timestamps.npy'
executed in 16ms, finished 15:54:19 2020-07-10
```

## 3.2 Annotations

```
In [48]: annotation_data = pupil_functions.load_annotations
    executed in 2.85s, finished 15:54:24 2020-07-10
```

# 3.3 Parameters

```
In [49]: min_confidence = 0.8
min_diameter = 1.5
max_diameter = 9
executed in 7ms, finished 15:54:24 2020-07-10
```

```
In [50]: extract_diameter.main(recordings=[EM_path], csv_outexcuted in 3.81s, finished 15:54:27 2020-07-10
    /home/teresa/Documents/Naive_Spring_Eye_Recordings,
```

# 3.4 Loop of trials

- 1 Initialize
- 2 Main
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    - 3.11.1 Baseline p
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```
In [39]: trial_unique = behavioral_data.trialNumber.unique()
block_unique = behavioral_data.blockNumber.unique()
numBlocks = len(block_unique)
numTrials = len(trial_unique)

totalNumTrials = len(behavioral_data)
executed in 12ms, finished 15:52:50 2020-07-10
```

In [40]:

```
Contents 2 &
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     3.3 Parameters
     3.4 Loop of trials
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     3.8 Baseline fixation
     3.9 Align timestamp
     3.10 Timeseries me
  ▼ 3.11 Plot
       3.11.1 Baseline p
       3.11.2 Baseline a
     3.12 extra
     3.13 Checking lengt
     3.14 Compare sd vs
     3.15 Count samples
```

```
tot trial = 0
row = 0
for block in block unique:
    if not np.isnan(block):
        print('Processing block ' + str(block) + '
        for trial number in trial unique:
            if not np.isnan(trial number):
                print('Processing trial ' + str(tr:
                # get timestamps of trial events
                trial_beg_ts = annotation_data[(an)
                trial_imOnset ts = annotation data
                trial end ts = annotation data[(ani
                trial_fix_beg_ts = annotation_data
                trial fix end ts = trial imOnset ts
                trial adjustment ts = annotation da
                trial_adjustment_ts_corrected = tr:
                trial fixation = df diameter[(df d:
                trial = df diameter[(df diameter['
                if not trial.empty:
                    # add info:
                    df diameter.loc[(df diameter['
                    df diameter.loc[(df diameter['
                      df diameter.loc[(df diameter)
                    # clean data
                    trial cleaned = trial[(trial['
                            (trial['diameter 3d [mm]
                            (trial['diameter 3d [mm]
                    trial fixation cleaned = trial
                            (trial_fixation['diamete
                            (trial fixation['diamete
                    bad samples = len(trial) - len
                    bad samples perc = (bad samples
                    print(str(bad samples) + ' bad
                    trial_cleaned['timestamp_correc
                    eye 1 cleaned = trial cleaned.
                    eye 0 cleaned = trial cleaned.
                    minimum cleaned = np.min(trial
                    maximum cleaned = np.max(trial
                    eye 1 fix cleaned = np.median(
                    eye 0 fix cleaned = np.median(
                    plt.plot(eye 1 cleaned['timesta'
                    plt.plot(eye 0 cleaned['timesta
                    plt.hlines(eye_0_fix_cleaned, r
                    plt.hlines(eye 1 fix cleaned, r
                    plt.vlines(trial adjustment ts
```

```
plt.xlabel('Time since image or
plt.ylabel('Diameter (mm)')
plt.ylim([1.5, 9])
plt.xlim([0, 7])
plt.legend()
plt.show()
```

executed in 46ms, finished 15:52:51 2020-07-10

```
Contents 2 ☆
```

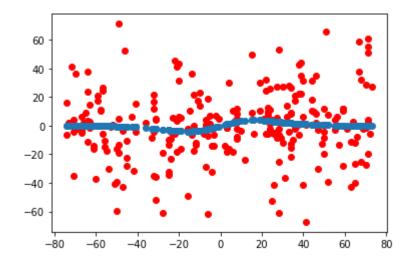
- 1 Initialize
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  - 3.5 Behavioral data
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# 3.5 Behavioral data

Type *Markdown* and LaTeX:  $\alpha^2$ 

```
In [17]: plt.plot(behavioral_data['Stim_diff'], behavioral_c
plt.plot(behavioral_data['Stim_diff'], behavioral_c
executed in 175ms, finished 15:00:56 2020-07-08
```

Out[17]: [<matplotlib.lines.Line2D at 0x1a23be0a10>]



