

# Eyelink眼动数据分析 与Data Viewer

## 学习资源

SR Research官网: <https://www.sr-research.com/>

SR Research论坛: <https://www.sr-support.com/>

## 学习资源

### 文献和书籍

### 眼动研究入门书籍推荐

SR Research中国办事处  
官网北京博润视动专注于  
眼动研究，为各位学者...



 EyeLink博润视动

## EyeLink Eye-Tracking Publications Library

### All EyeLink Publications

All 10,000+ peer-reviewed EyeLink research publications up until 2021 (with some early 2022s) are listed below by year. You can search the publications library using keywords such as Visual Search, Smooth Pursuit, Parkinson's, etc. You can also search for individual author names. Eye-tracking studies grouped by research area can be found on the solutions pages. If we missed any EyeLink eye-tracking papers, please [email us!](#)

Search

All years

10162 entries 1 of 102

2022

Floor van den Berg, Jelle Brouwer, Thomas B. Tienkamp, Josje Verhagen, Merel KeijzerFloor van den Berg  
**Language entropy relates to behavioral and pupil indices of executive control in young adult bilinguals** [Journal Article](#)  
In: Frontiers in Psychology, vol. 13, pp. 1-17, 2022.  
[Abstract](#) | [BibTeX](#)

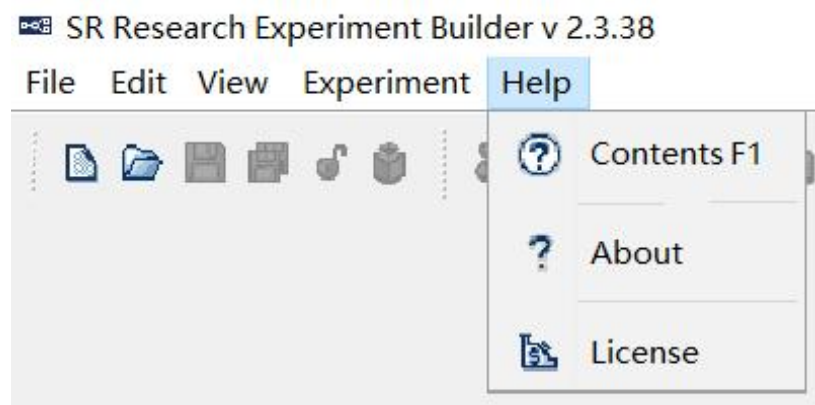
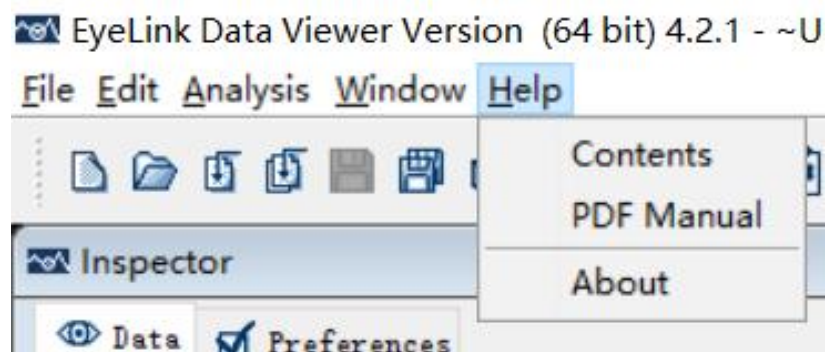
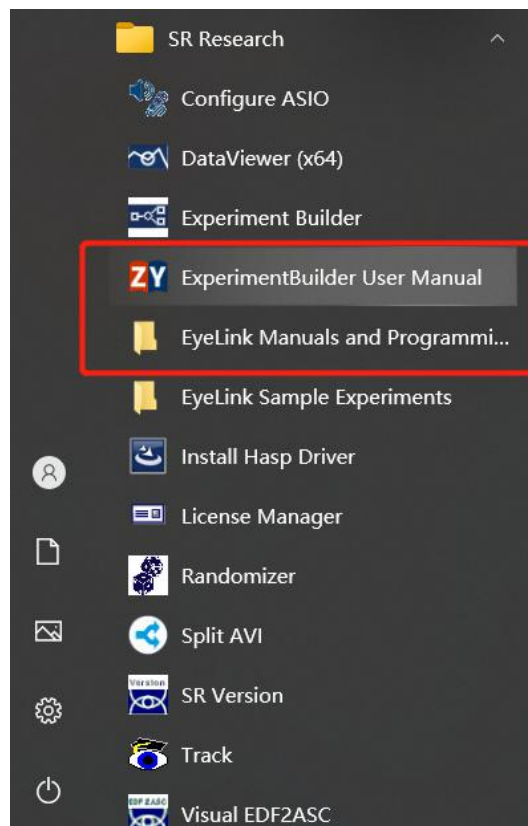
Yueyuan Zheng, Xinchun Ye, Janet H. Ho  
**Does adding video and subtitles to an audio lesson facilitate its comprehension?** [Journal Article](#)  
In: Learning and Instruction, vol. 77, pp. 101542, 2022.  
[Abstract](#) | [Links](#) | [BibTeX](#)

Aspen H. Yoo, Alfredo Bolaños, Grace E. Hallenbeck, Maah Rahmati, Thomas C. Sprague, Clayton E. Curtis  
**Behavioral prioritization enhances working memory precision and neural population gain** [Journal Article](#)  
In: Journal of Cognitive Neuroscience, vol. 34, no. 2, pp. 365-379, 2022.  
[Abstract](#) | [Links](#) | [BibTeX](#)

<https://www.sr-research.com/full-publications-list/>

# 学习资源

## 手册



## 学习资源

公众号 Eyelink博润视动



# Eyelink眼动数据分析简介

实验设计

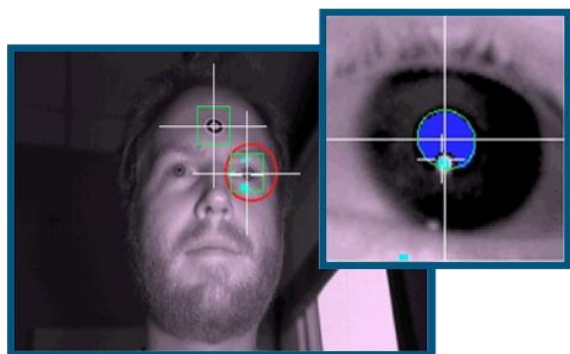
数据采集

数据分析及  
可视化

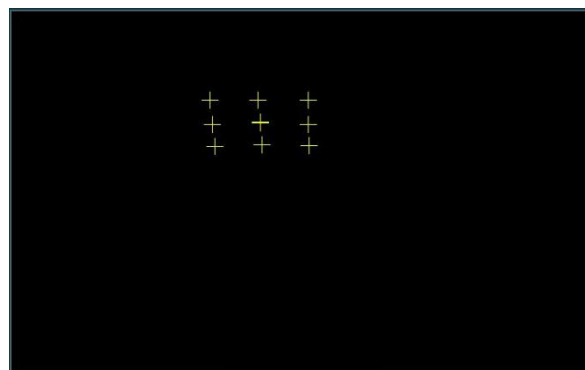
EyeLink API  
Experiment Builder  
*Screen Recorder*

EDF Access API  
**EDF2ASC**  
Data Viewer

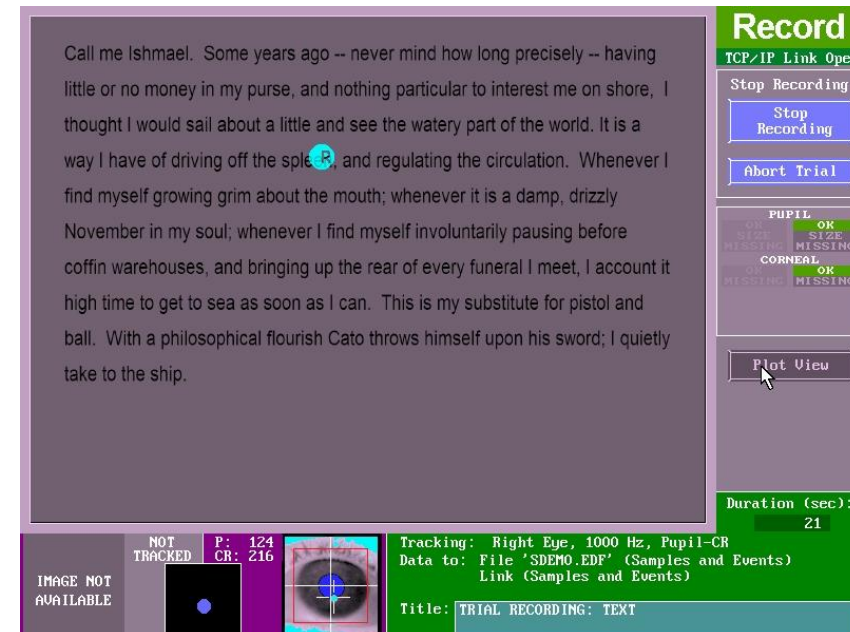
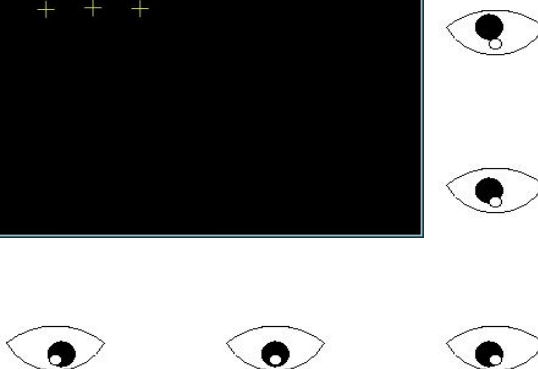
## 数据采集的过程



Pupil - CR Tracking



Calibration and validate



recording

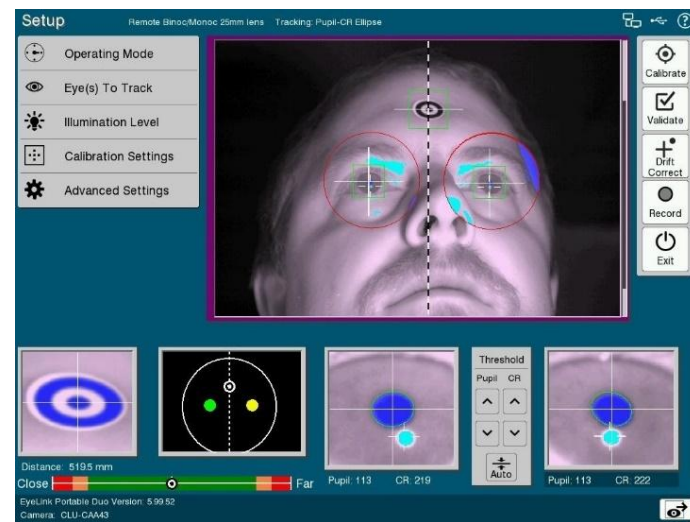
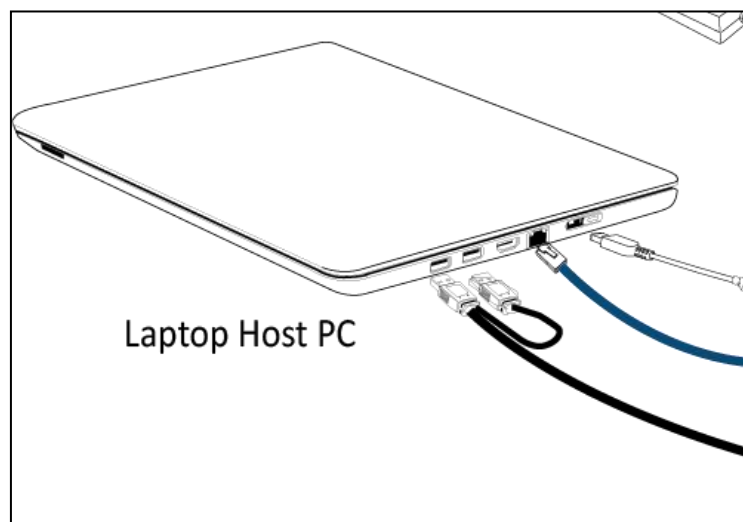
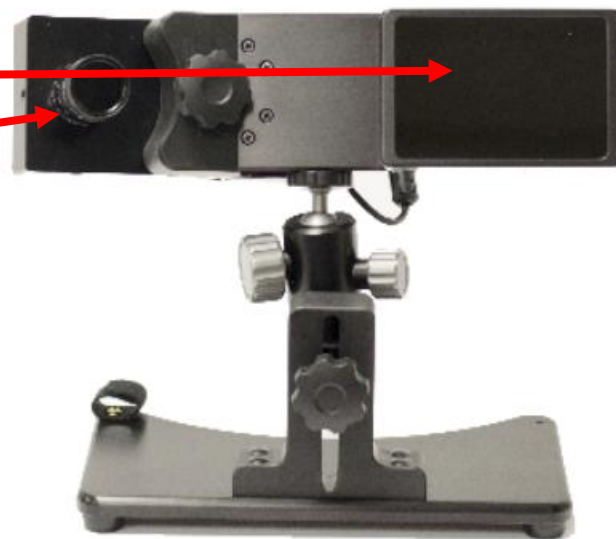
## How EyeLinks Work?

