First Steps into Eye-Tracking in Chemical Education Research
Justus-Liebig-University Giessen, Institute of Chemistry Education

Background

Area of application:
- Inspecting attention distribution and cognitive processes
- Studying the usability of multimedia and more

Assumptions & Attention:
- Immediate assumption: cognitive processes occur directly during visual perception
- Eye-mind assumption: as long as stimuli are in the visual focus they are cognitively processed
- These assumptions are valid in a situational context, in which a task directs overt and covert attention to the same stimuli

Eye Movements:
- Fixations:
  - Stabilize the retina over a stimulus
  - 150 - 600 ms
- Indicates visual attention & cognitive processing
- Saccades:
  - Redirects gaze
  - Speed: 700°/s, ballistic movement
  - Immediacy assumption: cognitive processes occur directly during visual perception
- Impedance expressions:
  - Speed: 150 - 600 ms
- Indicates visual attention & cognitive processing

Advantages:
- Investigation of conscious and unconscious processes
- Tracking eye movement in the moment of task solving without distracting the participant
- Non-invasive way of measuring the eye movement
- Applicable in different contexts
- Qualitative and quantitative analyses are feasible

Preliminary considerations

Questions to ask:
- Is eye-tracking suitable for my research goal?
- What data do I need to collect in addition to eye-tracking?
- Which type of eye-tracker do I need for my stimuli?
- Which accuracy and resolution do I need?

Eye-tracking glasses
Screen-based eye-tracker

Participants:
- No photosensitive epilepsy
- Droopy eyelids, mascara, visual aids, head movement could negatively impact data collection

Eye-tracking laboratory:
- Avoid direct sunlight, halogen lamps, vibrating and loud spaces
- Medium light (~500 Lux)
- The participant should face a distraction-free area

Calibration:
- Calibration necessary before each measurement and after breaks
- Set the calibration similar to the stimulus colour
- Validate your calibration with a given stimulus (e.g., one point) and live view function. If in doubt, recalibrate

Setup & Data Collection

Data collection process:
- Screen-based eye-tracker
- Oral answers can be recorded without deviating gaze from stimulus
- Prompt participants to keep their eyes on the monitor and avoid gestures
- Eye-tracking glasses
- Ensure that the glasses fit tightly (use nose piece and a head strap), are clean and intact

Pilot testing:
- Test your setup, task design, stimuli and data analysis in a pilot recording

Stimuli design & Recommendations:

Comparing visual attention distribution of experts (left) and novices (right) (illustration from Topczewski et al. 2017)

Comparing the interaction with learning material with regard to multimedia principles (spatial contiguity principle) (illustration from Schmidt 1993)

Analysis

Metrics & Calculation:
- Set Areas of Interest or Times of interest to determine particular events
- Eye-tracking software exports various metrics such as fixation duration, number of saccades, AOI visits, etc.
- Combine metrics to obtain a more definitive result (e.g., fixation-transition-ratio)
- Suitable visualizations: Gaze plots and heat maps

References (Book recommendations for further information)
- Duchon J. P. & et al. (2018), Eye Tracking for the Chemistry Education Researcher. American Chemical Society
- Schimmert A. P. (1993), Designing SA. Copyright 2016 American Chemical Society

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