# 3.6 tag trials with sd

# 

- 3.1 Paths3.2 Annotations
- 3.3 Parameters
- 3.4 Loop of trials
- 3.5 Behavioral data
- 5.5 Benavioral data
- 3.6 tag trials with sc
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- 3.9 Align timestamp
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  - 3.12 extra
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In [18]:

```
Contents 2 &
  1 Initialize
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     3.4 Loop of trials
    3.5 Behavioral data
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     3.7 Organize data
     3.8 Baseline fixation
    3.9 Align timestamp
    3.10 Timeseries me
  ▼ 3.11 Plot
       3.11.1 Baseline p
       3.11.2 Baseline a
     3.12 extra
     3.13 Checking lengt
     3.14 Compare sd vs
     3.15 Count samples
```

```
trial sd = pd.DataFrame()
row = 0
for block in block unique:
    if not np.isnan(block):
        print('Processing block ' + str(block) + '
        for trial in trial unique:
            if not np.isnan(trial):
                 print(trial)
                 trial_data = behavioral_data[(behav
                 if not trial data.empty:
                     if (trial_data.loc[0,'Stim_dif')
                         trial_sd.loc[row, 'BLOCK']
                         trial_sd.loc[row,
                                             'TRIAL']
                         trial sd.loc[row,
                                             'SD COND:
                         df diameter.loc[df diameter
                         row += 1
                     elif (trial data.loc[0, 'Stim (
                         trial sd.loc[row,
                                             'BLOCK']
                         trial_sd.loc[row,
                                             'TRIAL']
                         trial sd.loc[row, 'SD COND:
                         df diameter.loc[df diameter
                         row += 1
                     else:
                         trial sd.loc[row,
                                            'BLOCK']
                                             'TRIAL']
                         trial sd.loc[row,
                         trial sd.loc[row, 'SD COND:
                         df_diameter.loc[df_diameter
                         row += 1
executed in 1.91s, finished 15:01:02 2020-07-08
```

Processing block 1.0 out of 4

1.0

2.0

3.0

4.0

5.0

6.0

7.0

2 Main

# 1 Initialize ▼ 3 Exploratory analysis 3.1 Paths 3.2 Annotations 3.3 Parameters 3.4 Loop of trials 3.5 Behavioral data 3.6 tag trials with sc 3.7 Organize data 3.8 Baseline fixatior 3.9 Align timestamp 3.10 Timeseries me **▼** 3.11 Plot 3.11.1 Baseline p 3.11.2 Baseline a 3.12 extra 3.13 Checking lengt 3.14 Compare sd vs 3.15 Count samples

```
analysis_diameter - Jupyter Notebook
           8.0
           9.0
           10.0
           11.0
           12.0
           13.0
           14.0
           15.0
           16.0
           17.0
           18.0
In [19]:
           df_diameter_nonan = df_diameter.dropna()
           executed in 93ms, finished 15:01:03 2020-07-08
In [20]:
           eye_1 = df_diameter_nonan[df_diameter_nonan['eye_ic
           executed in 53ms, finished 15:01:03 2020-07-08
```

# 3.7 Organize data

In [52]:

```
Contents 2 &
  1 Initialize
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     3.3 Parameters
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     3.6 tag trials with sc
     3.7 Organize data
     3.8 Baseline fixation
    3.9 Align timestamp
     3.10 Timeseries me
  ▼ 3.11 Plot
       3.11.1 Baseline p
       3.11.2 Baseline a
    3.12 extra
     3.13 Checking lengt
     3.14 Compare sd vs
     3.15 Count samples
```

```
def initial clean(df, annotations df, min confidence
    df cleaned = df[(df['confidence'] >= min confic
                    (df['diameter 3d [mm]'] >= min
                    (df['diameter 3d [mm]'] <= max</pre>
    exp begins ts = annotations df[annotations df[
    exp ends ts = annotations df[annotations df['ex
    perc trials bad confidence = (len(df[df['confidence']
    print(str(round(perc_trials_bad_confidence, 2))
    perc trials outlier = (len(df[(df['diameter 3d
    print(str(round(perc_trials_outlier, 2)) + '% (
    df cleaned = df cleaned[(df cleaned['timestamp
    perc_good_data = (len(df_cleaned)/len(df))*100
    print('Total of ' + str(round(perc good data))
    return df cleaned
def correct_timestamps(df, annotations_df, behavio
    trial_unique = behavioral_df.trialNumber.unique
    block unique = behavioral df.blockNumber.unique
    for block in block unique:
        if not np.isnan(block):
            for trial number in trial unique:
                if not np.isnan(trial number):
                    # get timestamps of trial even
                    trial beg ts = annotations df[
                    trial_end_ts = annotations_df[
                      print('start: 'trial beg ts)
                    trial_imOnset_ts = annotations
                    trial fix beg ts = annotations
                    trial fix end ts = trial imOnse
                    trial_adjustment_ts = annotation
                    trial adjustment ts corrected:
                    trial = df[(df['timestamp'] >=
                    trial['TIMESTAMP CORRECTED'] =
                    # now the timestamp correct is
                    # now lets also have a timestar
                    trial['TIMESTAMP_CORRECTED_IMON
                    df.loc[(df['timestamp'] >= triage
                    df.loc[(df['timestamp'] >= triage
                    # label trials and blocks in e
                    df.loc[(df['timestamp'] >= triage
```

