

# Introduction to NeuroScript® MovAlyzeR® Handwriting Movement Software

(Draft 14 August 2015)

Our mission: Facilitate discoveries and applications with handwriting movement software at universities, hospitals, therapy clinics, forensic and private labs.

NeuroScript's MovAlyzeR has become the leading handwriting movement software: "Measure Motor Skill TODAY!"

## A. Why Handwriting?

Handwriting is the most taught motor skill worldwide. Yet, few measurement methods exist to compare teaching methods.

Handwriting requires the highest speed of the neuromuscular system. Neuromuscular disorder, medication, and mental distraction will affect movements and handwriting movements in particular.

Handwritten signatures are the gold standard for signing with pen and paper. The digital equivalent is handwritten signatures on electronic pads. This provides also dynamic information. This richer information must be included in court disputes. The proper way is to use independent electronic signature analysis software like MovAlyzeR. Exemplars recorded on an electronic signature pad reveals added information crucial in examining wet signatures.

## B. Why MovAlyzeR?

MovAlyzeR is the result of US\$4M+ funding by the National Institutes of Health to develop general purpose handwriting movement analysis software.

The pen tablets available in computer stores enable us to record pen movements at greater accuracies than 3D movement tracking equipment that is about 100 times more expensive.

MovAlyzeR helps professionals and students in education, therapy, forensics, neurology, psychiatry, and kinesiology can now design, run, process, and analyze handwriting and drawing movement tests without special computer skills. Movements are segmented and per segment duration, size, fluency, accuracy, ... are estimated. The design will be according to scientific standards. It can be replicated by others. Each participant tested with MovAlyzeR represents a value of typically US\$500 for organizations who wish to outsource human movement testing.

### C. Implement a MovAlyzeR test from scratch

Let us create a handwriting test from scratch, run it, analyze it, and document a result in 30 minutes. For example: What differences exist between movements with the left and right hands.

**If no pen tablet is available: Use the computer mouse as movement recording device**

#### If you have a pen tablet

Download the tablet's Wintab driver from the manufacturer's website and install it.

- o Select instead of Mouse: Tablet (in tool bar)
- o If the Tablet option is not available, the proper Wintab driver is not installed properly.
- o Verify the functioning of the tablet via the Tablet Properties in the Control Panel.
- o When changing tablets, the driver may emulate the first tablet. To erase the first tablet:  
Start >All Programs >Tablets >Tablet Preference File Utility >Remove all.

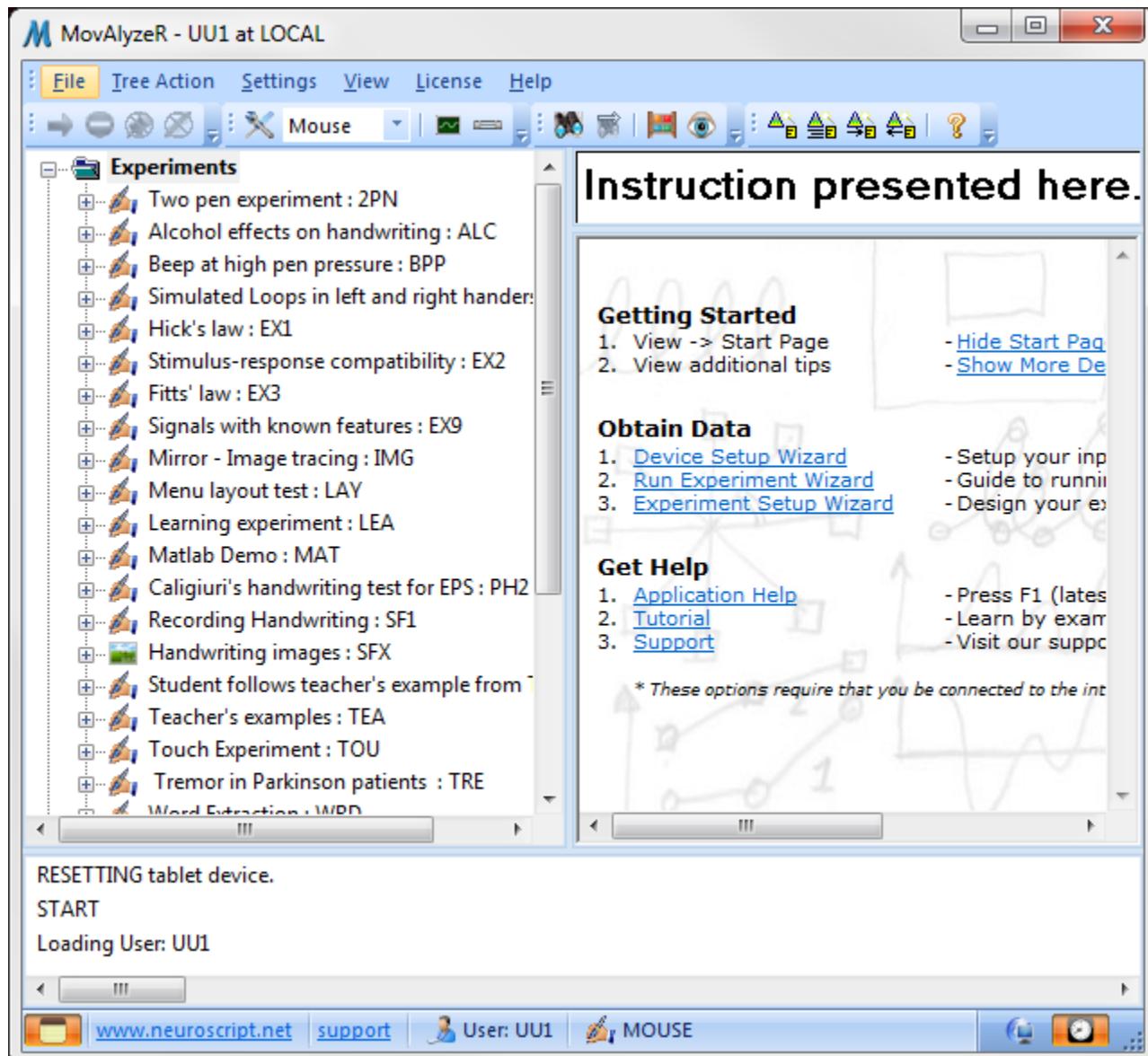
#### (1) Download MovAlyzeR

Search the internet for: Handwriting Movement Software. You will find [www.neuroscriptsoftware.com](http://www.neuroscriptsoftware.com) where you can download MovAlyzeR onto your MS Windows computer. When installing MovAlyzeR it will generate a Request Code that needs emailed to [Sales@neuroscriptsoftware.com](mailto:Sales@neuroscriptsoftware.com). A Trial Activation Code will be emailed.

## (2) Start MovAlyzeR

Start >Type: movalyzer, then hit Enter.

MovAlyzeR will open the first time with Example User UU1. It contains several handwriting tests. You can look at those later.