所有Eyelink系统都有三个关键部分：

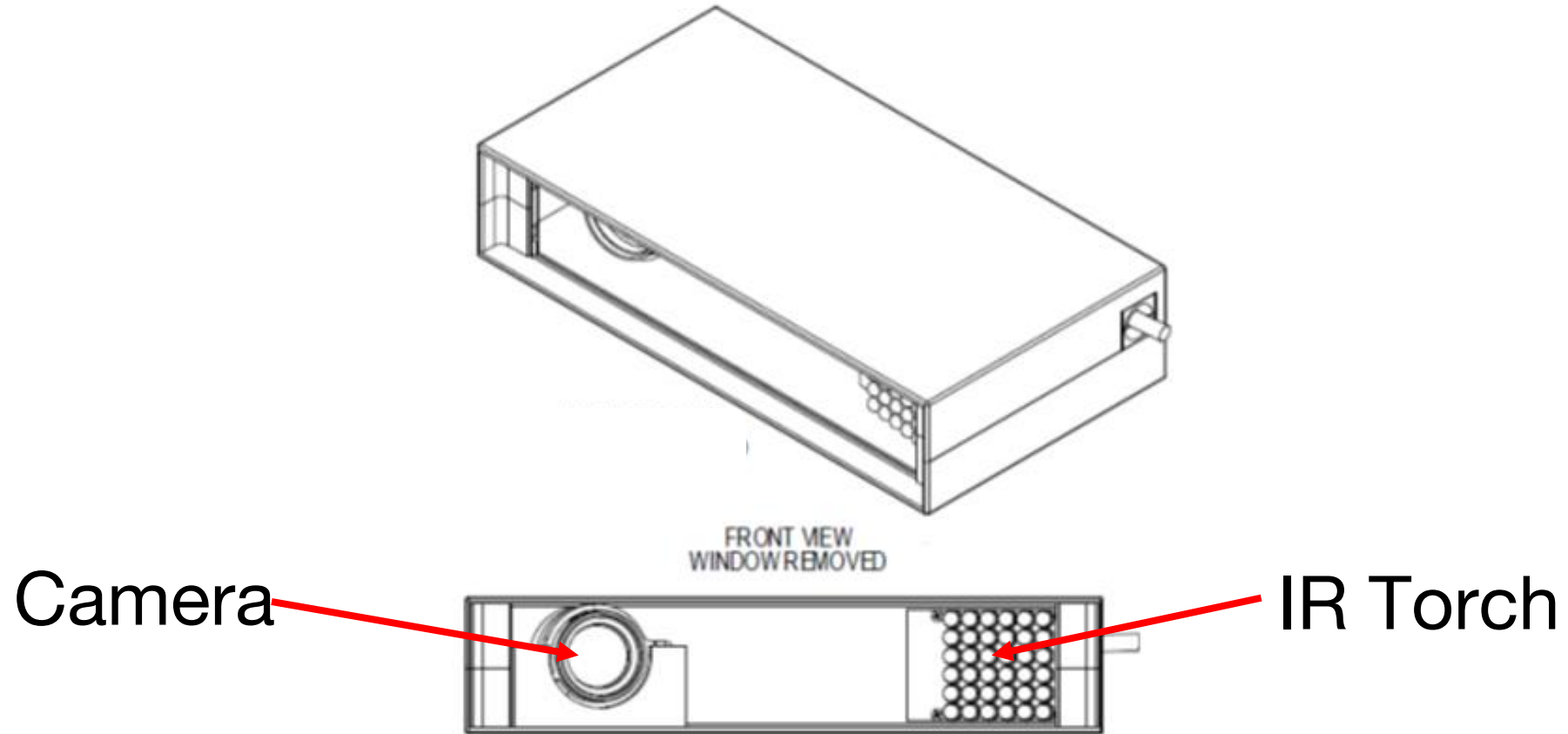
1) 红外光源

2) 高速摄像机

3) 主机+眼动软件

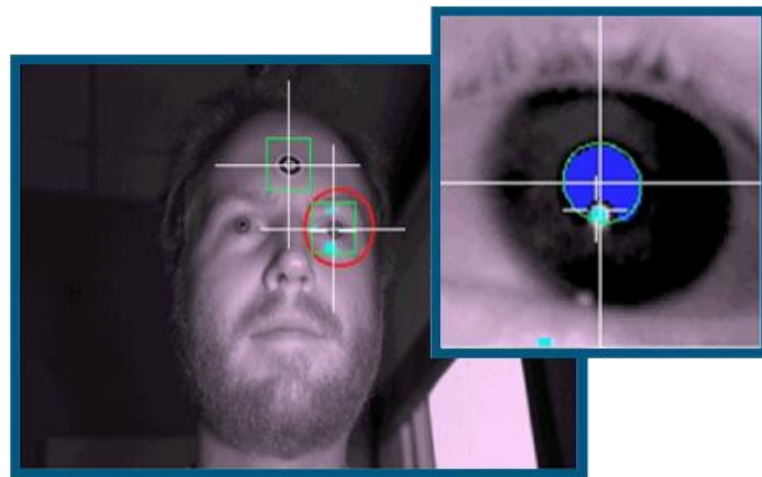


## Inside the Portable Duo:



*EyeLink Portable Duo Eye Tracker,  
Showing Internal Camera Lens and Illuminator*

- 1) 红外光源
  - 给眼睛照明
  - 提供角膜反射点 (CR)
- 2) 高速摄像机
  - 每秒最高可拍摄2000张照片
- 3) 主机+眼动追踪软件
  - 实时操作系统 (RTOS)
  - 接收并处理相机拍摄的图片
  - 计算注视位置
  - 分析数据
  - 存储数据



## 眼动数据入门：理解Sample and Eye movement events

- **Sample** (timestamp, eye position data in gaze, Pupil size)



- **Eye movement events** (Fixation, Saccade, Blink)

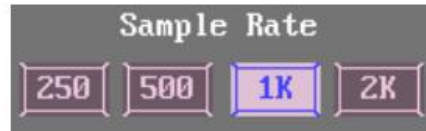
## 认识EyeLink Data File (.EDF)

### • Sample

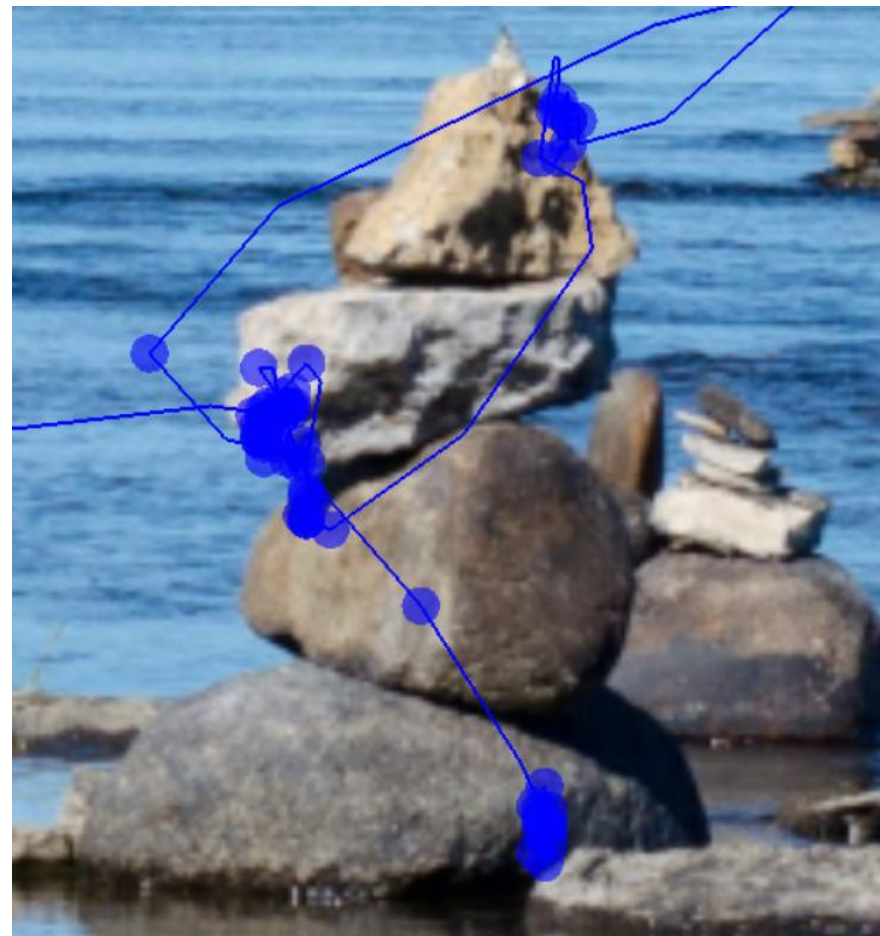
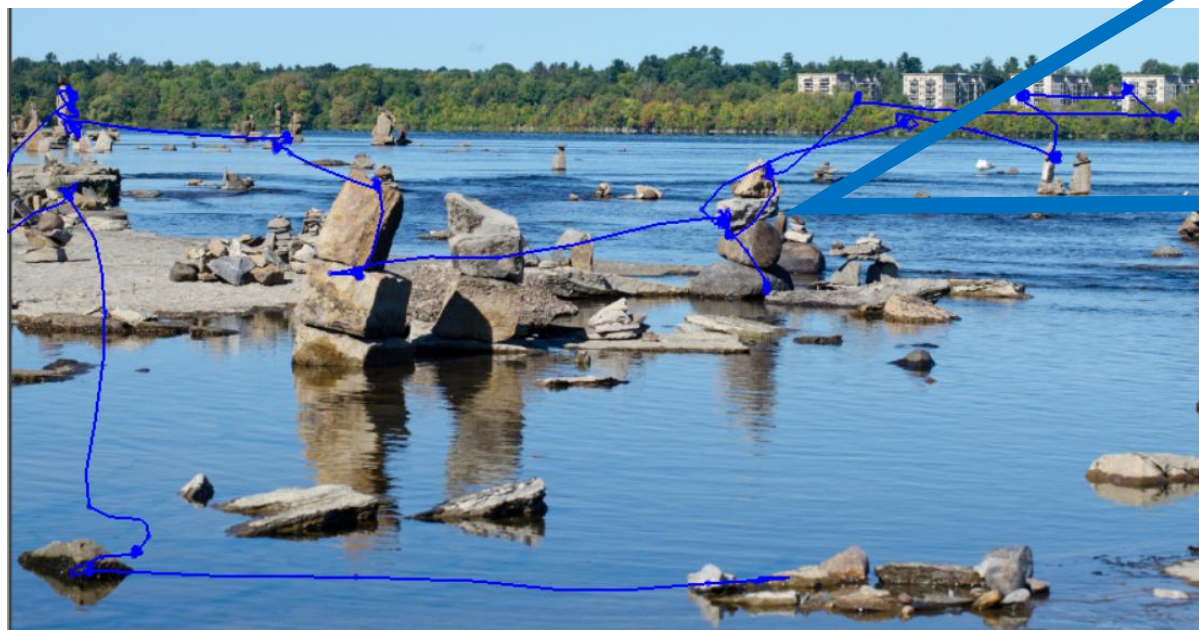
Each sample may contain several data field, including:

- Time of the sample (timestamp) in milliseconds
- eye position data in gaze, HREF, or RAW data, monocular or binocular
- Pupil size, monocular or binocular
- Button or input port state bits

| TimeStamp | X     | Y     | Pupil Size | Input |     |
|-----------|-------|-------|------------|-------|-----|
| 89415919  | 909.0 | 436.8 | 832.0      | 127.0 | ... |
| 89415920  | 908.1 | 435.8 | 833.0      | 127.0 | ... |
| 89415921  | 906.8 | 434.9 | 833.0      | 127.0 | ... |
| 89415922  | 905.6 | 434.6 | 832.0      | 127.0 | ... |
| 89415923  | 905.4 | 434.9 | 831.0      | 127.0 | ... |
| 89415924  | 905.7 | 435.2 | 829.0      | 127.0 | ... |
| 89415925  | 905.9 | 435.8 | 828.0      | 127.0 | ... |
| 89415926  | 906.5 | 437.5 | 828.0      | 127.0 | ... |
| 89415927  | 907.8 | 439.5 | 829.0      | 127.0 | ... |
| 89415928  | 909.0 | 440.9 | 830.0      | 127.0 | ... |
| 89415929  | 909.7 | 441.1 | 829.0      | 127.0 | ... |
| 89415930  | 909.9 | 441.0 | 828.0      | 127.0 | ... |
| 89415931  | 910.7 | 440.9 | 826.0      | 127.0 | ... |



## Sample



## 眼动数据入门：理解Sample and Eye movement events

- **Sample** (timestamp, eye position data in gaze, Pupil size)



- The EyeLink On-Line Parser (analyzes eye position data into meaningful events and states)
- DataViewer Event Reparsing

- **Eye movement events** (Fixation, Saccade, Blink)

## Eye movement events



  
fixation

  
saccade

  
blink

# 认识EyeLink Data File (.EDF)

## • EyeLink On-Line Parser

The eye movement events in EyeLink data files are generated by the **Host Software's on-line parser** in real-time during recording, based on an internal heuristic saccade detector that uses a **velocity- and acceleration-based saccade detection method**.