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    - 3.12 extra
    - 3.13 Checking lengt
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    - 3.15 Count samples

```
df.loc[(df['timestamp'] >= triage
    return df
def label_trials_sd(df, behavioral_df):
    trial unique = behavioral df.trialNumber.unique
    block unique = behavioral df.blockNumber.unique
    trial sd = pd.DataFrame()
    row = 0
    for block in block unique:
        if not np.isnan(block):
            print('Processing block ' + str(block)
            for trial in trial_unique:
                if not np.isnan(trial):
                    trial data = behavioral df[(bel
                    if not trial_data.empty:
                         if (trial_data.loc[0,'Stim_
                             trial sd.loc[row, 'BLOG
                             trial sd.loc[row,
                                                'TRI/
                             trial sd.loc[row, 'SD (
                             df.loc[df['TRIAL'] == 1
                             row += 1
                         elif (trial data.loc[0, 'S'
                             trial_sd.loc[row,
                                                'BL0(
                             trial_sd.loc[row, 'TRI/
                             trial sd.loc[row, 'SD (
                             df.loc[df['TRIAL'] == '
                             row += 1
                         else:
                             trial sd.loc[row, 'BLOG
                             trial_sd.loc[row,
                                                'TRI/
                             trial sd.loc[row, 'SD (
                             df.loc[df['TRIAL'] == 1
                             row += 1
    return df, trial sd
def label_events(df, annotations_df, behavioral_df)
```

```
Contents 2 &
  1 Initialize
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     3.3 Parameters
     3.4 Loop of trials
     3.5 Behavioral data
     3.6 tag trials with sc
     3.7 Organize data
     3.8 Baseline fixation
     3.9 Align timestamp
     3.10 Timeseries me
  ▼ 3.11 Plot
       3.11.1 Baseline p
       3.11.2 Baseline a
     3.12 extra
     3.13 Checking lengt
     3.14 Compare sd vs
     3.15 Count samples
```

```
trial unique = behavioral df.trialNumber.unique
             block_unique = behavioral_df.blockNumber.unique
             for block in block unique:
                  if not np.isnan(block):
                      for trial number in trial unique:
                          if not np.isnan(trial number):
                              # get timestamps of trial even
                              # trial starts & end
                              trial beg ts = annotations df[
                              trial_end_ts = annotations_df[
                              # fixation starts & end
                              trial fix beg ts = annotations
                              trial_fix_end_ts = annotations
                              df.loc[(df['timestamp'] >= triage
                              # image starts & end
                              trial imOnset ts = annotations
                              trial imOffset ts = annotation:
                              df.loc[(df['timestamp'] >= triage
                              # adjust starts & end
                              trial adjust beg ts = annotation
                              trial adjust end ts = annotation
                              df.loc[(df['timestamp'] >= triage
                              # beg of trial
                              df.loc[(df['timestamp'] >= triage
                              # end of trial
                              df.loc[(df['timestamp'] >= triage
              return df
         executed in 34ms, finished 15:54:42 2020-07-10
In [53]: def pupil_preprocess(df, annotation_df, behavioral_
             df diameter cleaned = initial clean(df, annotat
             df_diameter_cleaned_ts = correct_timestamps(df_
             df_diameter_cleaned_ts_labeled, trial_sd = labe
             df final = label events(df diameter cleaned ts
              return df final, trial sd
```

executed in 12ms, finished 15:54:43 2020-07-10

df final, trial sd = pupil preprocess(df diameter,

```
executed in 6.70s, finished 15:54:50 2020-07-10
                                       19.39% of data excluded because < mininum confidence
                                       0.0% of data excluded because of pupil size is out
                                       Total of 65% of data kept
Contents 2 &
                                       <ipython-input-52-1e921d8fe646>:46: SettingWithCopy
  1 Initialize
                                       A value is trying to be set on a copy of a slice f
  2 Main
                                       Try using .loc[row indexer,col indexer] = value in:

▼ 3 Exploratory analysis
   3.1 Paths
                                       See the caveats in the documentation: https://panda
   3.2 Annotations
                                       turning-a-view-versus-a-copy (https://pandas.pydata
                                       a-view-versus-a-copy)
   3.3 Parameters
                                         trial['TIMESTAMP CORRECTED'] = trial['timestamp'
   3.4 Loop of trials
                                       <ipython-input-52-le92ld8fe646>:50: SettingWithCop*
   3.5 Behavioral data
                                       A value is trying to be set on a copy of a slice f
   3.6 tag trials with sc
                                       Try using .loc[row indexer,col indexer] = value in:
   3.7 Organize data
   3.8 Baseline fixation
                                       See the caveats in the documentation: https://panda
   3.9 Align timestamp
                                       turning-a-view-versus-a-copy (https://pandas.pydata
   3.10 Timeseries me
                                       a-view-versus-a-copy)
  ▼ 3.11 Plot
                                         trial['TIMESTAMP CORRECTED IMONSET'] = trial['tir
     3.11.1 Baseline p
     3.11.2 Baseline a
                                       Processing block 1.0 out of 4
   3.12 extra
                                       Processing block 2.0 out of 4
   3.13 Checking lengt
                                       Processing block 3.0 out of 4
   3.14 Compare sd vs
   3.15 Count samples
                                       KeyboardInterrupt
                                       <ipython-input-54-9fc144044755> in <module>
                                       ----> 1 df final, trial sd = pupil preprocess(df d:
                                       <ipython-input-53-257834329e67> in pupil preproces:
                                                    df diameter cleaned ts labeled, trial :
                                              7
                                              8
                                                    df final = label events(df_diameter_cle
                                       ---> 9
                                             10
                                                    return df_final, trial sd
                                       <ipython-input-52-le92ld8fe646> in label events(df
                                                                      trial imOffset ts = ani
                                       (annotations df['trial'] == str(int(trial number))
                                       reset index(drop=True)[0]
                                            138
                                       --> 139
                                                                      df.loc[(df['timestamp'
                                       s), 'EVENT'] = 'blob'
                                            140
                                            141
                                                                      # adjust starts & end
                                       ~/.local/lib/python3.8/site-packages/pandas/core/ii
                                                             key = com.apply_if_callable(key)
                                           669
                                           670
                                                         indexer = self. get setitem indexe
                                       --> 671
                                                         self. setitem with indexer(indexer
                                            672
                                            673
                                                    def _validate_key(self, key, axis: int
```