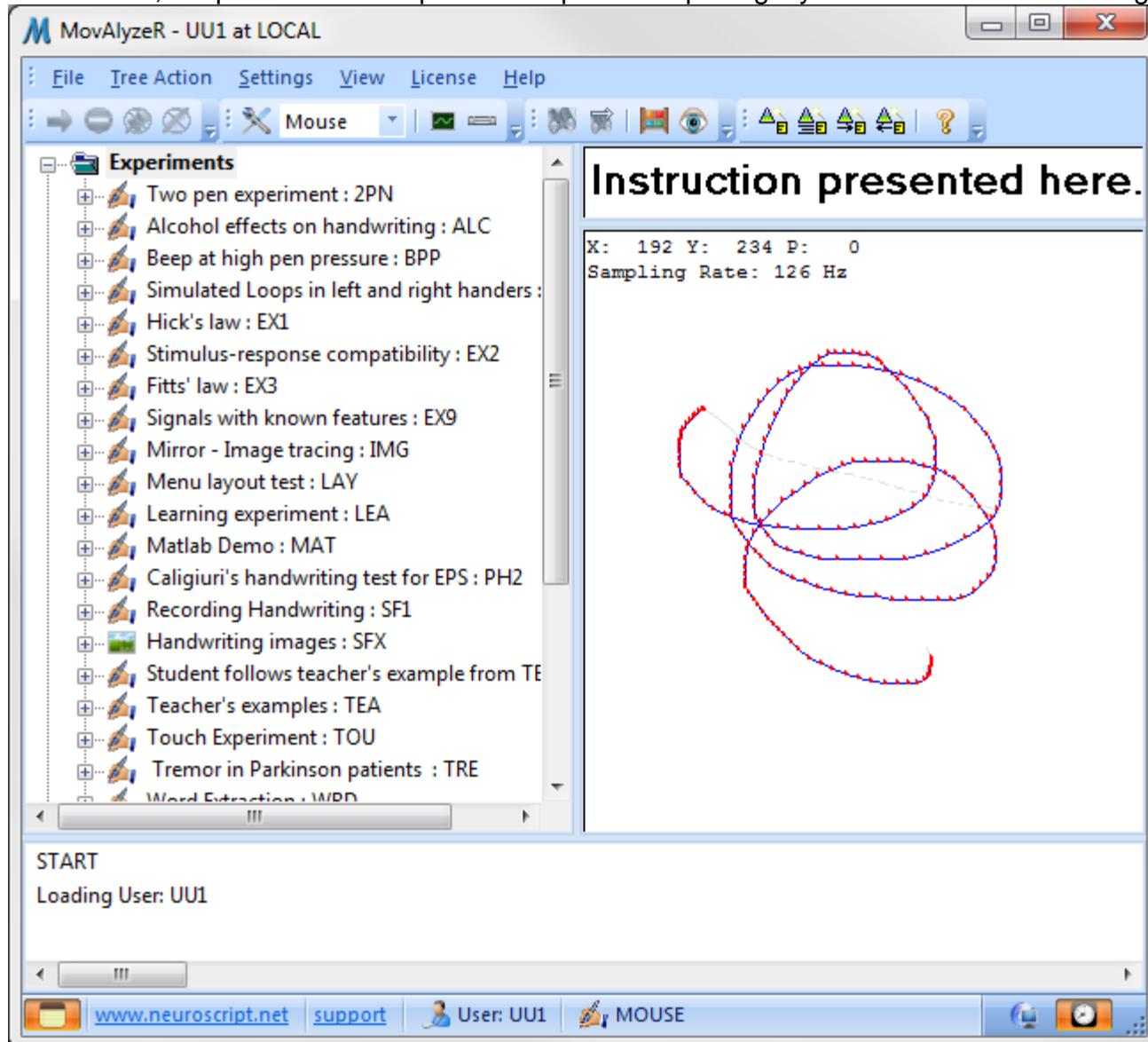


## Quick Test of Recording Device

Click: Hide Start Page

Move mouse or pen inside recording window.

With mouse, keep mouse button pressed or press the pen lightly on the tablet while moving.



To Erase: Rightclick in start window >Clear

### (3) Define yourself as user

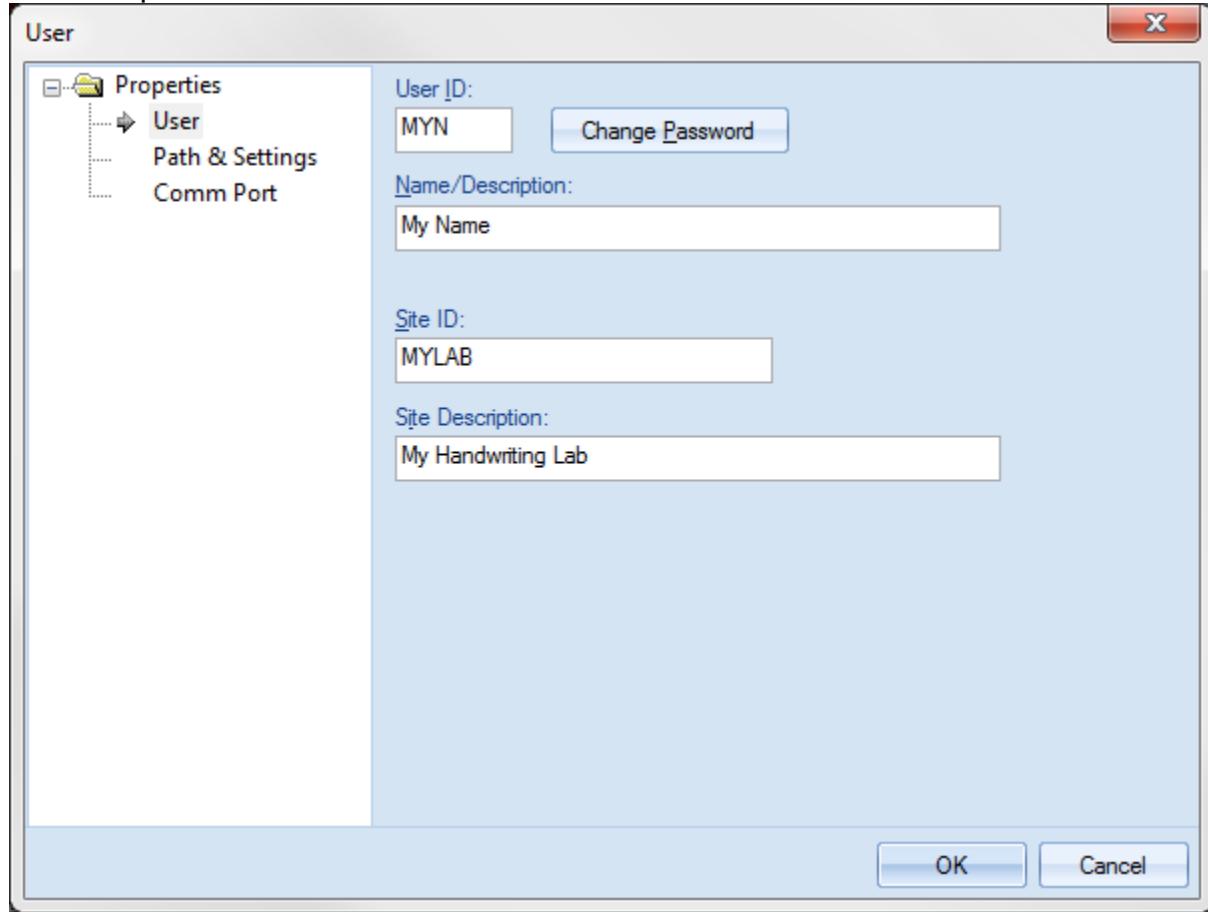
Click: File >Users >Create New (Shown as + sign)

Enter User ID

Enter your name

Additional information is optional

For example:



>OK.

You will be prompted to specify the default locations where all your data and the data backup will be.

You can password protect participant's data with a password. Say No.