Eye movement events record eye position changes identified by the EyeLink tracker's on-line parser, such as **fixations**, **blinks**, and **saccades**.

|          |          |          |       |       |       |
|----------|----------|----------|-------|-------|-------|
| 89416280 | 913.7    | 466.6    | 661.0 | 127.0 | ...   |
| EFIX R   | 89415915 | 89416280 | 366   | 913.3 | 454.3 |
| SSACC R  | 89416281 |          |       |       | 7     |
| 89416281 | 914.1    | 468.0    | 661.0 | 127.0 | ...   |
| 89416282 | 914.5    | 469.1    | 661.0 | 127.0 | ...   |
| 89416283 | 915.8    | 470.1    | 662.0 | 127.0 | ...   |
| 89416284 | 917.2    | 470.3    | 661.0 | 127.0 | ...   |
| 89416285 | 920.0    | 469.7    | 662.0 | 127.0 | ...   |
| 89416286 | 923.5    | 467.2    | 664.0 | 127.0 | ...   |
| 89416287 | 928.8    | 463.6    | 667.0 | 127.0 | ...   |
| 89416288 | 933.7    | 460.1    | 668.0 | 127.0 | ...   |
| 89416289 | 941.2    | 455.0    | 669.0 | 127.0 | ...   |
| 89416290 | 948.3    | 449.0    | 670.0 | 127.0 | ...   |
| 89416291 | 956.1    | 441.2    | 671.0 | 127.0 | ...   |
| 89416292 | 961.8    | 433.0    | 672.0 | 127.0 | ...   |
| 89416293 | 967.8    | 424.5    | 670.0 | 127.0 | ...   |
| 89416294 | 972.5    | 416.9    | 667.0 | 127.0 | ...   |
| 89416295 | 975.6    | 410.7    | 666.0 | 127.0 | ...   |
| 89416296 | 977.0    | 404.7    | 667.0 | 127.0 | ...   |
| 89416297 | 977.6    | 399.9    | 665.0 | 127.0 | ...   |
| 89416298 | 977.8    | 397.0    | 662.0 | 127.0 | ...   |
| 89416299 | 975.9    | 396.2    | 659.0 | 127.0 | ...   |
| ESACC R  | 89416281 | 89416299 | 19    | 914.1 | 468.0 |
|          | 396.2    | 1.50     | 137   |       | 975   |
| SFIX R   | 89416300 |          |       |       |       |
| 89416300 | 973.4    | 396.0    | 659.0 | 127.0 | ...   |

## 认识Eyelink眼动数据

### • Saccades detection

Three thresholds are used for saccade detection: [motion](#), [velocity](#), and [acceleration](#). The values of these are in degrees, degrees/sec, and degrees/sec<sup>2</sup> respectively.

```
recording_parse_type = GAZE
saccade_velocity_threshold = 30
saccade_acceleration_threshold = 8000
saccade_motion_threshold = 0.1
saccade_pursuit_fixup = 60
fixation_update_interval = 0
```

```
recording_parse_type = GAZE
saccade_velocity_threshold = 22
saccade_acceleration_threshold = 3800
saccade_motion_threshold = 0.0
saccade_pursuit_fixup = 60
fixation_update_interval = 0
```

## 认识Eyelink眼动数据

- **Blink**

A blink is defined as a period of saccade-detector activity with the pupil data missing for three or more samples in a sequence.

- **Fixation**

A fixation event is defined as any period that is not a blink or saccade.

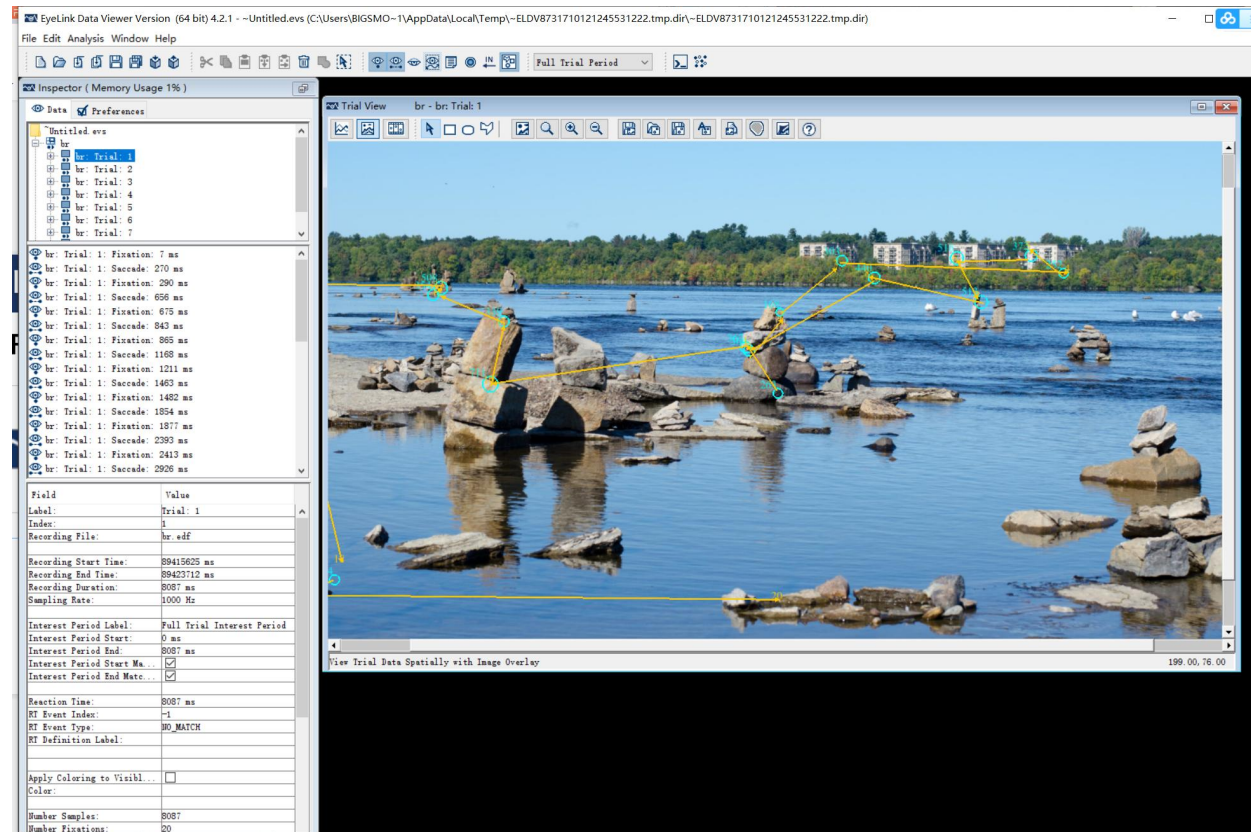
- **Note**

A detailed discussion of the online event parsing algorithm can be found in section "4. Data Files" of the EyeLink II or EyeLink 1000/1000 Plus/Portable Duo User Manual.

## EDF Access API

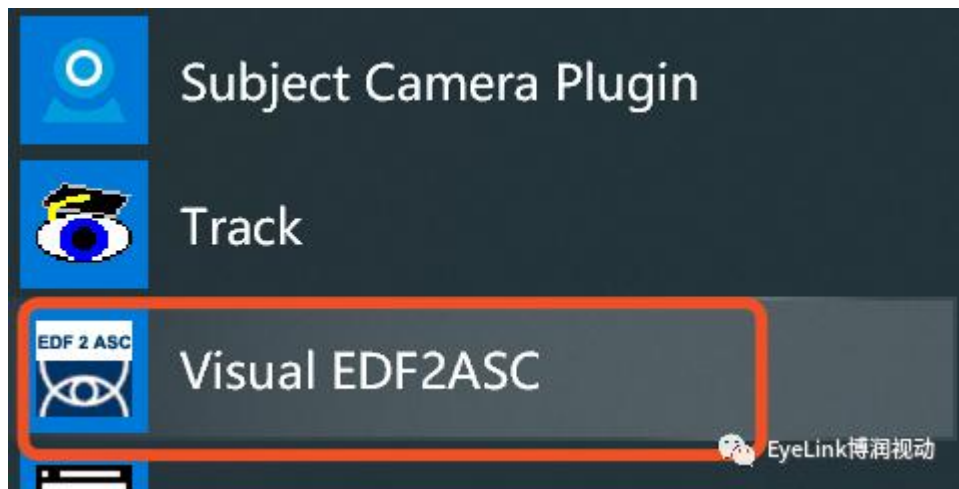


### • Data Viewer



## EDF Access API

- EDF2ASC



The screenshot shows the 'EDF Converter' application window. It has a menu bar with 'File', 'Preferences', and 'Help'. Below the menu bar are tabs for 'Selections' and 'Log'. There are icons for adding and deleting files. The main area is titled 'EDF File(s) to Convert' and contains a list of EDF files. The first column of the list is highlighted with a blue box.

|          |       |       |       |       |     |
|----------|-------|-------|-------|-------|-----|
| 89415919 | 909.0 | 436.8 | 832.0 | 127.0 | ... |
| 89415920 | 908.1 | 435.8 | 833.0 | 127.0 | ... |
| 89415921 | 906.8 | 434.9 | 833.0 | 127.0 | ... |
| 89415922 | 905.6 | 434.6 | 832.0 | 127.0 | ... |
| 89415923 | 905.4 | 434.9 | 831.0 | 127.0 | ... |
| 89415924 | 905.7 | 435.2 | 829.0 | 127.0 | ... |
| 89415925 | 905.9 | 435.8 | 828.0 | 127.0 | ... |
| 89415926 | 906.5 | 437.5 | 828.0 | 127.0 | ... |
| 89415927 | 907.8 | 439.5 | 829.0 | 127.0 | ... |
| 89415928 | 909.0 | 440.9 | 830.0 | 127.0 | ... |
| 89415929 | 909.7 | 441.1 | 829.0 | 127.0 | ... |
| 89415930 | 909.9 | 441.0 | 828.0 | 127.0 | ... |
| 89415931 | 910.7 | 440.9 | 826.0 | 127.0 | ... |

## EDF Access API

- **EDFMEX - Reading EDF data directly into MATLAB**

<https://www.sr-support.com/thread-28.html>

- **Pyedfread (非官方)**

<https://github.com/nwilming/pyedfread>

# DV下载安装和授权

## DV下载

从公众号或者官网下载。

08-27-2020, 06:23 PM

#1

### Data Viewer Download 4.2

*Last Updated April 19th, 2021*

EyeLink Data Viewer is an intuitive tool that is intended for viewing, filtering, and outputting EyeLink tracker data. Data Viewer supports EDF files recorded by EyeLink I, II, 1000, 1000 Plus, and Portable Duo.

Data Viewer 4.2 runs on Windows (7, 8, and 10), macOS (10.11 and later), and current 64-bit Ubuntu Desktop LTS releases (>= 16.04). A video card with OpenGL 2.0 support at minimum is required.