In [54]:

Traceback

```
Contents 2 &
  1 Initialize
   2 Main

▼ 3 Exploratory analysis
     3.1 Paths
     3.2 Annotations
     3.3 Parameters
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```

```
~/.local/lib/python3.8/site-packages/pandas/core/ii
   1027
                         # scalar
   1028
                         for item in labels:
-> 1029
                             setter(item, value)
   1030
   1031
                else:
~/.local/lib/python3.8/site-packages/pandas/core/ii
    964
    965
                         # reset the sliced object :
--> 966
                         self.obj[item] = s
    967
                    # we need an iterable, with a r
    968
~/.local/lib/python3.8/site-packages/pandas/core/f
   2936
                else:
   2937
                     # set column
-> 2938
                     self. set item(key, value)
   2939
   2940
            def setitem slice(self, key, value):
~/.local/lib/python3.8/site-packages/pandas/core/f
   2998
   2999
                self._ensure_valid_index(value)
                value = self._sanitize_column(key,
-> 3000
                NDFrame. set item(self, key, value
   3001
   3002
~/.local/lib/python3.8/site-packages/pandas/core/f
   3611
   3612
                if isinstance(value, Series):
-> 3613
                    value = reindexer(value)
   3614
   3615
                elif isinstance(value, DataFrame):
~/.local/lib/python3.8/site-packages/pandas/core/f
   3592
   3593
                     if value.index.equals(self.inde
-> 3594
                         value = value._values.copy
   3595
                     else:
   3596
```

### KeyboardInterrupt:

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88.99% of data excluded because < mininum confidence 0.0% of data excluded because of pupil size is out Total of 3% of data kept

/Users/teresa/PycharmProjects/serialdependence\_rad: A value is trying to be set on a copy of a slice f Try using .loc[row indexer,col indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED'] = trial['timestamp'
/Users/teresa/PycharmProjects/serialdependence\_rad:
A value is trying to be set on a copy of a slice f
Try using .loc[row indexer,col indexer] = value in:

See the caveats in the documentation: https://pandaturning-a-view-versus-a-copy (https://pandas.pydata-view-versus-a-copy)

trial['TIMESTAMP\_CORRECTED\_IMONSET'] = trial['tir

# 3.8 Baseline fixation

In [25]:

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```
def pupil baseline(df, behavioral df):
    trial unique = behavioral df.trialNumber.unique
    block unique = behavioral df.blockNumber.unique
    fixation baseline = pd.DataFrame()
    row=0
    for block in block_unique:
        if not np.isnan(block):
            for trial number in trial unique:
                 if not np.isnan(trial number):
                     # get fixation data:
                     trial data = df[(df['BLOCK'] ==
                     # it seems that for some trial
                     mean_fix, ci_low_fix, ci_up_fix
                     fixation baseline.loc[row,
                     fixation baseline.loc[row,
                                                  'TR:
                     fixation baseline.loc[row,
                                                  'ME/
                     fixation baseline.loc[row,
                                                 'CI
                     fixation baseline.loc[row,
                     row += 1
                     df.loc[(df['BLOCK'] == block) {
    return df, fixation_baseline
def pupil baseline alltrials(df):
    # get overall mean fixation:
    fix data = df[df['EVENT'] == 'fixation']
    mean_fix, ci_low_fix, ci_up_fix = mean_confider
    df['PS CORRECTED ALLTRIALS'] = df['diameter 3d
    return df
executed in 234ms, finished 15:01:25 2020-07-08
```

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In [26]: df\_final, fixation\_baseline = ad.pupil\_baseline(df\_
df\_final = ad.pupil\_baseline\_alltrials(df\_final)

executed in 2.20s, finished 15:01:27 2020-07-08

/opt/anaconda3/lib/python3.7/site-packages/numpy/co for slice

keepdims=keepdims)

/opt/anaconda3/lib/python3.7/site-packages/numpy/co
ed in true divide

arrmean, rcount, out=arrmean, casting='unsafe', sopt/anaconda3/lib/python3.7/site-packages/numpy/coed in double scalars

ret = ret.dtype.type(ret / rcount)

Out[27]:

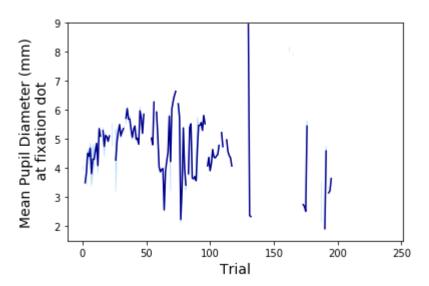
	eye_id	timestamp	topic	confidence	diameter_2d [px]	diame
0	1	1.583872e+09	pupil.1	0.806958	40.063453	5.
1	1	1.583872e+09	pupil.1	0.814146	40.121343	5.
2	1	1.583872e+09	pupil.1	0.831930	40.081970	5.
3	1	1.583872e+09	pupil.1	0.847075	40.169914	5.
4	0	1.583872e+09	pupil.0	0.865786	41.507917	3.
9361	1	1.583873e+09	pupil.1	0.996179	41.239358	5.
9362	1	1.583873e+09	pupil.1	0.995399	41.379825	5.
9363	1	1.583873e+09	pupil.1	0.968087	41.407540	5.
9364	1	1.583873e+09	pupil.1	0.994389	41.666612	5.
9365	1	1.583873e+09	pupil.1	0.994965	41.741721	5.