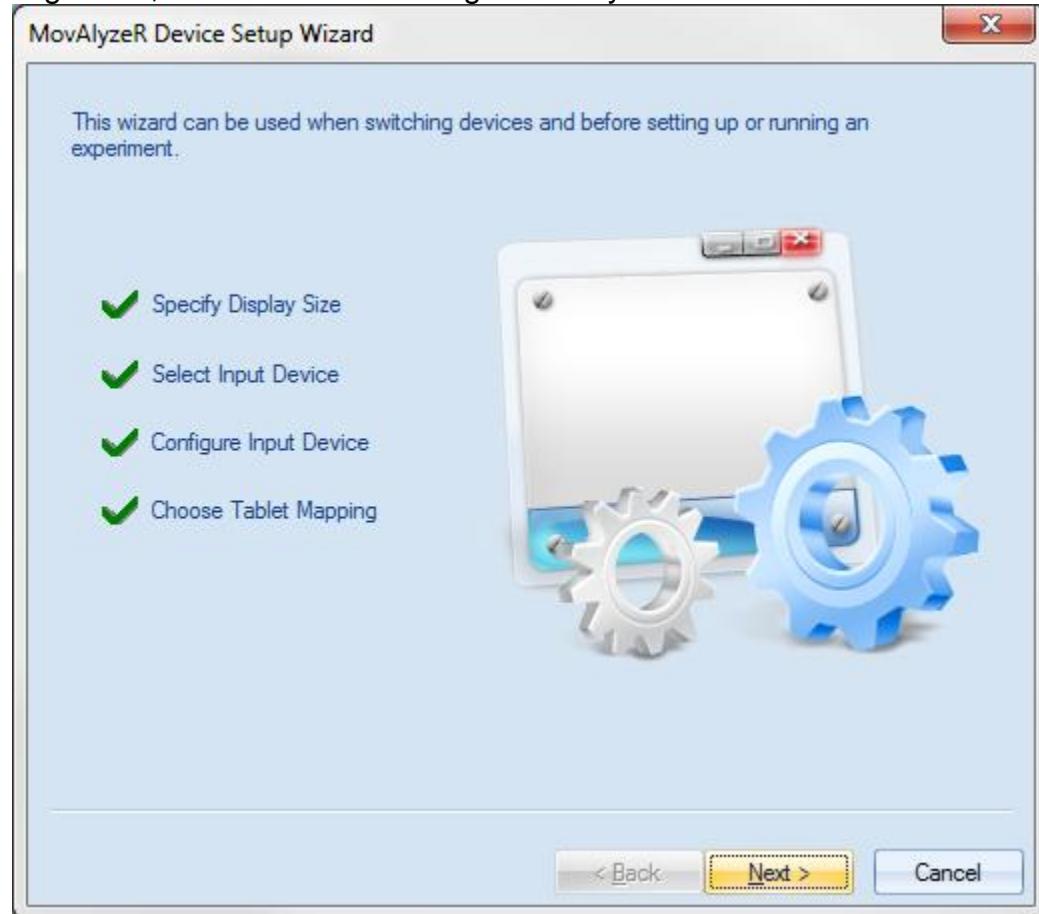
>OK

Confirm that new directories will be made (as there were no data yet)

### (3a) Input Device

The first time the input device needs setup. Say Yes. it will walk you through all steps. Click Next after each step.

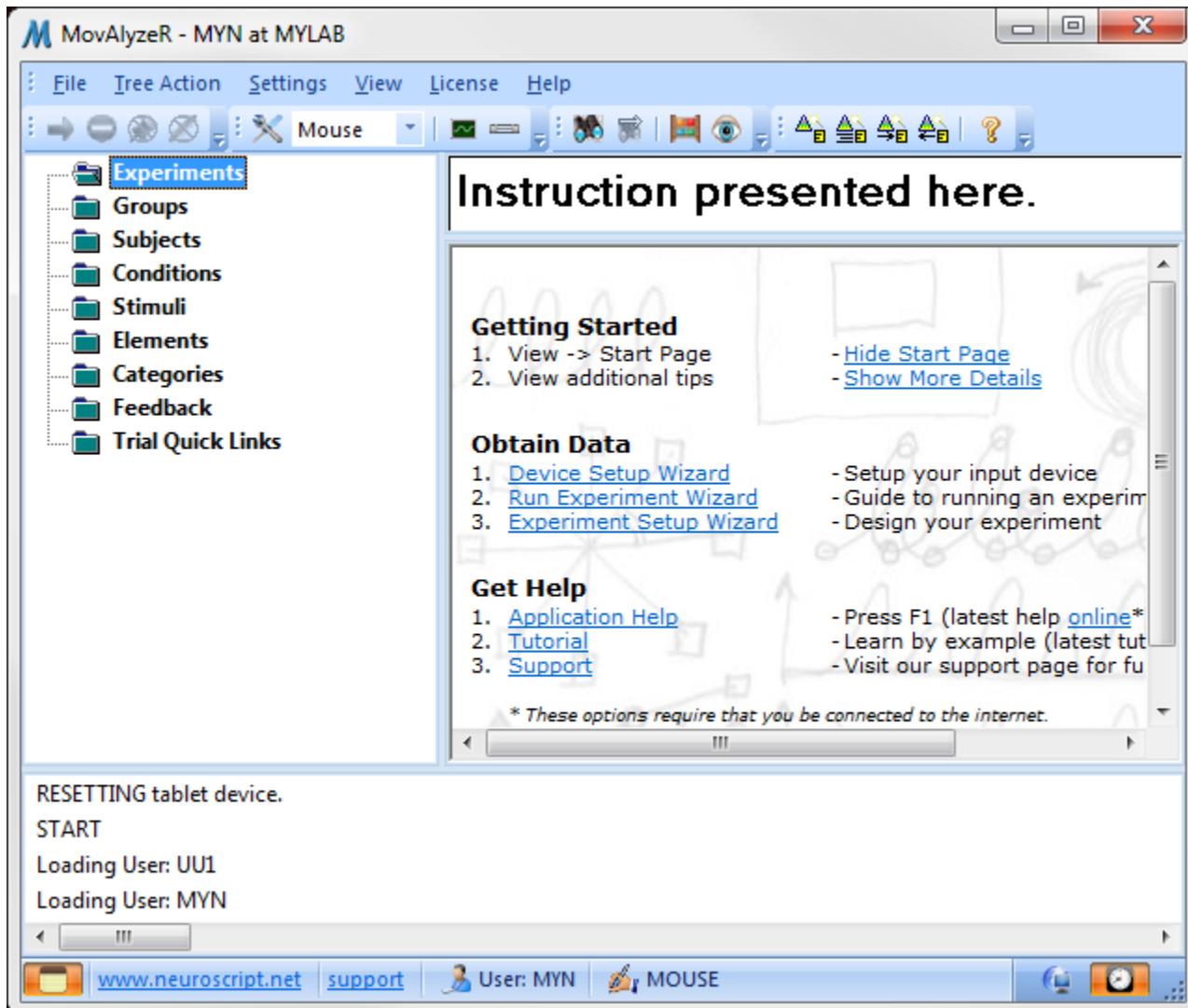
In general, use the default settings unless you have reasons to alter these.



#### (4) Setup a new experiment

When done you should see a clean user with no items created.

Nearly all instructions are Rightclick actions inside the left window. This window describes the hierarchical data structure.



We will use the basic method which will give you the most control.

There are other ways, e.g., using the Experiment Setup Wizard (Hold mouse over each of the tools).