#### Recent / Future OS Releases

The release of Windows 11 and macOS BigSur and Monterey may involve changes that impact the functionality of our software. We are currently testing our software on these OS versions and will update their supported status as soon as our tests are complete.

**Data Viewer is backward compatible** - Viewing sessions created in earlier versions of Data Viewer can be opened in the latest version, but viewing sessions created with Data Viewer 4.2 cannot be opened with earlier versions.

If Data Viewer launches in unlicensed (Demo) mode, please ensure you have an active software license, or that the USB license key is attached and you have installed the latest HASP drivers that are provided with the software downloads. Please download the latest version from the links below:

Windows:

- **Data Viewer 4.2.1**

macOS 10.11 and later:

- **Data Viewer 4.2.1 (preferably with macOS 10.14.6 and later for better drawing performance)**
- **Data Viewer 4.1.1**

macOS 10.6 to 10.10:

- **Data Viewer 3.1.215**

Linux:

- **Installation Instruction for Data Viewer and EyeLink Developers Kit (HTML)**
- **Installation Instruction for Data Viewer and EyeLink Developers Kit (PDF)**

## DV 安装

- 安装的时候关闭所有管家软件和杀毒软件，按默认路径安装在C盘，建议不要更改安装路径，否则程序运行可能会出错。
- 安装完成后，在开始 —— SR Research文件夹里面可以看到DV及其他功能软件。

## DV授权

- DV授权方式和EB是有区别的。任何时候都可以在不插加密狗的条件下打开 Data Viewer，但是可以处理的数据数量会受到限制。

EyeLink Data Viewer 4.1

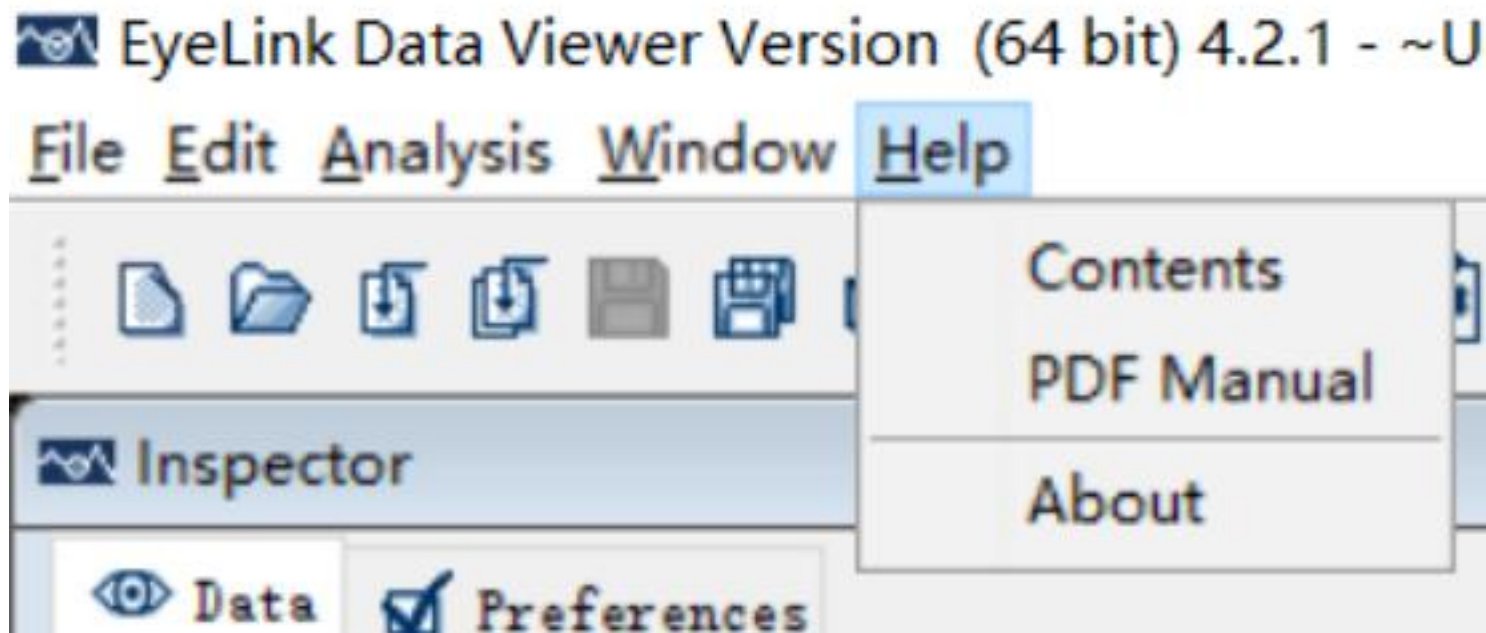
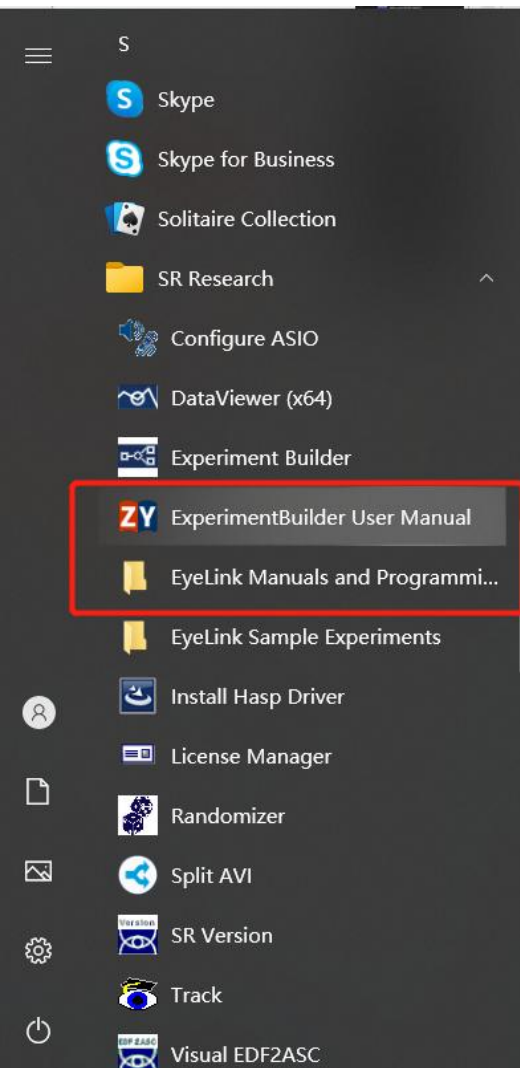


This program is running in an UNLICENSED DEMO MODE and has limited data loading functionality.  
The Demo version will only support loading of 3 EDF files, each with up to 5 trials, and 50 events per trial.  
Loading of saved analysis sessions has also been disabled.  
Contact SR Research for license pricing.

确定

# 学习DV的第一件事

- 学会查看和使用**DV**手册，90%的问题都可以轻松解决!



# 简单认识DV

## Introduction to EyeLink® DataViewer

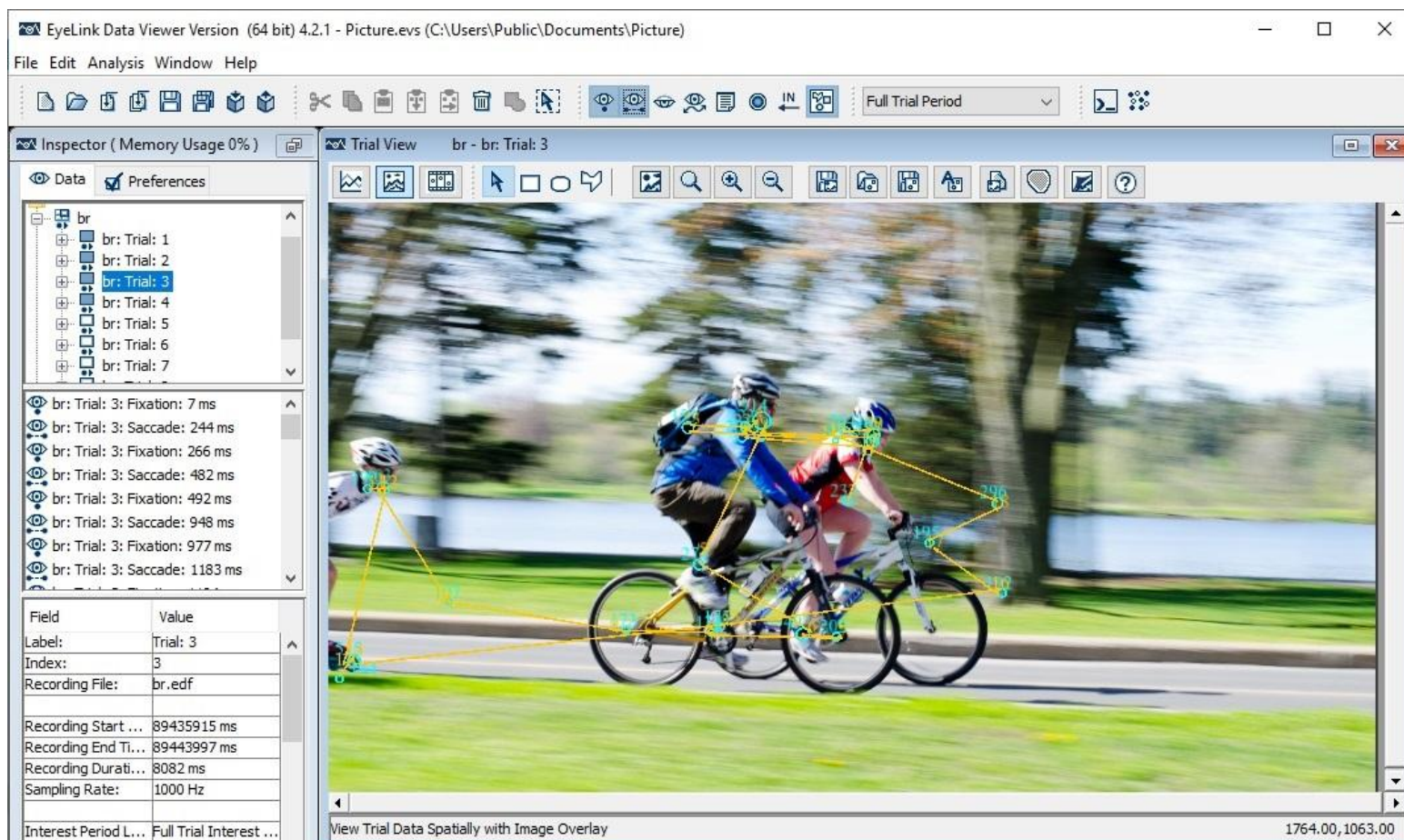
The EyeLink Data Viewer is a tool that allows users to display, filter, and create output reports from EDF data files recorded with EyeLink eye trackers (EyeLink I, EyeLink II, EyeLink 1000, EyeLink 1000 Plus, EyeLink Portable Duo, etc.). Data Viewer includes the following areas of functionality.