278 rows × 14 columns

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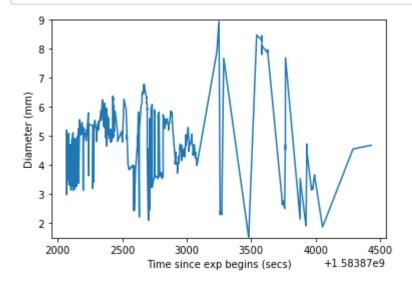
In [28]: plt.plot(range(len(fixation\_baseline)), fixation\_baseline)), fit.fill\_between(range(len(fixation\_baseline)), fit.plt.ylim([1.5, 9])
 plt.ylabel('Mean Pupil Diameter (mm)\n at fixation
 plt.xlabel('Trial', fontsize=14)

Out[28]: Text(0.5, 0, 'Trial')

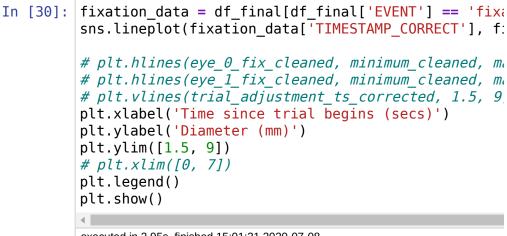


In [29]: fixation\_data = df\_final[df\_final['EVENT'] == 'fix;
plt.plot(fixation\_data['timestamp'], fixation\_data

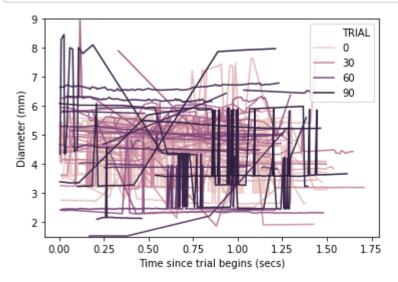
# plt.hlines(eye\_0\_fix\_cleaned, minimum\_cleaned, material\_fix\_cleaned, mater



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executed in 2.95s, finished 15:01:31 2020-07-08



# 3.9 Align timestamps

max\_time = int(np.max(df\_final.loc[df\_final['EVEN] In [31]: print(max time)

executed in 69ms, finished 15:01:31 2020-07-08

2

We have a maximum of 4 seconds, with a median of 70 samples

We also want to have samples from 1 second before the image onse

In [32]: time before imonset = -1 # seconds max time=4 median pupil samples per sec = 70executed in 91ms, finished 15:01:31 2020-07-08

In [33]: time\_before\_imonset = -1 # seconds
max\_time=4
median\_pupil\_samples\_per\_sec = 70
times\_selected = np.linspace(time\_before\_imonset, resecuted in 98ms, finished 15:01:31 2020-07-08

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In [45]:

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```

```
def align timestamps pupil(df, behavioral df, times
    trial unique = behavioral df.trialNumber.unique
    block unique = behavioral df.blockNumber.unique
    df matched = pd.DataFrame()
    row=0
    for block in block_unique:
        if not np.isnan(block):
            print('Block number: ' + str(block))
            for trial_number in trial_unique:
                 if not np.isnan(trial number):
                     print('Trial number: ' + str(t)
                     # first loop through the times
                     df trial = df[(df['BLOCK'] == I
                     if not df trial.empty:
                         type_sd = df_trial.loc[0,
                         for time sel in times select
                             if time sel < df trial</pre>
                                  print('Time selecte
                                  # find closest time
                                  closest number, clo
        #
                                        print(closes
                                  if (closest number
                                      # is it above (
                                      if closest num!
                                          closest nur
                                          closest nur
                                          # then the
                                          closest nur
                                          closest nur
                                      elif closest nu
                                          closest nur
                                          closest nur
                                          # then the
                                          closest nur
                                          closest nur
                                      duration = clos
                                      pupil size_1_co
                                      pupil size 2 co
                                      change pupil s:
                                      pupil_extrapola
                                      pupil_size_1 =
                                      pupil size 2 =
```