*Later you could try to import an experiment from User UU1:*

1. Switch to User UU1      *File >Users*
2. Export      *Rightclick an experiment >Export.*
3. Switch back to your own user ID
4. Import      *File >Import >Import Experiment*

#### (4a) Create Experiment

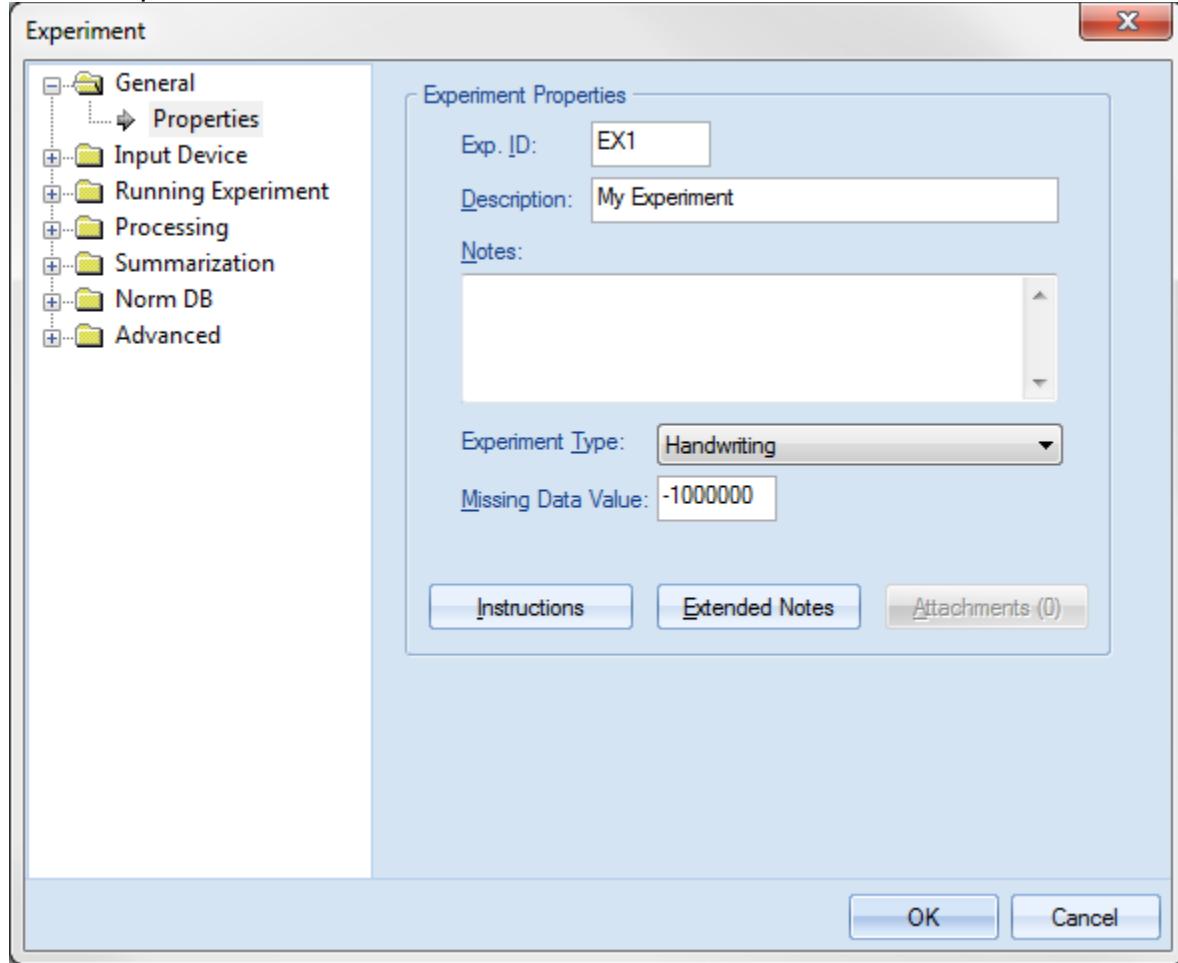
An Experiment is a test or a case. The jargon used is from Experimental Psychology.

Rightclick Experiments >Create New

Enter Experiment ID

Enter Description

For example:



#### Device setup for each new and (if you want to called data) each imported experiment

Each experiment can be produced with another device.

Click: Input Device >Run Device Setup Wizard

>OK

#### Experiment properties are the same for all Conditions

Later you can walk through all **Experiment Properties** and fine tune. These are properties that MUST be the same for all conditions (We will introduce different conditions in 4d).

#### Help

To obtain help on each Experiment Properties screen (and similarly on every other screen), just hit F1. This is a little known standard feature in all MS Windows programs.

#### (4b) Add or Create Group

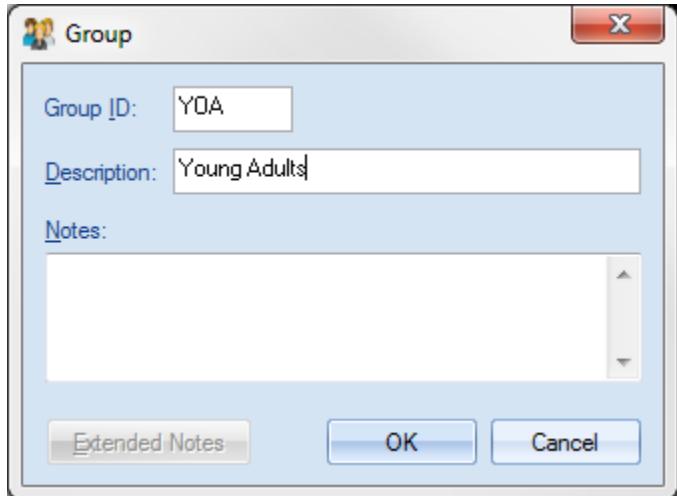
Under the Groups of participants, define a particular group, for example, Young Adults.

Rightclick on Groups >Add Groups

Enter: Group ID

Enter: Description

For example:



>OK

Add the selected Group.

#### Why Add Each Time?

"Add" is needed after "OK" because all items you define within a user will be reusable in all future experiments. Under the headings

Groups,

Subjects,

Conditions,

you will now find all items defined earlier.

To find where else an item is used, rightclick on it >Relationships

#### (4c) Add or Create Subject

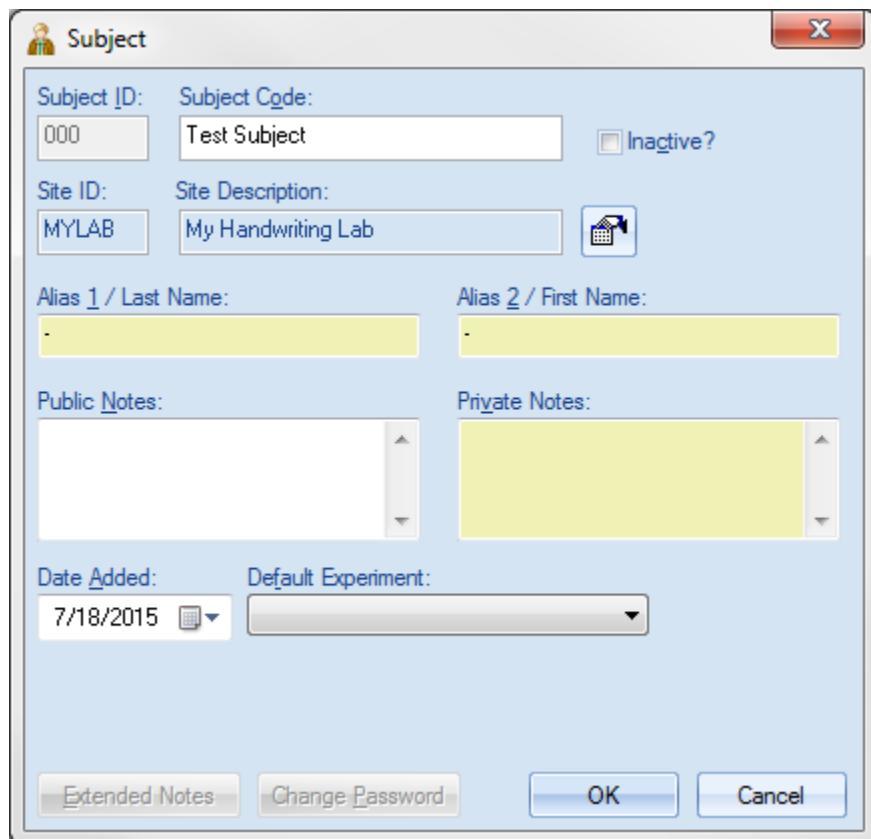
Under Subjects (or Writer, or Participants – A better term but it is longer), define a particular subject, for example Test Subject.