- Data Visualization
- Event Selection
- Interest Area Definition
- Event Filtering
- Interest Period and Reaction Time Definition
- Data Output and Analysis
- Experiment Integration
- WebLink Integration

## Working with Files

- Creating a Data Viewing Session
- Saving a Viewing Session
- Opening an Existing Viewing Session
- Saving an Existing Viewing Session to a Different File
- Importing EyeLink Data Files
- Packaging a Viewing Session
- Unpackaging a Packaged Viewing Session
- Merging Viewing Sessions
- Maintaining Data Session Integrity

# Data Viewer Windows



## Working with Events, Samples, and Interest Areas

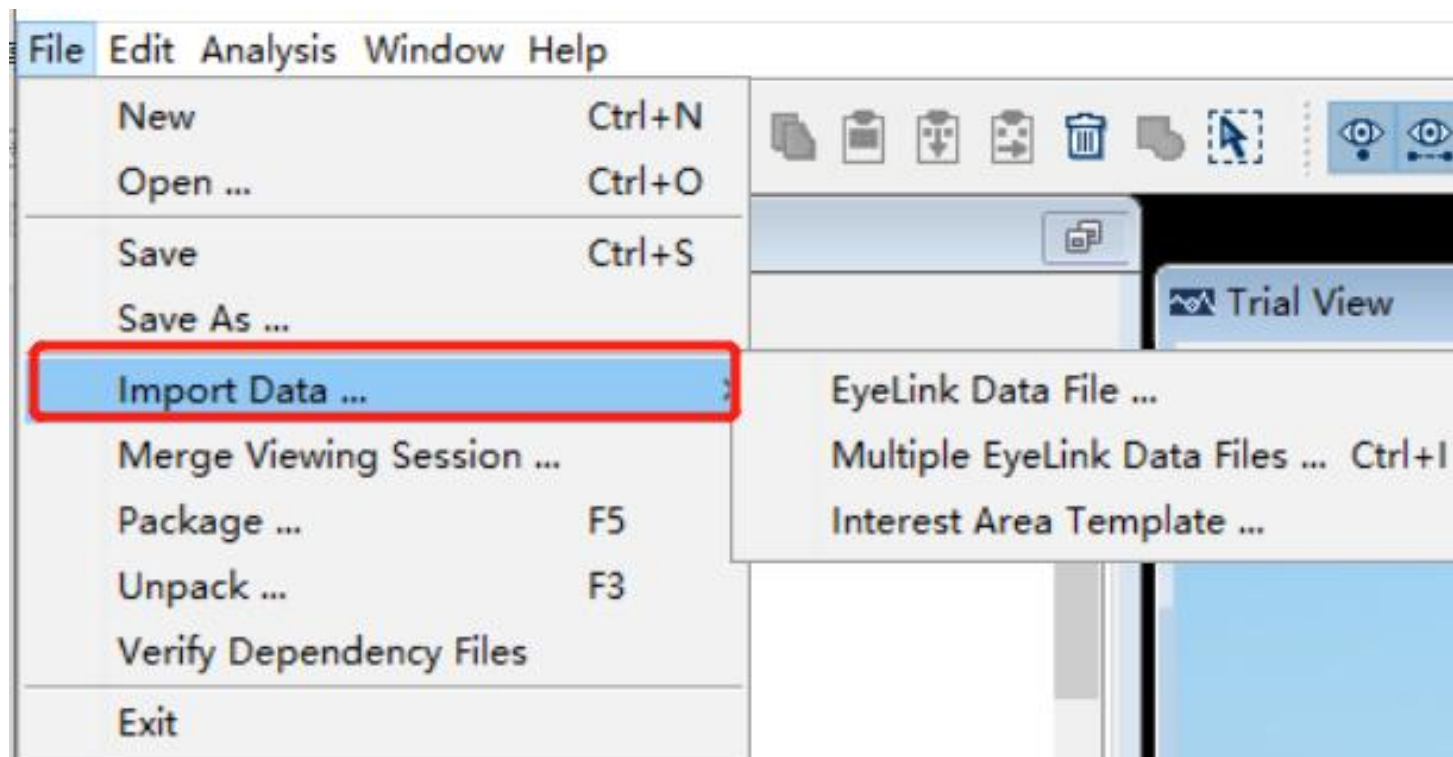
- Event Reparsing
- Enabling Event Visibility

| Button                                                                              | Function Description             |
|-------------------------------------------------------------------------------------|----------------------------------|
|    | Toggle Fixation Event Visibility |
|    | Toggle Saccade Event Visibility  |
|    | Toggle Blink Event Visibility    |
|    | Toggle Eye Sample Visibility     |
|  | Toggle Message Event Visibility  |
|  | Toggle Button Event Visibility   |
|  | Toggle Input Event Visibility    |
|  | Toggle Interest Area Visibility  |
|  | Enter/Exit Aggregate Mode        |

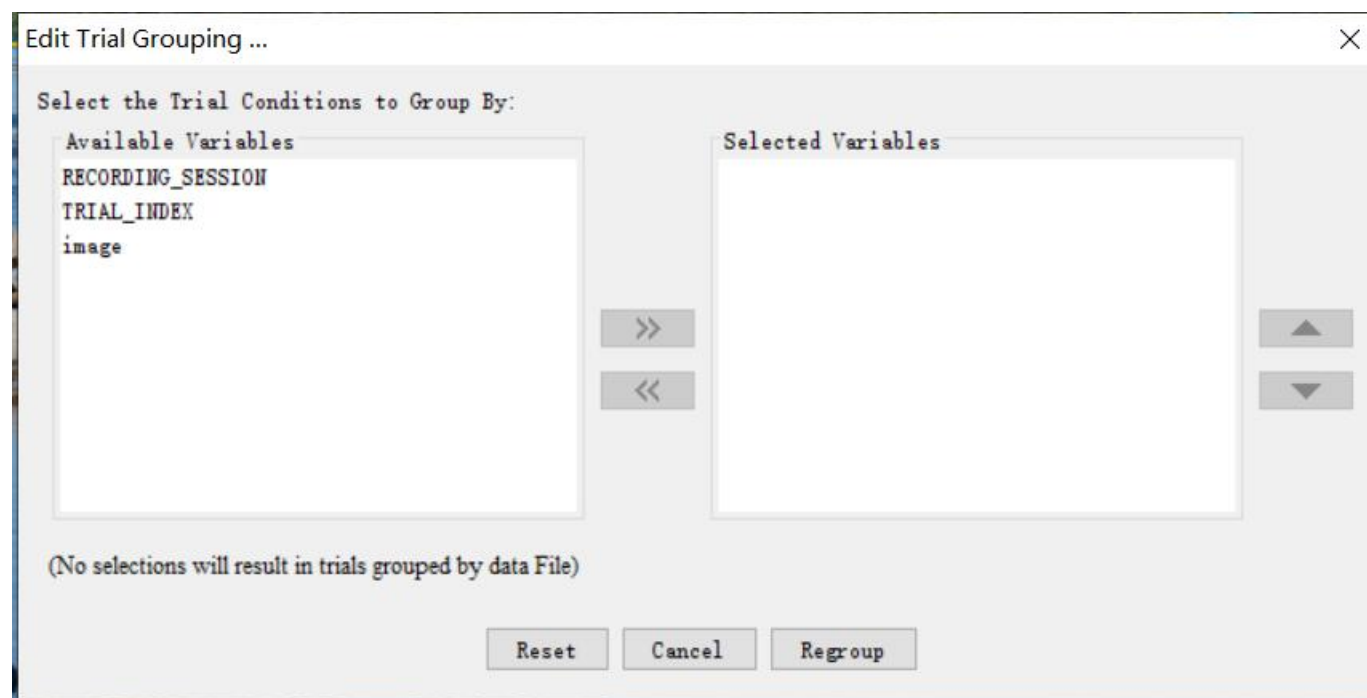
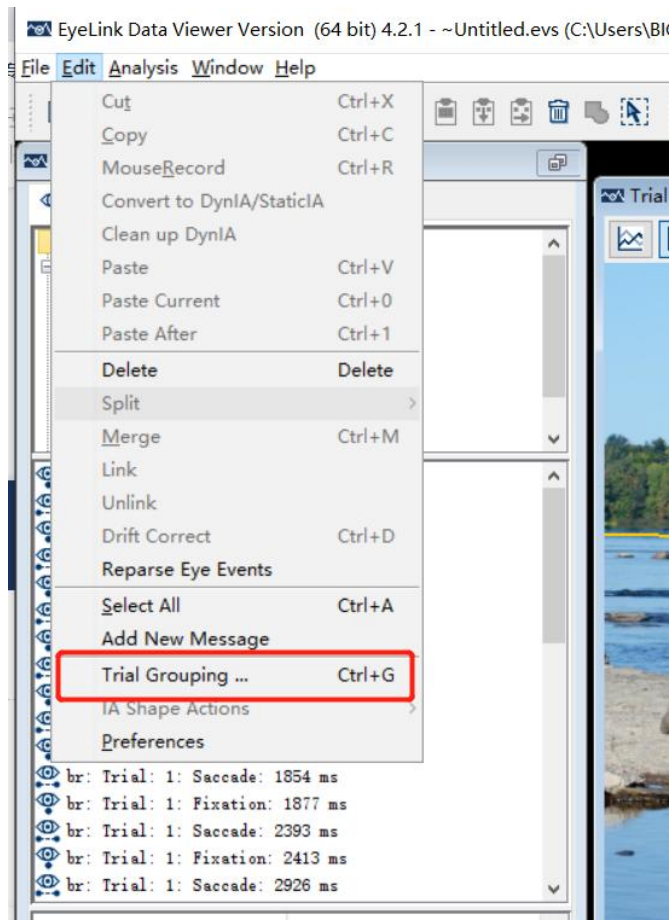
## 数据分析基本操作步骤

- Import Data - 导入数据
- Trial Grouping - 分组
- Set Interest Area - 设置兴趣区
- Creating Interest Periods - 设置兴趣期
- Report - 导入报告

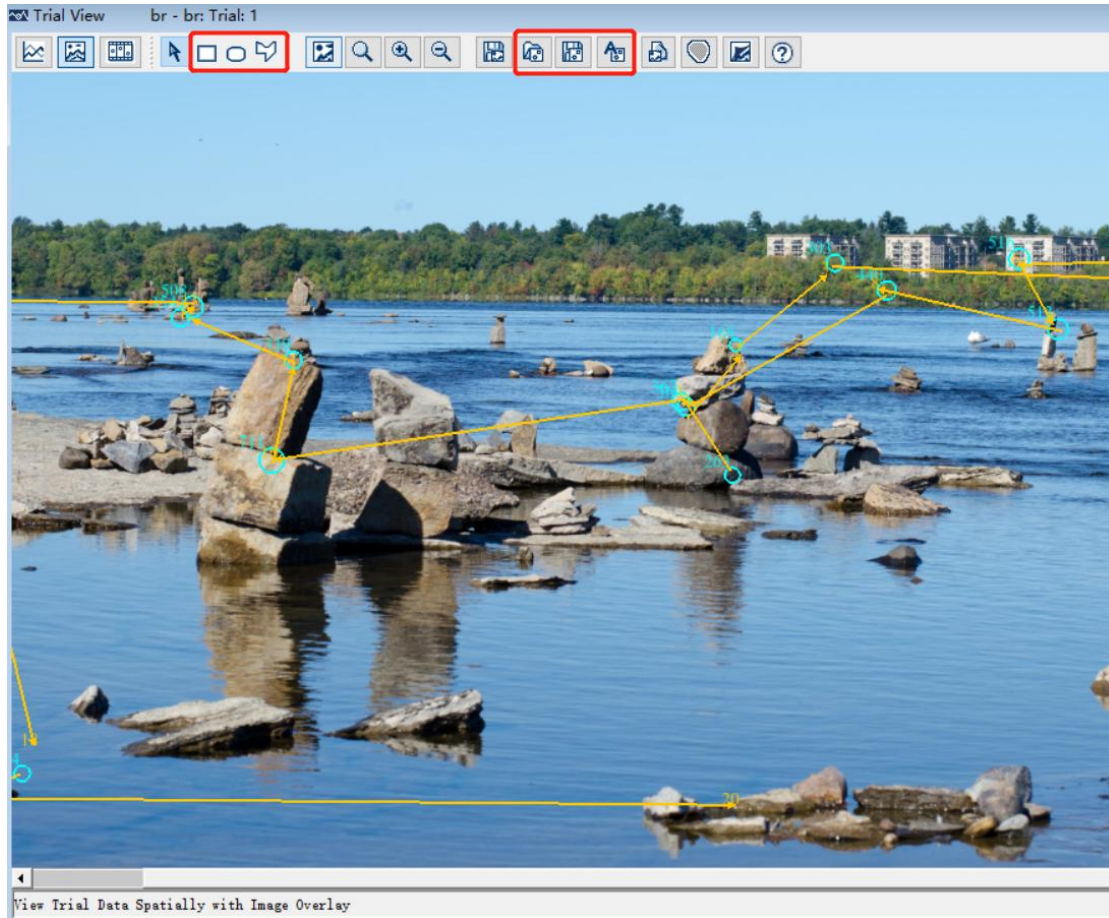
## Import Data



## Trial Grouping



## Interest Area



- Creating Interest Area
- Saving Interest Areas
- Importing Interest Area File
- Loading Interest Area Templates
- Merging Interest Areas
- Linking/Unlinking Interest Areas
- Creating Dynamic Interest Areas

# Interest Periods

EyeLink Data Viewer Version (64 bit) 4.2.1 - Picture.evs (C:\Users\Public\Documents\Picture)

File Edit Analysis Window Help

Inspector (Memory Usage 0%)

br

- br: Trial: 1
- br: Trial: 2
- br: Trial: 3
- br: Trial: 4
- br: Trial: 5
- br: Trial: 6
- br: Trial: 7

br: Trial: 3: Message: -56 ms : TRIA

br: Trial: 3: Message: -1 ms : RECC

br: Trial: 3: Message: -1 ms : ELCLC

br: Trial: 3: Message: -1 ms : GAZE

br: Trial: 3: Message: -1 ms : THRE

br: Trial: 3: Messaao: -1 ms : ELCL

| Field                | Value                   |
|----------------------|-------------------------|
| Label:               | Trial: 3                |
| Index:               | 3                       |
| Recording File:      | br.edf                  |
| Recording Start ...  | 89435915 ms             |
| Recording End Ti...  | 89443997 ms             |
| Recording Durati...  | 8082 ms                 |
| Sampling Rate:       | 1000 Hz                 |
| Interest Period L... | Full Trial Interest ... |
| Interest Period S... | 0 ms                    |
| Interest Period E... | 8082 ms                 |

RT manager

Full Trial Period

Edit ...

