PURSUING THE SMOOTH PURSUIT

Research questions:

What is the slowest motion of a target that will induce smooth pursuit in a healthy population (not for example Schizophrenics or people with Parkinson's disease)? [At what lowest speed of the target does the smooth pursuit break into fixations and saccades?]

What is the fastest motion of a target that eyes can follow with smooth pursuit before they perform catch-up saccades? [At what speed do people start with catch-up saccades to keep track of the target?]

At what speed of a target does the smooth pursuit achieve best accuracy? [At what speed of the target can the eyes best anticipate the movement = they are moving at exactly the same location (or the closest possible=least distance and latency possible) as the target? Is this speed different for different paths of movement? Is the distribution of speeds following a Gaussian curve for a given path, and is accuracy the best for the "middle speed" and poorest for the fastest speed? Why would the accuracy be the best at that specific speed → *Off topic question: Is the "middle speed" coinciding with the speed of some objects we are used to in real life, e.g. the average walking speed of human beings? Or cars in the cities? "Predators" speed? Is our smooth pursuit's best accuracy adaptive to the environment?* Is accuracy dependent on age?]

Are there always the same latencies for starting to pursue the target? [Does the latency differ for different speed of the target? Is this difference statistically significant? And if I would change the position of the target unexpectedly during the experiment, how long would people take before making a catch-up saccade?]

Can accuracy of smooth pursuit be enhanced by motivation? [Would there be any difference in performance? Will motivation for following the target lead to sufficient increase in the speed of the eyes to match the speed of the target as best as possible when people would be rewarded?]

Overview of literature:

Here I will describe what is known about smooth pursuit and the methods how to measure it. [Literature overview found until now listed at the end.]

Stimuli and task:

There will be two groups of participants, control group and experiment group.

Experiment setup: a 9point calibration, validation, trials (number to be decided according to different speed of the target – need to set a range of speed, for each "speed" there could be 3 trials in the whole experiment; possibly changing the path and/or direction of the movement of the target), calibration (to recognize any shifts in data)

Tasks for control group:

Target (a black dot) will be moving horizontally, starting at different heights, towards the other side of the monitor, at different speeds (random order, predefined ranges of speed based on what is known about smooth pursuit + slower and faster on both edges, to make the margins broader). The path factor not yet decided.

Tasks for experiment group:

Same target, type and speed of movement and number of trials, the only difference is that when the eyes will get close enough to the target, the target will change the colour to green. ["How many targets as an overall score can you catch before they disappear on the other side of the monitor?" This boundary needs to be backed up by relevant theory. Would people stop being interested in pursuing the target after they caught it? Would adding the length of the path for which they could follow the dot in "green" as a part of the score solve the interest question? Would this vary as a function of the speed?]

Eye-tracker:

SR Eyelink – fast changes of display will be required; online detection of velocities – applying the filter could change the target colour from black to green in the experiment group as a feedback of "good pursuing"

Analysis:

There is a mathematical model of smooth pursuit developed by Jansson (2014, *Mathematical Modeling of the Human Smooth Pursuit System*). The results of the experiment can be compared with the model to see how accurately the model can predict eye behaviour in reality.

Thoughts to consider:

[Do we do smooth pursuit in vertical direction? What would the distinction be from blinks?]

[Interaction with the task/measure of performance: if the dot would change to green from black when the eye speed would match it for e.g.90%; would it become a motivation to "catch it"? Would people stop trying to get on 100% if the target would turn to green already at 90%?]

[Predictability of path: what types of paths are predictable for people? What types of path can be mentally tracked – e.g." hiding" the moving target under a white non-transparent rectangle, and checking if people can follow the moving target mentally, without breaking the smooth pursuit to fixations and saccades.]

[Should I let people have practise trials?]

[Should I put attention tasks? E.g. two targets moving at different speeds, following only the black dot and not the grey dot=distractor]

[Is the latency changing as a function of the motivation, how can I tell the difference in the "basic" motivation to follow the target as a task of the experiment, and the "enhanced motivation" by changing the colour of the target and counting the score?]

Implications:

Knowing the minimum and maximum possible speed of a target inducing smooth pursuit could be implemented into smooth pursuit algorithms – e.g. suggesting improvements to the mathematical model.

The "best accuracy"/"most optimal speed of a moving target for obtaining the best accuracy result for given path" of a smooth pursuit could become a new measure how to evaluate the quality of smooth pursuit [How well could they follow it in terms of latencies/speed and location of the eyes? And is it really a pursuit, and not anticipation of the movement for most of the time?]; and perhaps a recommendation for the speed of a target for eye-tracking experiments using smooth pursuit. [Would any such recommendation be useful?]

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