Rightclick on Subjects >Add Subjects

Subject ID is filled automatically (This can be disabled in the Settings >User properties). This is handy because each Subject ID needs to be unique. In multi-site studies, the ranges of Subject IDs can be set differently per site.

Enter a subject code. Note this code needs to be public to protect the identity of research subjects. In forensic case work it may be allowed to enter personal information.

For example:



>OK

Add the selected Subject.

#### (4d) Add or Create Condition

A condition is a task or situation under which something is written. For example, writing with the right and the left hands are 2 different conditions.

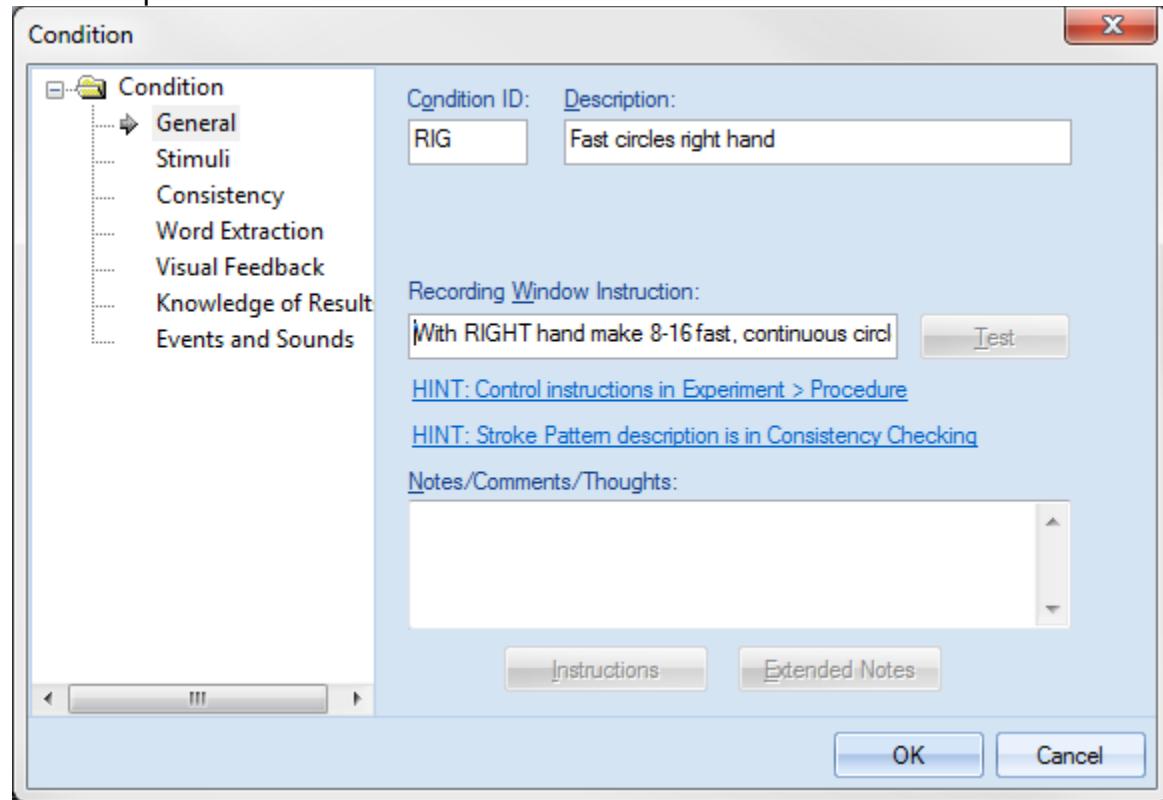
Rightclick on Conditions >Add Conditions

Enter Condition ID

Enter your description

Enter a 1-line recording window instruction (You can create a multi-line condition instruction window later)

For example:



>OK

Add selected condition.

#### Condition Properties Differ Per Condition

Later you can walk through all **Condition Properties** and fine tune. These are properties that you often wish to COMPARE in one experiment, for example, the instruction to write with left or right hands. The sequence of trials can be set in the Experiment Conditions >Running Experiment >Procedure.

**We want to add a SECOND condition to this experiment.**

A second condition is a good idea as you now can compare participants when a particular effect should and should not occur, respectively.

You can create a second condition like the first one but better is to migrate a second condition from the first condition by:

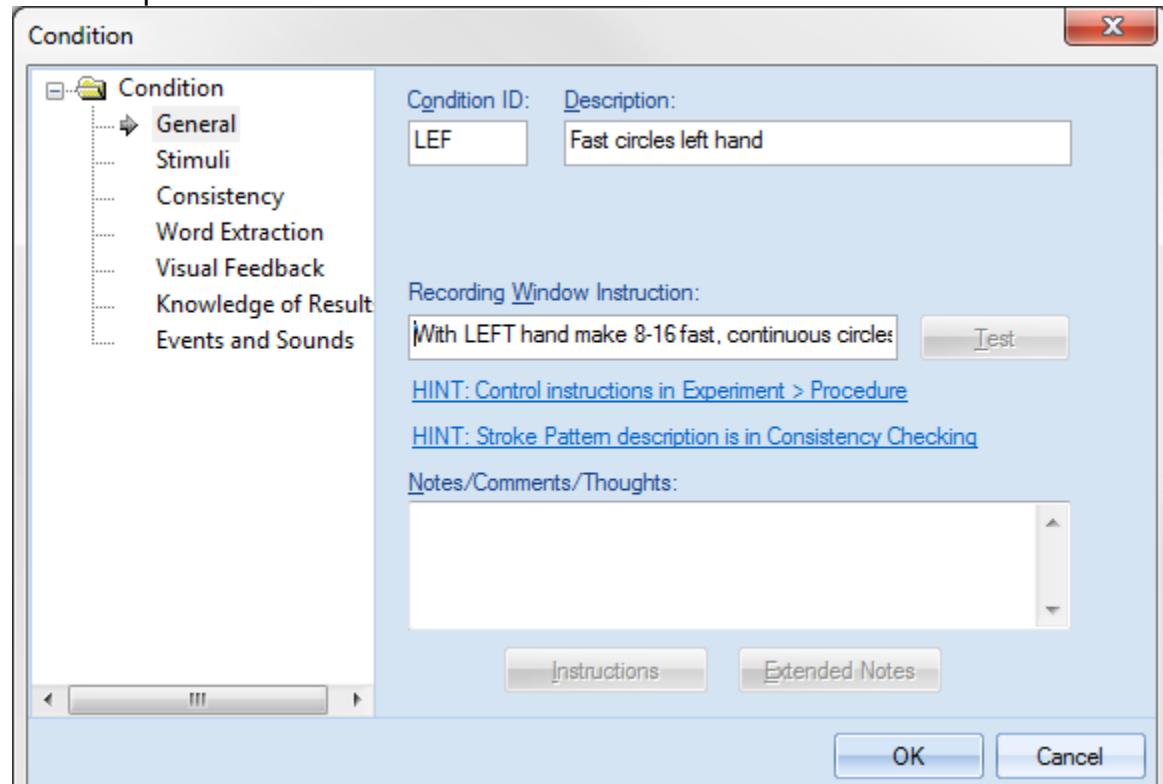
Rightclick on the particular condition >Duplicate

Alter Condition ID

Alter your description

Alter a 1-line recording window instruction (You can create a multi-line condition instruction window later)

For example:



>OK

Add selected condition.