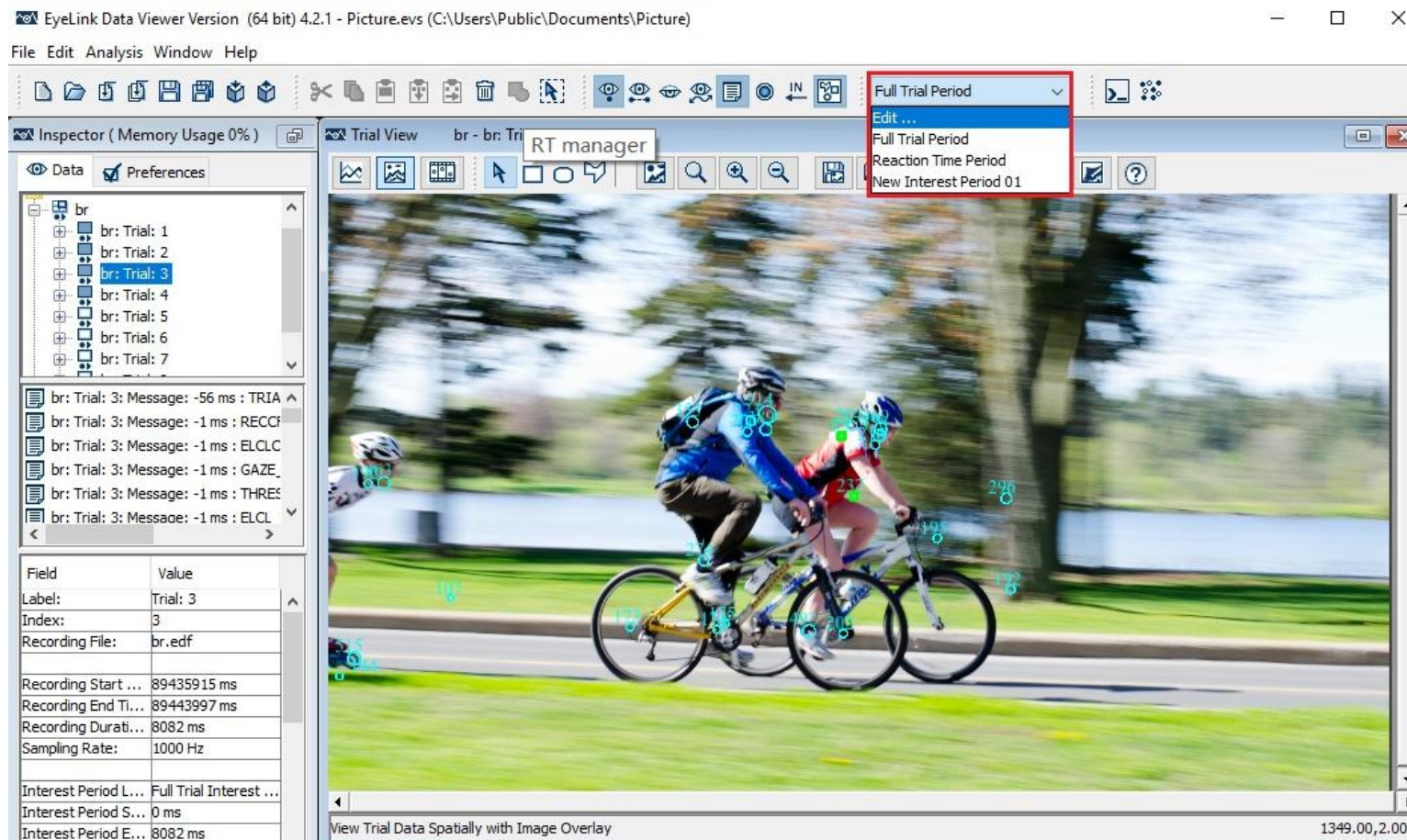
Full Trial Period

Reaction Time Period

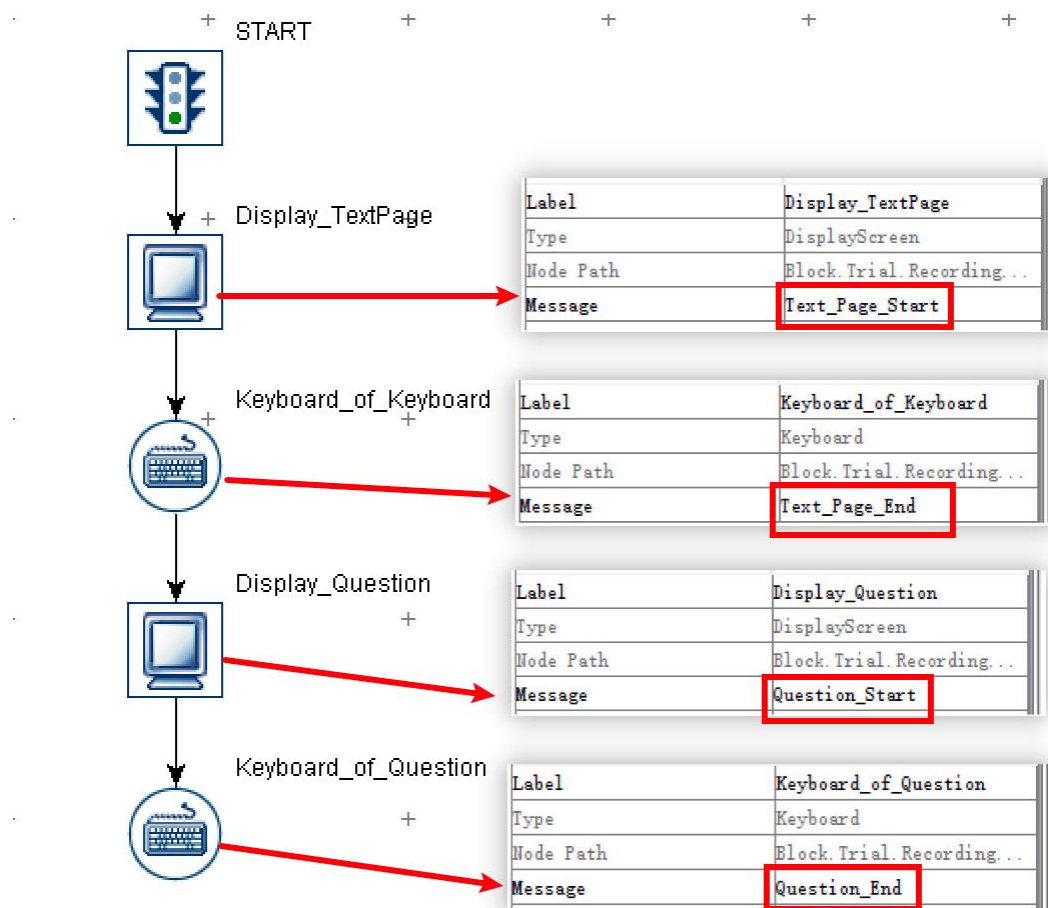
New Interest Period 01

View Trial Data Spatially with Image Overlay

1349.00, 2.00

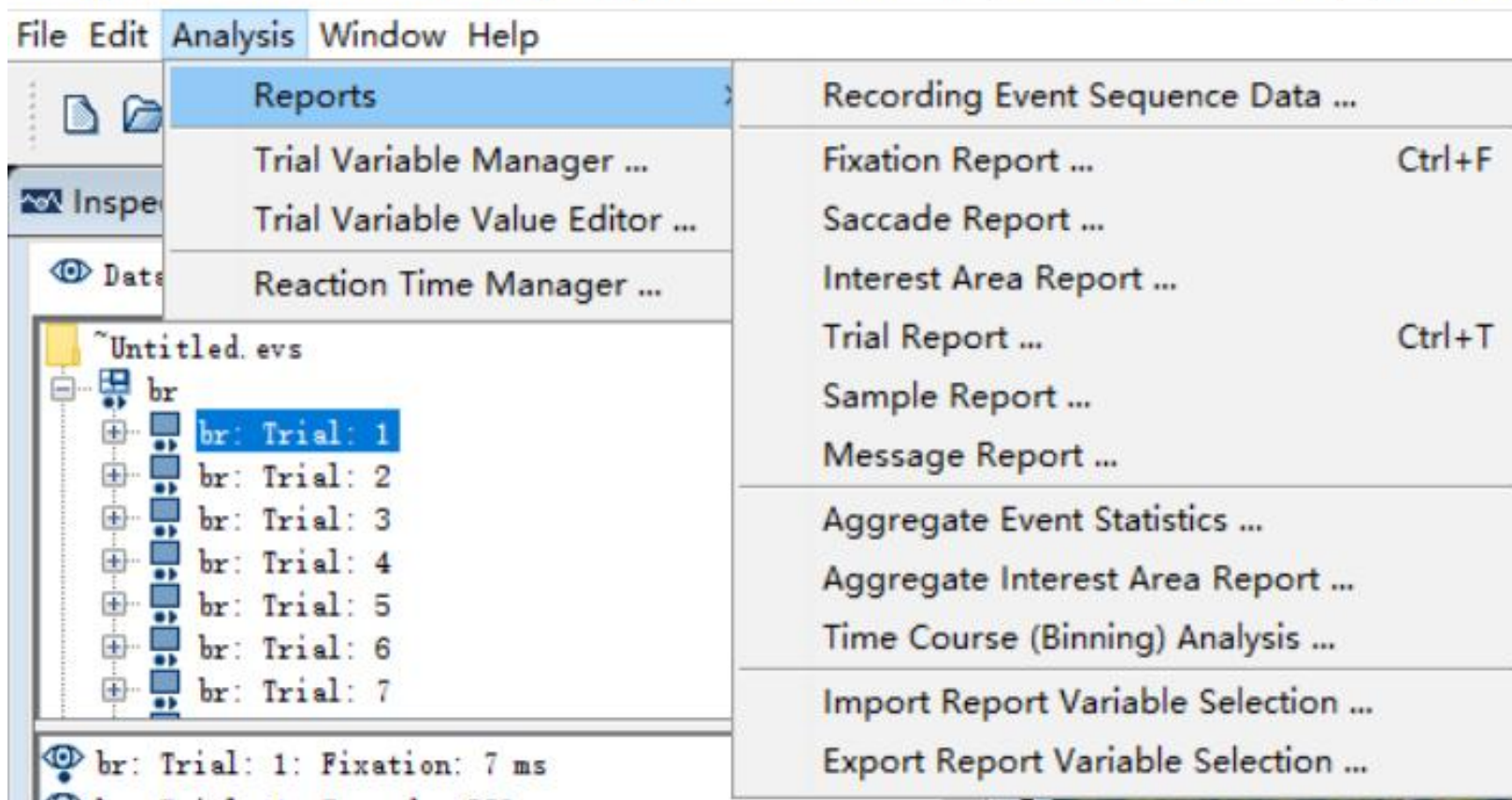


# Message



# Report

EyeLink Data Viewer Version (64 bit) 4.2.1 - ~Untitled.evs (C:\Users\BIGSMO~1\AppData\Loc