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```
change_pupil_s:
                                       pupil_extrapola
                                       # include in da
                                       df matched.loc
                                       df matched.loc
                                       df matched.loc
                                       df matched.loc
                                       df matched.loc
                                       df matched.loc
                                  elif closest number
                                       pupil_extrapola
                                       pupil extrapola
                                       df matched.loc
                                       df matched.loc
                                       df matched.loc
                                       df matched.loc
                                       df matched.loc
                                       df_matched.loc
                                  elif closest number
                                       pupil_extrapola
                                       pupil_extrapola
                                       df matched.loc
                                       df matched.loc
                                       df matched.loc
                                       df matched.loc
                                       df matched.loc
                                       df_matched.loc
                                   row += 1
    return df_matched
executed in 64ms, finished 15:20:28 2020-07-08
```

localhost:8888/notebooks/analysis\_diameter.ipynb

In [46]: df\_matched = align\_timestamps\_pupil(df\_final, behave executed in 2m 15s, finished 15:22:47 2020-07-08

> Block number: 1.0 Trial number: 1.0 Time selected: -1.0 Time selected: -0.9856733524355301 Time selected: -0.9713467048710601 Time selected: -0.9570200573065902 Time selected: -0.9426934097421203 Time selected: -0.9283667621776505 Time selected: -0.9140401146131805 Time selected: -0.8997134670487106 Time selected: -0.8853868194842407 Time selected: -0.8710601719197708 Time selected: -0.8567335243553008 Time selected: -0.8424068767908309 Time selected: -0.828080229226361 Time selected: -0.813753581661891 Time selected: -0.7994269340974212

> Time selected: -0.7851002865329513

Time selected: -0.7707736389684814

```
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```

In [38]: df\_final[(df\_final['BLOCK'] == 1) & (df\_final['TRI/
executed in 68ms, finished 15:12:31 2020-07-08

Out[38]:

	eye_id	timestamp	topic	confidence	diameter_2d [px]	diame
1338	1	1.583872e+09	pupil.1	0.807289	40.241896	5.
1339	1	1.583872e+09	pupil.1	0.813711	38.268477	5.
1340	0	1.583872e+09	pupil.0	0.864823	40.054433	3.
1341	1	1.583872e+09	pupil.1	0.813626	38.255677	5.
1342	1	1.583872e+09	pupil.1	0.934747	37.574239	5.
1343	0	1.583872e+09	pupil.0	0.845581	40.578517	3.
1344	0	1.583872e+09	pupil.0	0.802648	36.516243	3.
1345	0	1.583872e+09	pupil.0	0.824839	36.764980	3.
1346	0	1.583872e+09	pupil.0	0.850187	37.435979	3.
1347	0	1.583872e+09	pupil.0	0.803575	37.401743	3.
1348	1	1.583872e+09	pupil.1	0.853858	36.466022	5.
1349	1	1.583872e+09	pupil.1	0.870916	36.568415	5.
1350	1	1.583872e+09	pupil.1	0.833989	36.532839	5.
1351	1	1.583872e+09	pupil.1	0.868953	36.667968	5.
1352	1	1.583872e+09	pupil.1	0.832906	36.597359	5.
1353	1	1.583872e+09	pupil.1	0.802839	36.690938	5.
1354	1	1.583872e+09	pupil.1	0.814757	36.585430	5.
1355	1	1.583872e+09	pupil.1	0.840025	36.728629	5.
1356	1	1.583872e+09	pupil.1	0.805473	36.594478	5.
1357	1	1.583872e+09	pupil.1	0.888336	36.700216	5.
1358	1	1.583872e+09	pupil.1	0.823432	36.650577	5.
1359	1	1.583872e+09	pupil.1	0.823211	36.666438	5.
1360	1	1.583872e+09	pupil.1	0.814284	36.648387	5.
1361	1	1.583872e+09	pupil.1	0.800922	36.778828	5.
1362	1	1.583872e+09	pupil.1	0.812185	38.707209	5.
1363	1	1.583872e+09	pupil.1	0.807419	40.694592	5.
1364	1	1.583872e+09	pupil.1	0.815794	40.720651	5.
1365	1	1.583872e+09	pupil.1	0.837836	41.125286	5.
1366	1	1.583872e+09	pupil.1	0.814914	40.847946	5.
1367	1	1.583872e+09	pupil.1	0.816344	40.675151	5.
1368	1	1.583872e+09	pupil.1	0.816137	40.347885	5.
1369	1	1.583872e+09	pupil.1	0.800077	41.075946	5.
1370	1	1.583872e+09	pupil.1	0.818535	40.366474	5.

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timestamp

eye\_id

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```
1 1.583872e+09
             1371
                                                             40.795127
                                        pupil.1
                                                  0.809388
                                                                           5.
             1372
                       1 1.583872e+09 pupil.1
                                                  0.800869
                                                              40.721154
                                                                           5.
             1373
                       1 1.583872e+09 pupil.1
                                                  0.805879
                                                             40.190365
                       1 1.583872e+09 pupil.1
                                                  0.817108
                                                             40.447477
                                                                           5.
             1374
                       1 1.583872e+09 pupil.1
                                                  0.822972
                                                             39.986806
             1375
                                                                           5.
            df trial = df_final[(df_final['BLOCK'] == 1) & (df_
In [44]:
            df_trial.empty
            executed in 59ms, finished 15:19:47 2020-07-08
Out[44]: True
 In [ ]: | df_matched_v2 = align_timestamps_pupil(df_final, be
            executed in 46.3s, finished 15:01:47 2020-07-08
            len(df_matched[(df_matched['BLOCK'] == 1) & (df_mat
            executed in 46.3s, finished 15:01:47 2020-07-08
 In [ ]:
            len(df_matched[(df_matched['BLOCK'] == 1) & (df_matched[)
            executed in 46.3s, finished 15:01:47 2020-07-08
 In [ ]:
            df_matched
            executed in 46.3s, finished 15:01:47 2020-07-08
 In [ ]:
            df_matched_v2
            executed in 46.3s, finished 15:01:47 2020-07-08
```

## 3.10 Timeseries means across trials

diameter\_2d diame

[px]

topic confidence