**Number of Trials**

Each condition has still a few replications (Called Trials) of exactly the same task. By default the number of trials is 3. This is the absolute minimum to do comparisons between conditions. The number can be set differently for each experiment and condition: Rightclick your condition WITHIN and experiment >Number of trials.

## (5) Test MovAlyzeR and pen tablet or pen tablet PC

To verify the sampling you could do the following 5 tests in one experiment. Repeat each test at least 2 times. You can check the processed results immediately after the recording of each trial or you can record first all trials and then check the processed results.

TEST1: Draw an capital L shape of 5 cm x 5 cm by threading the lines and stand briefly still at the corner. The shape should be aligned with the sides of the tablet. Double-click on the trial and verify in the processed XY chart that the measured sizes are 5 cm x 5 cm.

TEST2: Record a slow circle of 2 cm diameter and lasting 5 seconds from pen down to pen up. Circle does not need complete. Use a stop watch in your smart phone to time the 5 seconds. What sampling rate is measured and shown top left?

TEST3: Record rapid, repetitive circles of 2 cm diameter and lasting 5 seconds from pen down to pen up. The sampling rate should be the same as in TEST 2. Double-click on the recording and select as Chart: Velocity Spectrum. The part above 10 Hz should be like low-amplitude white noise without structure.

TEST4: Draw a rapid, fluent, diagonal line of 5 cm length along a good ruler with the pen upright. Rightclick on the recording >Linearity test.

Ensure:

View >Detailed Output

is checked.

Then the output details will be in the lowest window. Move the separators to see more. The test will verify whether the sampling rate is constant (Ideally there should be no missing samples or double samples) and what the RMS error per sample is in cm. This needs reported.

TEST5: Draw a rapid, fluent, diagonal line of 5 cm length along a good ruler with the pen held constantly upright plus reverse the movement with an equally fast line so that you are back at the starting point. The lines should cover each other on the screen. If you see an eye shape, the sampling rate

## (6) Run experiment

Running an experiment means testing a subject, one at a time. We could also have called it Run Subject or Test Subject.

Rightclick your subject (e.g., Test Subject) >Run experiment.

**Alternative ways to run an experiment are:**

- o Select your subject >Click Green arrow
- o Select your subject >Hit F9
- o Run Experiment Wizard (in tool bar)
- o Tree Action (in menu bar) >Subjects >Subject >Run Experiment

**Know how to stop before you begin.**

Normally, experiments end when all trials are done. To stop prematurely, locate and use the tools in the toolbar that are grouped with the Run tool (Green arrow).

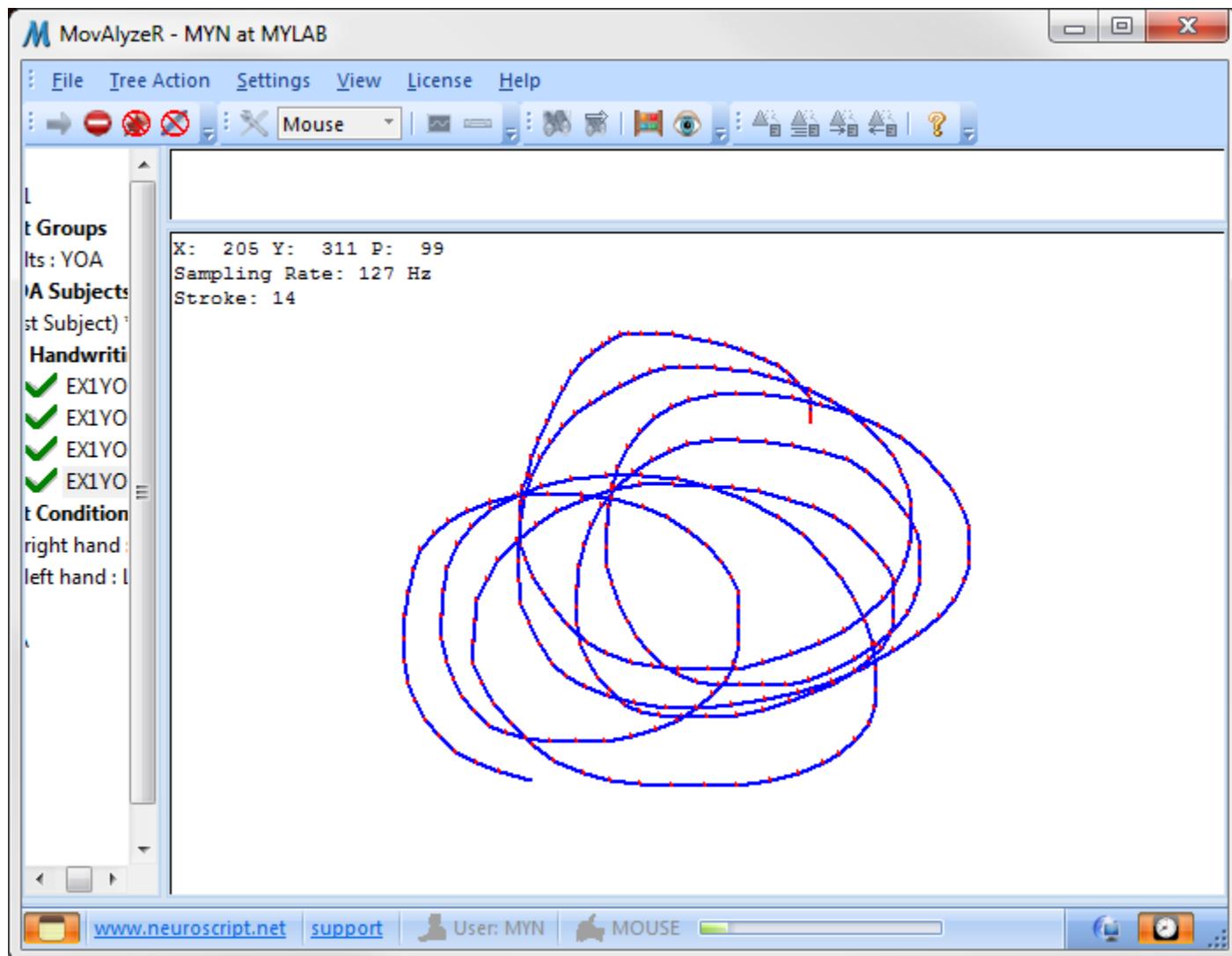
- o Stop everything
- o Stop condition
- o Stop recording

### **What does the subject do during the experiment?**

- o Normally there is a subject (research participant) sitting in front of the computer (or pen tablet)
- o Ideally, the experiment needs to be self-explanatory for the subject
- o Reads the 1-line instructions shown in the top window. The instruction disappears by default when the movement starts
- o Performs the instruction
  - To “write” with the mouse, keep the mouse button pressed (equivalent with placing pen on paper)
  - Starts to produce the instructed task (e.g., circles).
  - When done stop the movement and release the mouse button. The pen-lift time out will end the trial. If the subject does not seem to stop, the trial time out will end the trial. These time outs are settable in the Experiment Properties >Running Experiment >Trial.
  - Waits for the next task to appear.