## Report

- 常见的眼动指标

### First Fixation Duration

兴趣区内第一个注视点的持续时间

眼动研究中最普遍的指标之一，能有效反应词汇通达的早期阶段特征  
对多言语特征反应敏感，如：词频、词长及可预测性等……

### First Fixation Time

兴趣区内第一个注视点的开始时间

体现加工顺序或被试被该兴趣区的吸引程度

## Report

- 常见的眼动指标

### Gaze Duration

凝视时间是目标区域首次加工中所有注视点时间的和

反应词汇通达早期阶段的最好指标 —— Just & Carpenter, 1993

大部分影响首次注释时间的因素都会影响凝视时间 —— Rayner, 1998

### Dwell Time

兴趣区内所有注视点持续时间的总和

反应加工难度

对被试的吸引程度

## Report

### • 常见的眼动指标

#### Number of Fixation

兴趣区内被注视的总次数

反应认知加工负荷 —— Henderson & Ferreira, 1990

受阅读水平影响 —— Rayner, Yang, Castelhana & Liversedge, 2011

编码任务中：

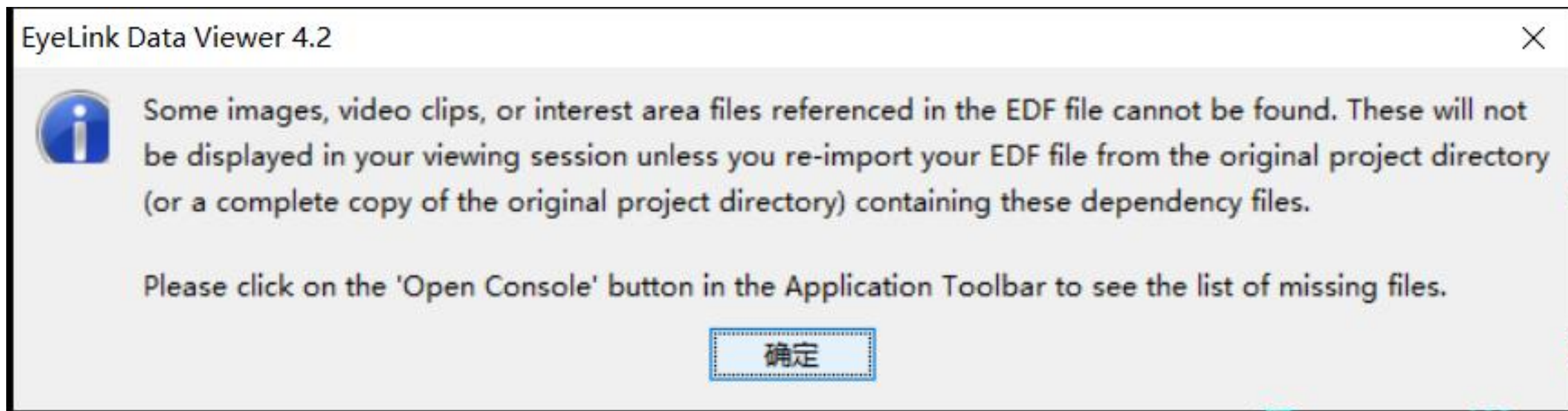
被试对这个区域感兴趣程度 —— Jacob & Karn, 2003

这个区域包含着复杂的信息，编码比较困难 —— Just & Carpenter, 1976

搜索任务中：

表明对目标就越不能确定 —— Jacob & Karn, 2003

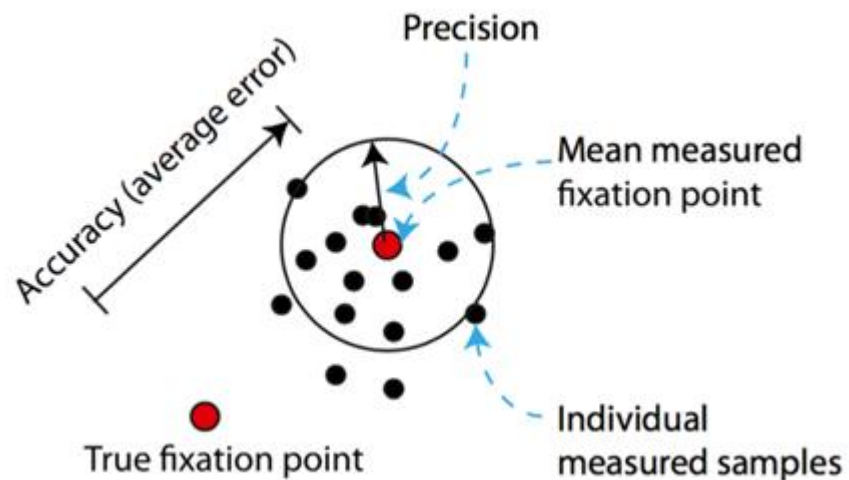
## Trouble Shooting



## Trouble Shooting

- 1.移动或者复制实验数据时，未将整个实验文件夹全部移动或复制，导致部分文件丢失。比如说，您在复制或移动数据结果时，仅仅是复制或移动了EDF文件，则将无法在DV中查看背景图，EDF文件中不包含背景图，仅包含message信息和眼动数据，当复制或移动整个实验文件夹时，EDF文件将通过message链接背景图，这时就可查看背景图；
- 2.可能将已保存的.evs文件移动到另一个文件夹位置，正确的方式是通过菜单栏中File-package创建新的.dvz文件，然后在另一台电脑上直接打开.dvz文件即可查看已处理步骤的数据。
- 3.还可能源材料格式存在不支持的情况，比如视频格式等。
- 4.还可能是E-prime的实验设计问题。

## 眼动数据质量



- Accuracy

difference between measured gaze position and actual target position

- Precision

Reproducibility / Repeatability, variance

- Data access latency

The time between the eye being at position X and eye tracker working out that information and making it available to other devices