```
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```

```
In [ ]: def tsmeans SD pupil(df matched, times selected, pr
             conditions = ['SD', 'NO SD']
             for cond in conditions:
                 df matched wide = pd.DataFrame()
                 df matched wide.loc[:, 'TIMESTAMP IMONSET']
                 df = df matched[df matched['SD CONDITION']
                 # get number of trials in this condition
                 numTrials = len(df.BLOCK.unique()) * len(d.
                 for block in df.BLOCK.unique():
                      for trial in df.TRIAL.unique():
                          df tmp = df[(df['BLOCK'] == block)
                                   & (df['TRIAL'] == trial)].
                            print(df tmp['PUPIL SIZE CORRECT.
                          column name = 'BLOCK' + str(block)
                          df matched wide[column name] = df +
                 # calculate means across trials
                 for row in range(len(df matched wide)):
                      mean, low, high = mean confidence intel
                      df_matched_wide.loc[row, 'MEAN'] = mear
df_matched_wide.loc[row, 'SEM_LOW'] = 
                      df matched wide.loc[row, 'SEM HIGH'] =
                      # get number of NaNs on that timestamp
                      df matched wide.loc[row, 'COUNT NAN'] =
                 if cond == 'SD':
                      df matched wide sd = df matched wide
                 elif cond == 'NO SD':
                      df matched wide nosd = df matched wide
             return df_matched_wide_sd, df_matched_wide_nosc
         executed in 46.3s, finished 15:01:47 2020-07-08
        df_sd, df_nosd = tsmeans_SD_pupil(df_matched, time:
        df_sd_alltrials, df_nosd_alltrials = tsmeans_SD_puj
         executed in 46.3s, finished 15:01:47 2020-07-08
```

3.11 Plot

In [ ]:

```
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     3.14 Compare sd vs
     3.15 Count samples
```

```
In [ ]: def plot sd category(df sd, df nosd, time limit, y
             plot sd = df sd[df sd['TIMESTAMP IMONSET'] <= f</pre>
             plot nosd = df nosd[df nosd['TIMESTAMP IMONSET
             plt.plot(plot_sd['TIMESTAMP_IMONSET'], plot_sd
             plt.fill between(plot sd['TIMESTAMP IMONSET'],
             plt.plot(plot nosd['TIMESTAMP IMONSET'], plot r
             plt.fill between(plot nosd['TIMESTAMP IMONSET']
             plt.ylabel(ylabel, fontsize=14)
             plt.xlabel(xlabel, fontsize=14)
             plt.axvline(x=0, color='k', linestyle='--', lak
             plt.ylim(ylimit)
             plt.legend()
             plt.title(title)
             plt.savefig(title + '.png')
             plt.show()
        executed in 46.3s, finished 15:01:47 2020-07-08
```

### 3.11.1 Baseline per trial

```
In [ ]:
         plot sd = df sd[df sd['TIMESTAMP IMONSET'] <= 3]</pre>
         plot nosd = df nosd[df nosd['TIMESTAMP IMONSET'] <=</pre>
         executed in 46.3s, finished 15:01:47 2020-07-08
         plt.plot(plot sd['TIMESTAMP IMONSET'], plot sd['ME/
In [ ]:
         plt.fill between(plot sd['TIMESTAMP IMONSET'], plot
         plt.plot(plot nosd['TIMESTAMP IMONSET'], plot nosd
         plt.fill between(plot nosd['TIMESTAMP IMONSET'], p
         plt.vlabel('Pupil diameter change\n from per trial'
         plt.xlabel('Time from Image onset (secs)', fontsize
         plt.axvline(x=0, color='k', linestyle='--', label=
         plt.ylim([-0.2, 0.5])
         plt.legend()
         plt.title('Fixation correction per trial')
         executed in 46.3s, finished 15:01:47 2020-07-08
```

Find out how many data points are nans in each timestamp

```
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```

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```
In []: fig, (ax1, ax2) = plt.subplots(1, 2)

ax1.plot(df_nosd['TIMESTAMP_IMONSET'], df_nosd['COU ax1.set_xlabel('Time from image onset\n (secs)', for ax1.set_ylabel('% of NaNs across trials', fontsize: ax1.set_title('NO_SD', fontsize=14)

ax2.plot(df_sd['TIMESTAMP_IMONSET'], df_sd['COUNT_I ax2.set_xlabel('Time from image onset\n (secs)', for ax2.set_ylabel('% of NaNs across trials', fontsize: ax2.set_title('SD', fontsize=14)

for ax in fig.get_axes():
    ax.label_outer()

fig.tight_layout()
    executed in 46.3s, finished 15:01:47 2020-07-08
```

It seems we loose 25% of trials at around 2.5, so we will set the cuto

```
In []: sd = df_matched[df_matched['SD_CONDITION'] == 'SD']
x = len(sd.BLOCK.unique()) * len(sd.TRIAL.unique())
np.isnan(df_matched_wide_sd.iloc[-1, range(1, x+1)])
executed in 46.3s, finished 15:01:47 2020-07-08
```