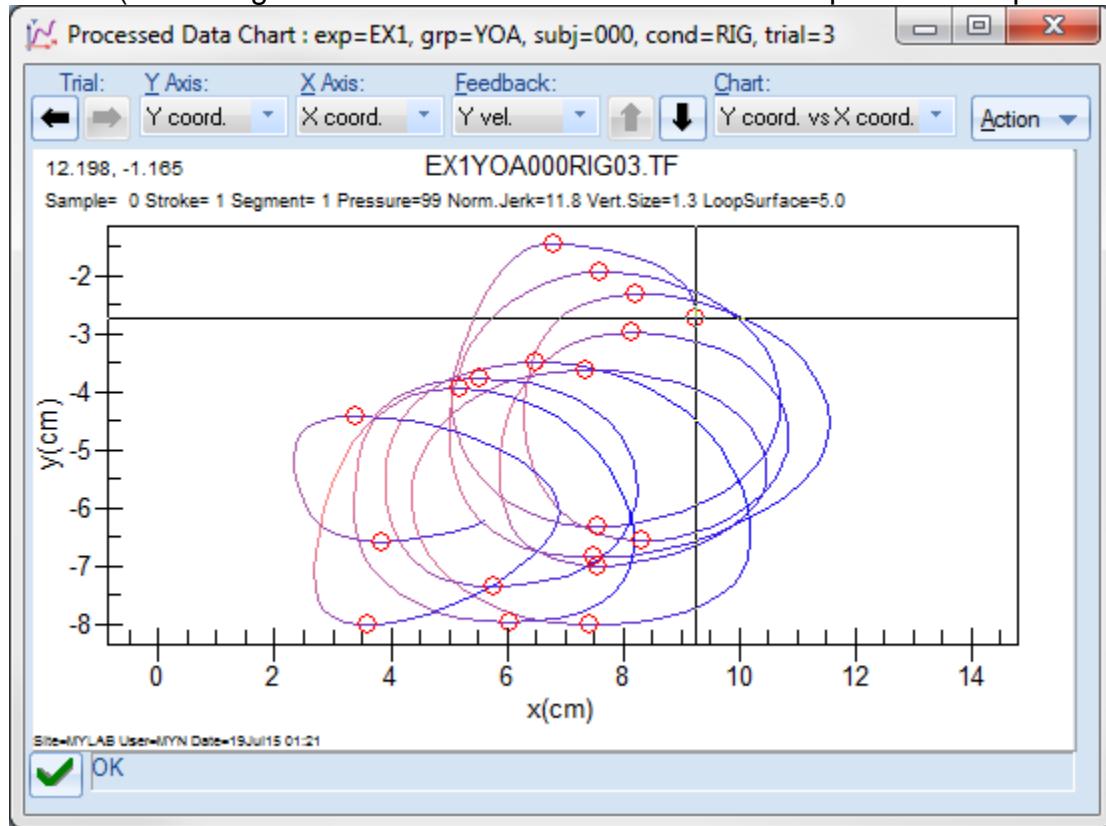
### **What does the experimenter do during the experiment?**

- o Normally the experimenter (investigator, supervisor) is sitting next to the tablet and monitors the screen.
- o The experimenter see in the left window green check marks for each successfully completed trial.
- o The top left of the recording window lists
  - X and Y coordinates
  - P for “pen pressure”. If there is just a mouse P will be 0 or 99.
  - Sampling rate. This is the true sampling rate. In many cases MovAlyzeR does not obtain the correct sampling rate via Acquire. The correct sampling rate is thus only relevant for processing, not recording. When the sampling rate is changed, all trials need reprocessed. When recording the mouse the sampling rate fails to be constant. Where the mouse is moving fast the rate is maximal. Where the mouse moves very slowly the sampling rate drops, and when the mouse does not move the rate will drop to 0. Therefore, the mouse is not reliable for duration measurements. For accurate duration measurements a pen tablet with Wintab driver is required.
  - Stroke: This is a stroke counter added for your convenience. A stroke is an upward or a downward movement. A circle counts for 2 strokes.
- o The red dots are the individual samples collected. The blue line is the connection between successive points. Dot and line color and size can be set in the experiment properties.



## (7) Processing

Immediately after each trial is completed the raw data are stored and also backed up and the data are processed. Double click on each trial will yield an analysis chart. The circles mark the up and down strokes (Other segmentation methods can be set in the Experiment Properties).



Click on the Vertical arrow bottom to walk through all time curves and frequency spectra.

Click in the chart. Use the left and right keyboard arrows to navigate through the signals.

You can have many charts (and numerical views – introduced next) open at the same time. You can also have many MovAlyzeRs running at the same time.

All charts (and views) (of the same trial) are synchronized.

## Numerical Data per Trial

Action >View >Yields various numerical view options.

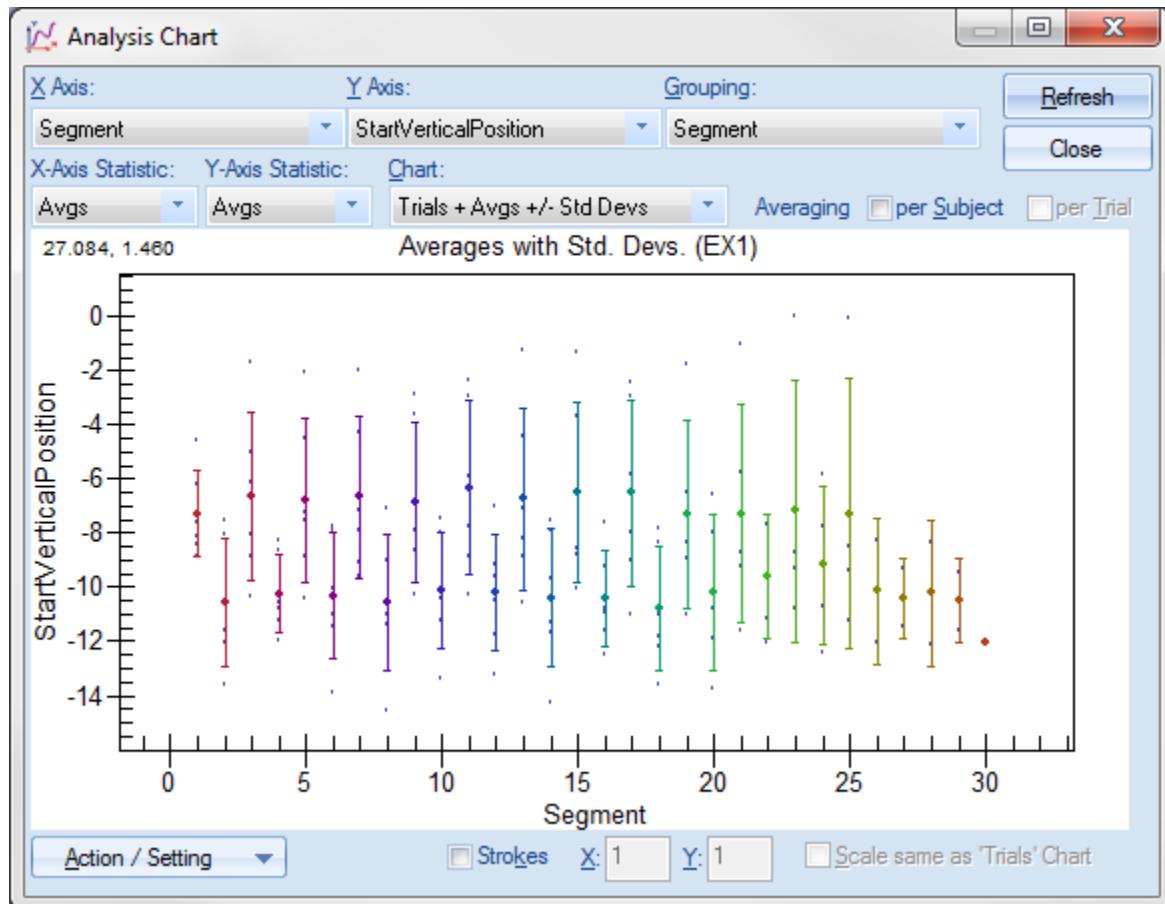
The extracted data show per Condition (for example RIG), all trials (for example, 03), all strokes or segments, Start Time, Duration, etc (many data).