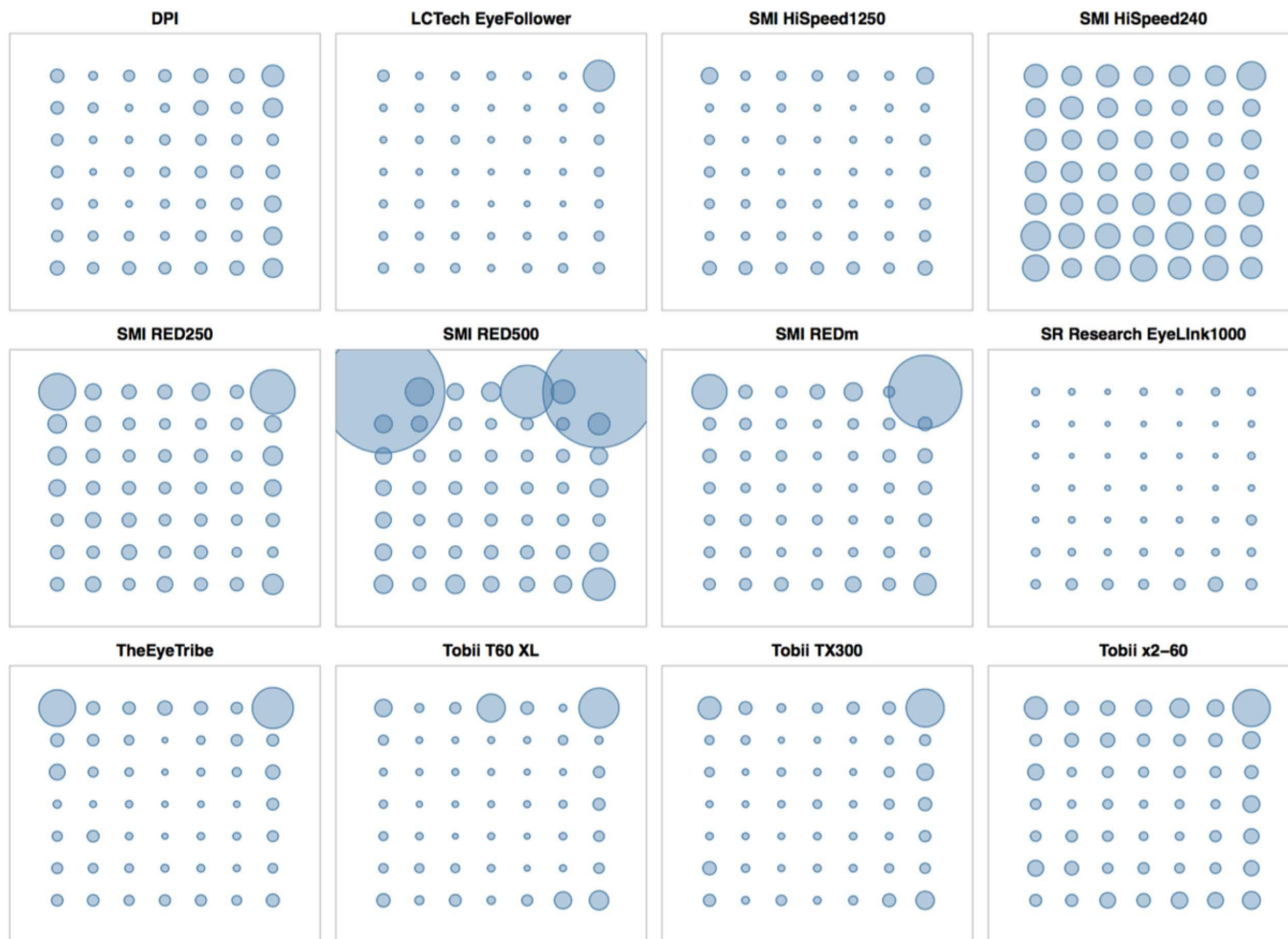
- Temporal resolution

sampling rate

- Spatial resolution

The smallest detectable change in position

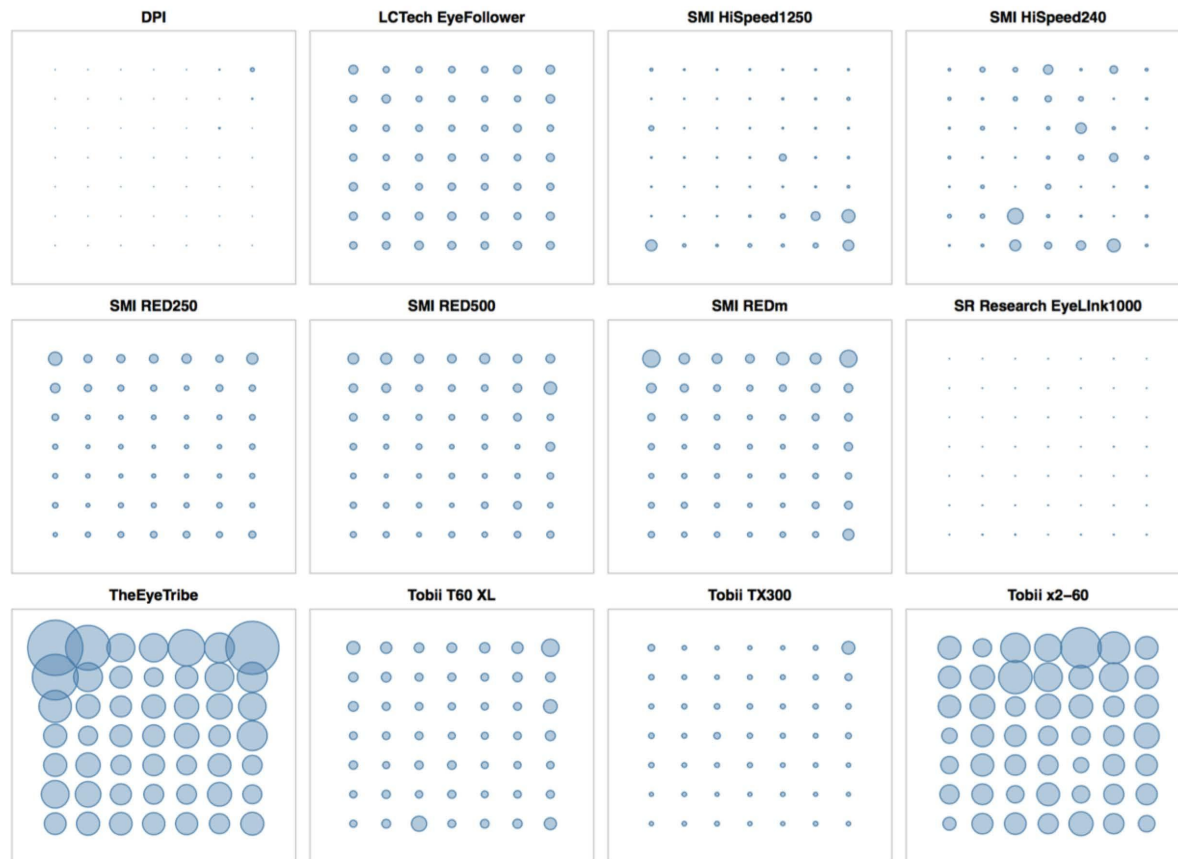
# Accuracy



**Accuracy:** 准确性通常被定义为测量值和真实值之间的平均差。

在19寸屏幕上全屏幕所获取的准确性，圆圈越小，误差越小

# Precision



Precision/RMS: 精度指再现的可重复性。

在19寸屏幕上精度数据，圆圈越小，精度越高

## 眼动数据质量

- Data access latency

数据访问延迟，即在线计算识别眼动事件的计算能力，它也决定着数据的精度，它与电脑本身的性能和帧率有关。

- Temporal resolution

采样率，设置在250hz以上较好

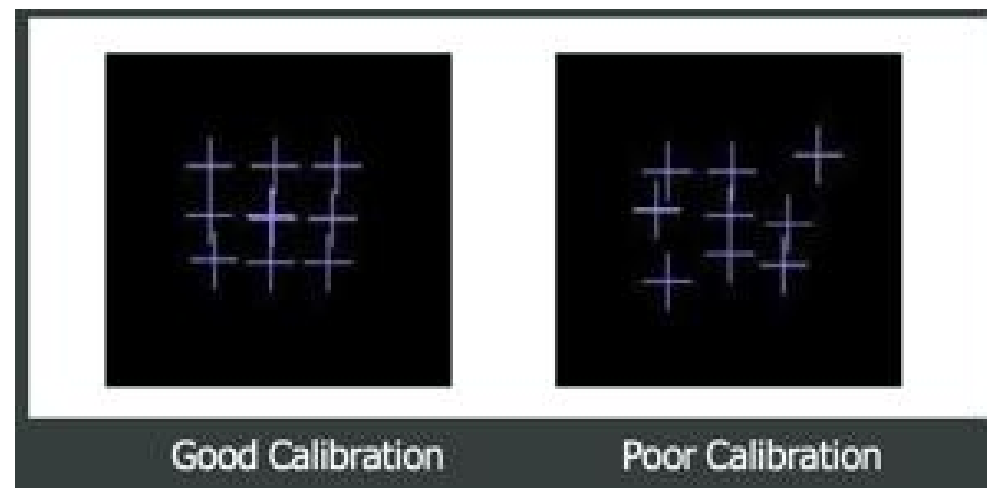
- Spatial resolution

The smallest detectable change in position

| EyeLink 1000 Plus<br>Core System<br><br>EyeLink 1000 Plus<br>Camera and<br>Workstation<br>or Laptop Host PC | Key Specifications    | Head Supported                                       | Remote (Head Free-to-Move)                |
|-------------------------------------------------------------------------------------------------------------|-----------------------|------------------------------------------------------|-------------------------------------------|
|                                                                                                             | Sampling Rate         | 2000 Hz Monocular<br>2000 Hz Binocular               | 1000 Hz Monocular<br>1000 Hz Binocular    |
|                                                                                                             | Accuracy              | Down to 0.15°<br>(0.25° - 0.50° typical)             | 0.25-0.50° typical                        |
|                                                                                                             | Resolution            | 0.01° RMS<br>0.05° Microsaccade resolution           | 0.05° RMS<br>0.25° saccade resolution     |
|                                                                                                             | Real-time Data Access | M = 1.4 msec (SD < 0.2 msec)<br>@ 2000 Hz            | M = 2.2 msec (SD < 0.3 msec)<br>@ 1000 Hz |
|                                                                                                             | Data Output           | X, Y, and Pupil Size                                 |                                           |
|                                                                                                             | Host PC               | Workstation or Laptop Host PC                        |                                           |
|                                                                                                             | Participant Setup     | Very simple and easy. Typically less than 5 minutes. |                                           |
|                                                                                                             |                       | EyeLink博润视动                                          |                                           |

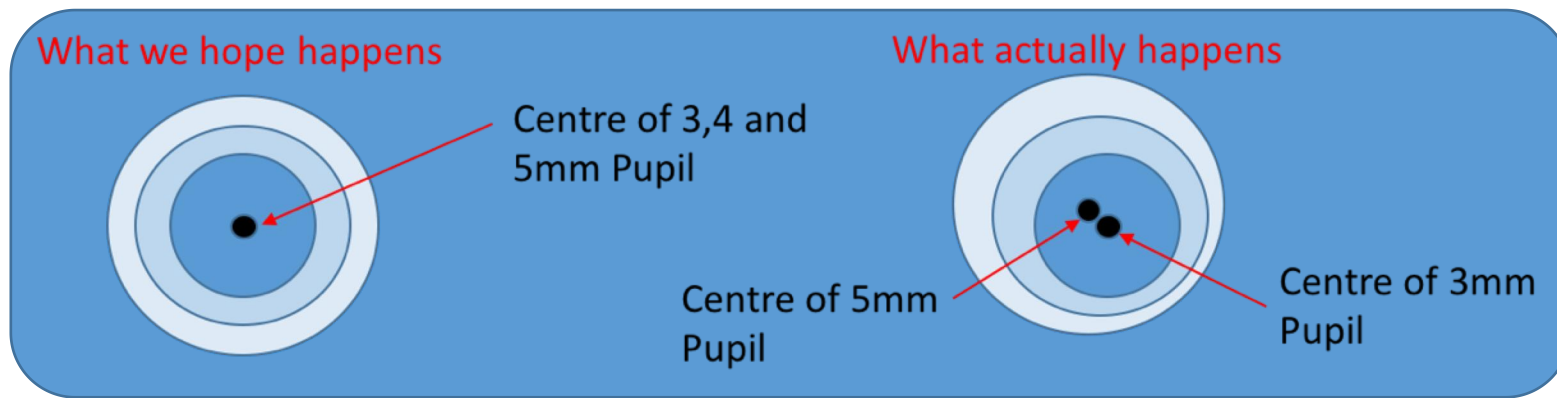
## 影响数据质量的人为因素——校准

- 任何精度/性能的眼动仪都需要校准
- 校准的过程需要人的参与，而且校准结果很大程度上取决于主试的经验
- 眼睛完全盯住校准点是不可能的——生理限制
- 不存在完美的校准

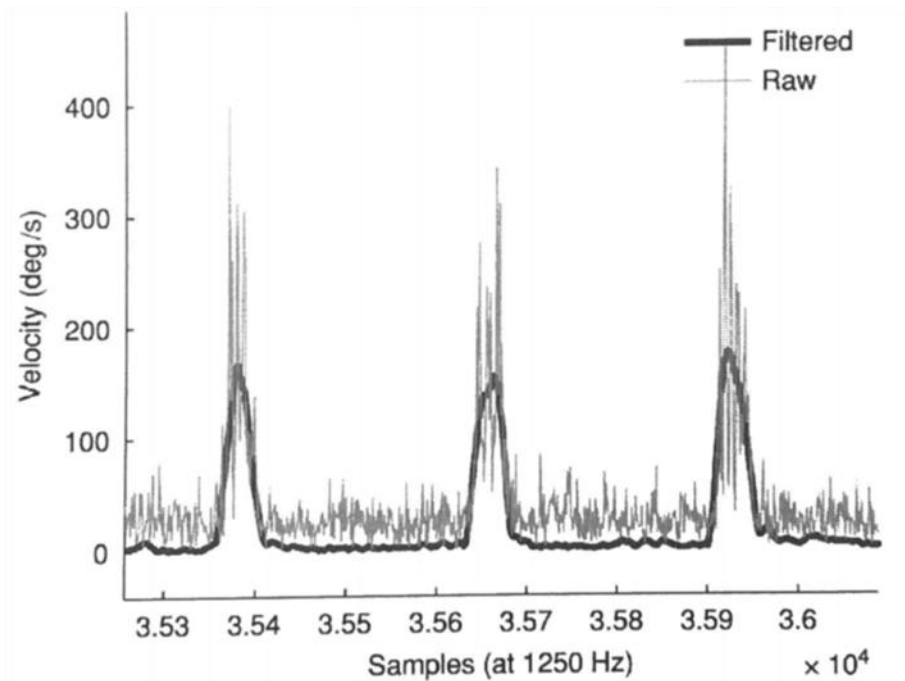


## 影响数据质量的人为因素——漂移

- 疲劳性漂移
  - 疲劳状态下对眼球运动的控制能力下降
- 微眼动漂移
  - 注视过程中时时刻刻发生，但影响较小。
- 瞳孔缩放漂移



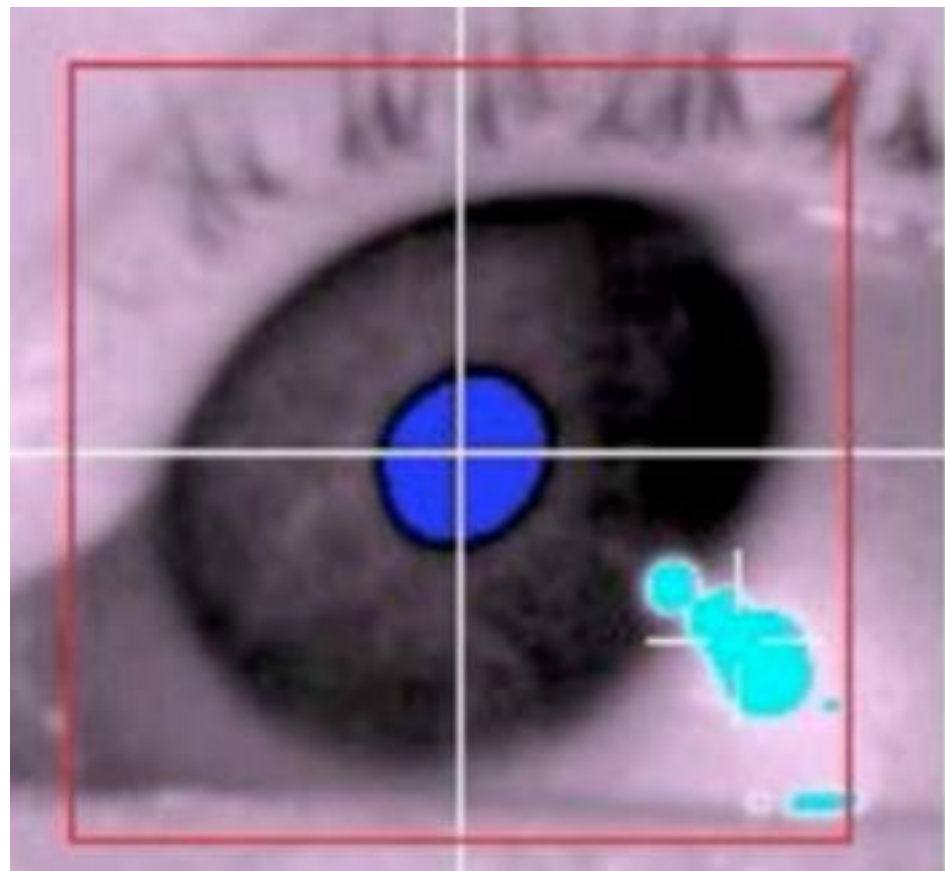
## 影响数据质量的人为因素——滤波/数据过滤



- 滤波改善了数据的稳定性，但也丢失了细节信息。
- 滤波对于速度和加速度的瞬时值影响显著。
- 对注视和扫视起止点位置影响不大。

## 影响数据质量的人为因素——追踪范围

- 追踪范围的限制主要和眼动仪的摆放位置有关
- 眼动仪位置欠佳会导致眼球转动时的CR脱落到虹膜甚至眼球之外，导致无法采集到数据



## 推荐阅读

Kenneth Holmqvist, Marcus Nyström, and Fiona Mulvey. 2012. Eye tracker data quality: what it is and how to measure it. In Proceedings of the Symposium on Eye Tracking Research and Applications. Association for Computing Machinery, New York, NY, USA, 45–52. DOI:<https://doi.org/10.1145/2168556.2168563>

该文献发表于2012年，在该文中，作者说明了为什么数据质量很重要，并回顾了以前关于如何测量和报告眼动数据质量的工作。目标是对什么是数据质量以及如何定义，测量，评估和报告数据质量达成共识。

Eyal M. Reingold (2014) Eye tracking research and technology: Towards objective measurement of data quality, Visual Cognition, 22:3-4, 635-652,

DOI: 10.1080/13506285.2013.876481

发表与2014年，文中探讨了两种客观测量眼动数据质量的方法。

## 推荐阅读

Holmqvist, Kenneth. (2017). Common predictors of accuracy, precision and data loss in 12 eye-trackers. 10.13140/RG.2.2.16805.22246.

发表与2017年，探讨了12种眼动仪的有效性、准确性和重要性，并提出了客观数据质量价值。

Andersson, R. , M Nyström, & Holmqvist, K. . (2010). Sampling frequency and eye-tracking measures: how speed affects durations, latencies, and more. Journal of Eye Movement Research, 3(3), 1-12.

发表与2010年，探讨了采样频率影响眼动事件的持续时间等