#### 3.11.2 Baseline across trials

```
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```

## ▼ 3.12 extra

## 3.13 Checking length of blocks

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In [ ]:|

```
trial unique = behavioral data.trialNumber.unique()
In [ ]:
        block unique = behavioral data.blockNumber.unique(
        fixation time df = pd.DataFrame()
         row=0
        for block in block unique:
             if not np.isnan(block):
                 for trial number in trial unique:
                     if not np.isnan(trial_number):
                          fix_df = df_final.loc[(df_final['BI
                          fixation_time = fix_df.loc[0, 'TIMI
                          fixation time df.loc[row, 'BLOCK']
                                                      'TRIAL']
                          fixation_time_df.loc[row,
                          fixation time df.loc[row, 'FIXATION
                          row += 1
         executed in 46.3s, finished 15:01:47 2020-07-08
```

sns.barplot(np.arange(len(fixation time df)), fixat

executed in 46.3s, finished 15:01:47 2020-07-08

```
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```
In [ ]:
        trial unique = behavioral data.trialNumber.unique()
        block unique = behavioral data.blockNumber.unique(
        blob time df = pd.DataFrame()
        row=0
        for block in block unique:
             if not np.isnan(block):
                 for trial number in trial unique:
                     if not np.isnan(trial_number):
                         blob df = df final.loc[(df final['!
                         blob time = blob df.iloc[-1]
                         blob time = blob time['TIMESTAMP C(
                         blob_time_df.loc[row, 'BLOCK'] = b
                         blob time df.loc[row, 'TRIAL'] = ti
                         blob time df.loc[row, 'BLOB TIME']
                         row += 1
        executed in 46.3s, finished 15:01:47 2020-07-08
In [ ]: | sns.barplot(np.arange(len(blob_time_df)), blob_time
```

# 3.14 Compare sd vs. no sd

executed in 46.3s, finished 15:01:47 2020-07-08

```
sd blob = df final[(df final['SD CONDITION'] == 'SI
In [ ]:
         nosd_blob = df_final[(df_final['SD_CONDITION'] ==
         executed in 46.3s, finished 15:01:47 2020-07-08
In [ ]: plt.plot(sd_blob['TIMESTAMP_CORRECT_IMONSET'], sd_I
         plt.plot(nosd blob['TIMESTAMP CORRECT IMONSET'], no
         plt.xlabel('Time since image onset begins (secs)')
         plt.vlabel('Diameter (mm)')
         # plt.ylim([1.5, 9])
         # plt.xlim([0, 7])
         plt.legend()
         plt.show()
         executed in 46.3s, finished 15:01:47 2020-07-08
```

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# 3.15 Count samples per trial and per sec

```
In [ ]: test times = [sd blob['TIMESTAMP CORRECT IMONSET']
         executed in 46.3s, finished 15:01:47 2020-07-08
In [ ]:
         # find how many samples of image onset there are po
         trial unique = behavioral data.trialNumber.unique(
         block unique = behavioral data.blockNumber.unique()
         samples per trial = pd.DataFrame()
         row=0
         for block in block unique:
             if not np.isnan(block):
                  for trial number in trial unique:
                      if not np.isnan(trial number):
                           im_onset = df_final[(df_final['BLO(
                           print('Block: ' + str(block) + '.
                           samples per trial.loc[row,
                           samples_per_trial.loc[row,
                                                         'TRIAL'
                           samples per trial.loc[row,
                                                        'NSAMPLI
                           row += 1
         executed in 46.3s, finished 15:01:47 2020-07-08
In [ ]:
         executed in 46.3s, finished 15:01:47 2020-07-08
```

sns.barplot(np.arange(len(samples per trial)), samples

In [ ]: np.mean(samples\_per\_trial['NSAMPLES']) executed in 46.3s, finished 15:01:47 2020-07-08

How many samples per second?

print(median\_pupil\_samples\_per\_sec)

executed in 46.2s, finished 15:01:47 2020-07-08

```
In [ ]:
                                            initial_ts = df_final.loc[0, 'timestamp']
                                            count list = list()
                                            count samples = 0
                                            for row in range(len(df_final)):
Contents 2 &
  1 Initialize
                                                 if row > 0:
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                                                      time_elapsed = df_final.loc[row, 'timestamp
    3.1 Paths
                                                      if time_elapsed >= 1: # if one second has |
    3.2 Annotations
    3.3 Parameters
                                                           initial ts = df final.loc[row, 'timesta
    3.4 Loop of trials
                                                           count_list.append(count_samples)
    3.5 Behavioral data
    3.6 tag trials with sc
                                                          count_samples= 0
    3.7 Organize data
                                                      else:
    3.8 Baseline fixation
    3.9 Align timestamp
                                                           count samples += 1
    3.10 Timeseries me
                                            executed in 46.3s, finished 15:01:47 2020-07-08
  ▼ 3.11 Plot
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                                  In [ ]: |count_list
    3.12 extra
                                            executed in 46.3s, finished 15:01:47 2020-07-08
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                                            plt.hist(count_list)
                                  In [ ]:
    3.15 Count samples
                                            executed in 46.2s, finished 15:01:47 2020-07-08
                                  In [ ]:
                                            median_pupil_samples_per_sec = int(np.median(count_
                                            print(type(median pupil samples per sec))
```

In [ ]:

