Session 3 – Data Analysis

Recommended schedule:

**Session 3. Data analysis (*approx. 2 hours*)**

- Trainee/students should bring with them some example signals of collected data (or the Trainer supplies them, as above).
- This is usually a particularly "content-heavy" session where students can feel overwhelmed – it is recommended to constantly remind students that it is a lot of information to take in at first, but with practice – it is relatively straightforward!
- It is recommended that this session 3 guideline is given to trainees/students before the session, for them to look over (again with the warning that it might seem complex)
- Trainer shows them AcqKnowledge interface and slowly walks them through all stages of the analysis.
- Take a break (*approx. 10 mins*)
- With the guideline open, students go through the procedure in their own time (depending on numbers/PC availability etc.)
- Trainer remains available, checking for problems, answering questions, checking each stage has been completed etc.
- Analysis can be performed on as many signals as required, students may check each other's outputs (or work on the same signal to compare).
- Trainer should check the output and provide feedback.
- Finally, trainer should provide an overall summary of the training course and what students have learnt and completed, against their intended learning outcomes.

Let's go through some of your example signals and how to conduct the analysis. This procedure will export the data to an excel file – you can then then analyse / plot data using your preferred statistical package.

Please refer back to Session 2: the AcqKnowledge interface.

But the key symbols to remember:

- The importance of the I-Beam (I) and Magnifier tools (a magnifying glass)
- Scale icons horizontally and vertically to condense / return entire signal on screen
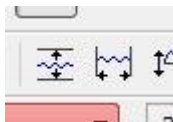
Signal Preparation

- Importantly, keep two copies of each signal. One raw, and then one copy to perform the analysis on.
- Do a visual analysis first - look for artefacts / problems in the signal (anything excessive that you made a note of during testing, coughs, sneezing etc.)

- Ensure triggers (e.g. hot keys such as flags) are correctly labelled, placed at the correct time and consistent across participants.
- Signal should be one straight, neat thin line (see example below)
- Hide channels (Alt and click on top box)
- Copy or extract signal
    - via File → Save as or Save selection → save as Jpeg etc.
    - via Edit → Clipboard or Create data snapshot

Optional signal edits (if required):
- If required, you can use the Smoothing algorithm function (recommended) this uses down-sampling algorithm to remove signals (depending on your sampling rate). For high samples e.g. 1000/2000 samples a second, smoothing by 200 samples is reasonable. It is recommended to apply this smoothing to the entire signal.
    - Transform → Smoothing → Smoothing factor
- Connect endpoints function (highlight area / artefact, will flatten signal to the points either end of your highlight)
    - Transform → Maths → Connect Endpoints
- Cut or remove artefacts or edit signal (only in extreme circumstances)

Analysis Part 1: Locate SCRs
- Finds significant changes (peaks) in signal based on your criteria
- Analysis → Electrodermal Activity → Locate SCRs (or recently used)
- Water droplets = a significant change in signal (based on preferences)
- Looks for changes (peaks) in the Tonic signal from the overall background Phasic signal = the SCL, based on the set threshold
- Droplets tied to stimuli (or events) = SCRs (specific or event-related)
- Droplets not tied to stimuli (e.g., during Baseline) = NSSCRs (non-specific)

Analysis Part 2: Find Cycles Routine
- Gives values e.g., size of SCRs for entire signal (SCRs and NSSCRs)
- Advantage: includes ALL SCRs / NSSCRs (peaks) in the signal. Can include and compare multiple points in time across the signal e.g., baseline vs. stimuli.
- Must have completed: Locate SCRs and assigned Measurement boxes
- Measurement boxes are the options for analysis values. They are exported to Excel in columns (and each row is a SCR).
- Make sure I-Beam tool / cursor is set at the start of the signal (analysis will run from the point of the cursor onwards!)
1. Analysis → Find Cycle (or recently used)
2. Cycles / peaks tab – Peaks

- Check Find Peaks is set to correct channel (CH 1)
- Check Threshold level (.05, .03 or .01 are common).
- You will need to delete any values of 0.00 (artefacts)in the data file

3. Cycles / peaks tab – Events
   - Start event: General → Waveform onset. Located on Channel 1
   - End event: EDA → Skin conductance response. Located on Channel 1
   - Could select location to 'Anywhere' but best to specify
   - Important: Automatically sets to Waveform onset and Waveform offset (from one bracket to another).
   - Commonly used = Waveform onset (bracket opening) to SCR (the max point of peak / droplet)
   - Blue lines should appear on signal - can preview

4. Selection tab
   - Values automatically appear negative - reverse for ease.
   - Left Edge Time of = Ending event.
   - Right Edge Time of = Starting event.
   - The + boxes can be used to include time before / after the brackets (e.g., to include the SCL just before the SCR onset)

5. Output tab - Measurements (recommended)
   - Save measurements into Excel spreadsheet file
   - Create a temporary file
   - Open spreadsheet after final cycle is found

6. Click Find all Cycles

7. Temporary spreadsheet should open (to be saved) with measurement boxes along the columns, and all SCRs and NSSCRs (droplets) should be listed as rows

You are finished in AcqKnowledge!