The screenshot shows a software window titled "EX1YOAO000RIG.EXT". The window contains a grid of numerical data with the following columns: Row, Trial (1), Segment (2), Start Time (3), Duration (4), and StartVertica.. The data spans rows 46 to 58. The "Trial (1)" column shows values 2 and 3, indicating multiple trials. The "Segment (2)" column shows values from 1 to 11. The "Start Time (3)" column contains numerical values such as 5.7926, 6.0151, 0.0000, etc. The "Duration (4)" column contains values like 0.2225, 0.2103, 0.1905, etc. The "StartVertica.." column contains values like -4.0954, -7.2345, -2.7345, etc. The window has standard operating system controls (Close, Minimize, Maximize) and buttons for Close, Edit..., Refresh, Cells..., and Excel... at the top.

Row	Trial (1)	Segment (2)	Start Time (3)	Duration (4)	StartVertica..
46	2	27	5.7926	0.2225	-4.0954
47	2	28	6.0151	0.2103	-7.2345
48	3	1	0.0000	0.1905	-2.7345
49	3	2	0.1905	0.2849	-1.4583
50	3	3	0.4755	0.2750	-6.3186
51	3	4	0.7504	0.2669	-1.9400
52	3	5	1.0174	0.2419	-6.8531
53	3	6	1.2593	0.2242	-2.3182
54	3	7	1.4835	0.2182	-6.5602
55	3	8	1.7017	0.2228	-2.9872
56	3	9	1.9245	0.2430	-6.9956
57	3	10	2.1674	0.2164	-3.6233
58	3	11	2.3838	0.2222	-7.9990

## (8) Summarize across groups and subjects and analysis of summary results

When the experiment is completed MovAlyzeR summarizes the subjects and groups collected and shows a summary analysis chart. For example

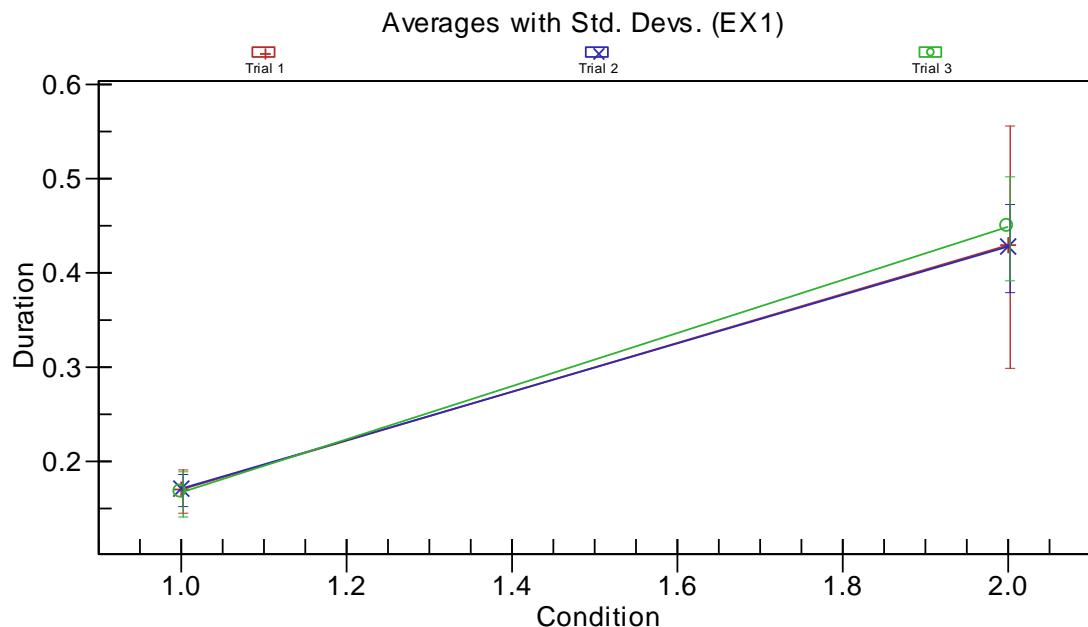


This is a generic chart which is mostly not appropriate for the present experiment.

## Customizing Analysis Chart

In the present experiment we wanted to compare the speed (or the stroke duration) between left and right hands. Therefore we want to select:

- o X Axis = Condition (Right vs. Left hands)
- o Y Axis = Duration (Duration per up and down stroke)
- o Grouping = Trial (showing results for trials 1, 2, and 3 in one chart).
- o Chart = Averages +- Standard Deviations
- o Refresh



The chart shows that Condition 1 (Right hand) has stroke durations of about 0.2 s while Condition 2 (Left hand) has stroke durations of about 0.4 s. Considering the non-overlapping standard deviations this difference is likely significant.

## Export Chart into Your Document

You can export a chart with: Rightclick in chart >Export Dialog >Export.  
Then paste (Control V) in your MS Word document.

## (9) Statistics

To obtain all data for your statistical analysis:

Rightclick your experiment >Summarize >Summarized data

The screenshot shows a software window titled "EX1.INC". The window contains a table with the following columns: Row, Group (1), Subject (2), Condition (3), Trial (4), and Segment (5). The table has 13 rows, each corresponding to a trial. The data shows a single subject (000) in the Group (1) column, all trials under Condition (3) are LEF, and the Trial (4) column shows values from 1 to 13. The Segment (5) column also shows values from 1 to 13. The table includes standard Windows-style controls like Close, Edit..., Refresh, Sorting..., and Excel... buttons at the top.

Row	Group (1)	Subject (2)	Condition (3)	Trial (4)	Segment (5)
1	YOA	000	LEF	1	1
2	YOA	000	LEF	1	2
3	YOA	000	LEF	1	3
4	YOA	000	LEF	1	4
5	YOA	000	LEF	1	5
6	YOA	000	LEF	1	6
7	YOA	000	LEF	1	7
8	YOA	000	LEF	1	8
9	YOA	000	LEF	1	9
10	YOA	000	LEF	1	10
11	YOA	000	LEF	1	11
12	YOA	000	LEF	1	12
13	YOA	000	LEF	1	13