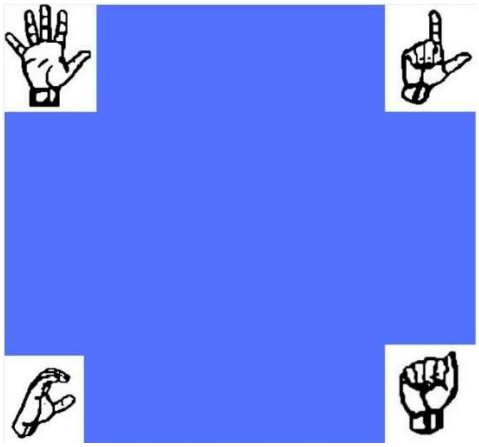
Welcome to the Study: Assessing sequential motor learning in complex 3D movements. The aim of this study is to better understand how people learn and plan sequential motor actions.

We will use a motion capturing device to track your 3D hand/finger movements. The initial goal is to learn 4 novel hand gestures which allow you to control a cursor on the screen and move towards visual targets. This will be achieved through a calibration session where we calibrate these 4 gestures with movement to a corner of the screen:

We employed a linear mapping process to translate 15-dimensional finger joint angle signals (captured by Leap Motion Infrared hand tracking camera) into 2D cursor coordinates on a screen. The first step in all subjects' day 1 is personal calibration. During calibration, subjects assumed four distinct hand postures, each corresponding to a corner of a predefined rectangular workspace on the monitor. These postures generated 15D gesture signal vectors $\boldsymbol{h^{(1)}, h^{(2)}, h^{(3)}, h^{(4)}}$, which were mapped to the 2D screen coordinates $\boldsymbol{p^{(1)}, p^{(2)}, p^{(3)}, p^{(4)}}$ (4 workspace corners). A linear transformation matrix $\boldsymbol{A}$ was derived to satisfy the equation $\boldsymbol{p = Ah}$, where $\boldsymbol{p = \begin{bmatrix} x \\ y \end{bmatrix}}$ represents cursor coordinates and $\boldsymbol{h}$ represents 15D gesture signal vector. To compute $\boldsymbol{A}$, the calibration data were structured into an $\boldsymbol{8 \times 30}$ matrix $\boldsymbol{H}$ (combining gesture signals from all 4 postures) and an 8D vector $\boldsymbol{P}$ (containing 4 corner coordinates). The mapping coefficients in $\boldsymbol{A}$ were determined using the Moore-Penrose pseudoinverse $\boldsymbol{H^{+}}$, yielding $\boldsymbol{A = H^{+}P}$. This method minimized the Euclidean norm of the solution, ensuring that the linear transformation was uniquely defined and compatible with the calibration constraints. The calibration process established a consistent, albeit underdetermined, relationship between finger movements and cursor motion, enabling subjects to explore the novel visuomotor mapping during subsequent tasks.



Upper Left corner corresponds open hand. (press ↑ to capture)
Upper Right corner corresponds gun hand. (press ↓ to capture)
Lower Left corner corresponds claw hand. (press ← to capture)
Lower Left corner corresponds close hand. (press → to capture)
If the four gestures are all captured correctly, the white cursor will leave the original point and move following your gesture change.

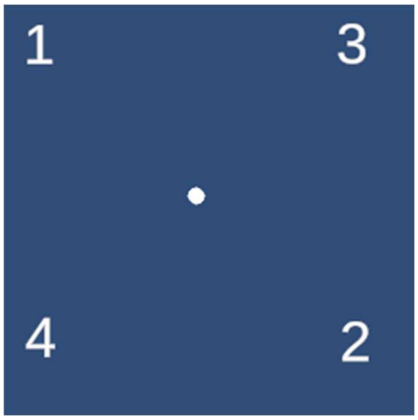
In the center of the screen you can also see a small virtual hand. This is the hand data captured by the IR camera. In these situations the game cannot go correctly:

- **No virtual hands in the center**
- **Two or more hands in the center**
- **The virtual hand is constantly flashing/does not match your gesture**

If you find any of these, report to the researchers. We will handle it accordingly.

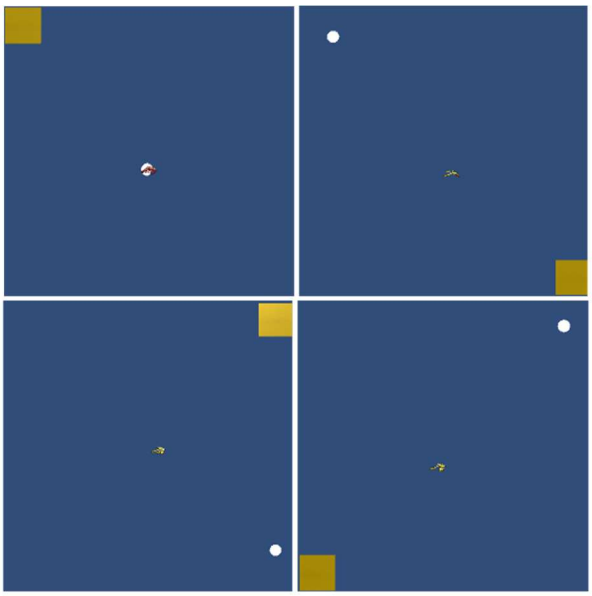
The main experiment will then start which involves 2 types of trials:

Sequence Trial: 4 targets will appear with a numbered sequential order.

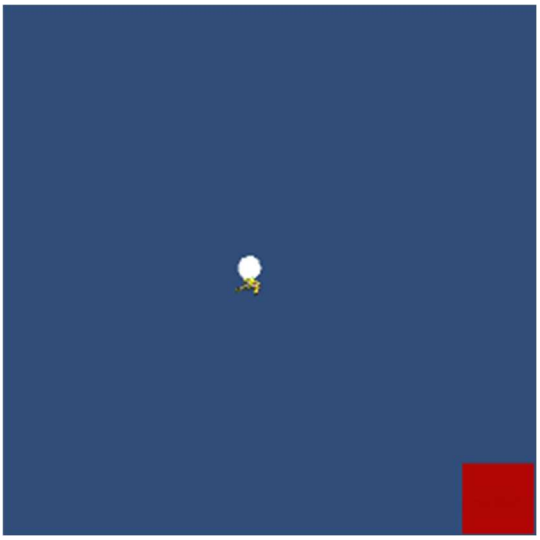


This will disappear in seconds and then we will ask you to plan the sequence of gestures/movements required to complete that sequence.

Once an orange target appears attempt to move towards each sequential target as fast and accurately as possible.



Probe Trial: This will be identical to a sequence trial however after the plan phase, a single red target will appear in one of the four positions. Please attempt to move towards the target as fast and accurately as you can.



Remember to try to plan the sequence of movements during the planning phase. Maximizing your speed and accuracy will result in additional payment.

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