When closing a signal, if you select 'Open another graph' instead of 'Quit' it *should* remember preferences (e.g., Find Cycles). Good for analysing signals one after the other

Further recommendations in the Excel output file:
- From the Measurement boxes – "**Delta**" is often the primary measure of interest and appears in your excel file (see Session 2). This is the difference between the SCR onset to the Peak SCR value (otherwise known as the SCR or SCR amplitude).
- Find the event-related (or stimulus-specific) SCR based on set criteria (e.g., dependent on stimulus duration and prior research/pilot data etc.) among the remaining SCRs (from the whole signal, e.g. which include a baseline condition)
- Find cycles routine is a recommended method as it produces all SCRs from the experiment (i.e. the whole signal). This allows for the amplitude (delta) of the chosen event-related (or stimulus specific) SCR to be compared against the average SCRs from the rest of the signal/experiment using the Z-score standardisation procedure.

Optimum design & analysis

A Word on Interpretation

- With individual difference research – it is important to test as many participants as possible
- Don't worry if low values – many significant differences (paper by Ehrsson) are less than 1 microsiemen.
- There is a lot of variability – keep an eye on scales!
- Where appropriate, it is important to include as much of the signal as possible in analysis / calculations – e.g. have a baseline (see Standardising SCRs later)

Normalising SCRs – normally Log(SCR+1) to add a constant and make the distribution normal – SCL is normally skewed. Important when values of zero are given for a stimulus failing to generate a SCR.

Standardizing SCRs

- Why? = A threat-related SCR of 5 microsiemens for two individuals. Person A has a baseline (background) of 4 microsiemens – so they increased by 1 microsiemen to the threat. Whereas Person 2 has a baseline (background) of 1 microsiemens, therefore rising by 4 microsiemens for the threat. These two people are not showing the same autonomic arousal to the threat. They are behaving very differently, despite both showing a delta of 5 microsiemens to the threat.
- The general background EDA / SCL is important, and standardizing allows you to see how strong of a response '5 microsiemens' *really* is.

   Options:
   1. Startle: during task make participants jump (i.e. a loud clap or balloon burst) which gives a maximum peak response
      - Problem = may not cause all participants to jump – different tolerance to noise levels
   2. Min and Max range: look at the range of SCR response - calculate difference between minimum and maximum SCR
      - Problem = what if the maximum SCR is the threat-SCR in question? We would be comparing it / making a ratio with itself
   3. **Z-score transformation** (recommended)
      - Threat SCR subtract the mean of all SCRs / NSSCS divided by standard deviation
      - Looks at all other SCRs and calculates a ratio of how much bigger the threat SCR is, relative to that person's mean / overall level of SCR / SCL.
      - Benefit = accounts for individual differences and allows comparisons across

participants to be made. The threat SCRs are transformed relative to the participant's actual physiological capacity to respond

SCR Amplitude vs SCR Magnitude
Mean amplitude
- Mean value computed across only those stimulus presentations that produced a measurable response (i.e., non-zero)
- A problem = values (like the mean) will vary depending on how many measurable responses (1 or above) a participant gives

Mean magnitude
- Mean value computed across ALL stimulus presentations including those without a measurable response (i.e. includes zero's)
- A problem = confounds frequency of response and response strength which do not necessarily co-vary.
- Therefore, the frequency (number of SCRs) is also a very important value for examining the effectiveness of the stimuli at inducing threat-related SCRs.
- It is advisable that if magnitude is to be reported - that it is complemented with a frequency measure.
- Can be considered with multiple presentations of the same stimulus e.g., as a measure of habituation.
- Note: Amplitude / Magnitude values will only differ if the frequency of event-related SCRs drops below 100%. That is, if you have one stimulus and it elicits a response (i.e., an event-related response) the amplitude and magnitude values will be the same.

Summary of Training (Example)
You have received training and guidance on:
- Introduction to the measure, theory, and application of EDA / SCR (with Biopac/ AcqKnowledge)
- Individual research aims, design and expected outcomes of the research project or development / training.
- Hands-on practical experience in the application and data collection of EDA / SCR measures (and acted as a participant)
- Comprehensive data analysis (e.g., amplitude, frequency of SCR components, event-related and whole signal analysis)
- Additional options for data analysis, e.g., how to transform / apply data in the context of experimental theory such as standardisation.
- Recommendations for interpretation, and good testing practice.