Cue combinatie voor het inschatten van helling in perceptie en actie

People can estimate 3D position based on monocular cues such as the size, shape and texture gradient of the projection of the object on the retina, but they can also use the difference in projection between the eyes (binocular disparity) to estimate depth. Multiple studies have found that monocular and binocular cues are first processed independently from one another in different areas of the brain before they are optimally combined in one estimate of depth. This combination is termed optimal because the amount of variability in each cue is taken into account. That is, a cue with a high level of noise receives less weight than a cue with a low level of noise.

The separation of initial processing of monocular and binocular cues might result in timing differences between the same event in the two cues. In Chapters 2 and 3, I studied how timing differences influence optimal cue combination for slant estimates. Timing differences smaller than 100 ms did not affect the quality of the combined estimate. However, bigger differences resulted in people using the fastest cue. Does this mean that small timing differences between cues are simply ignored, or do people somehow compensate for them before they integrate the two cues into one estimate? Chapter 3 shows that neural latency differences between cues are visible in the online correction of movement, thus suggesting that timing differences between cues are not compensated for. Additionally, participants could use both position and motion in the monocular information but only position in binocular disparity when correcting their movement.

When the brain needs to combine an incorrect but precise signal with a correct but noisy signal, it should give the incorrect signal more weight according to current optimal cue combination theory. This would be very detrimental for any interaction with the stimulus in question. In Chapter 4, I studied whether a combined estimate of slant is affected by a change in the perceived correctness of the monocular and binocular cues during the experiment. I found that participants estimated the slant of the target to be different after the change in perceived correctness. This change in the combined estimate could not be explained by a rescaling of the cues or a change in their perceived precision. These findings suggest that we do take the correctness of each of the cues into account when we integrate them into one optimal estimate. Incorrect cues will receive less weight than cues that are not biased even if there is no difference in precision between them. Furthermore, the finding that subjects reweighted the cues within just a few trials after the change in perceived correctness, implies that the values of the individual cues remain available after their combination into one estimate. In this way, the quality of the combined estimate can be quickly evaluated after the integration.

Not everyone can use the difference in position between the eyes to estimate depth. Surprisingly, a stereoblind subject could use the difference in change in slant between the eyes in Chapter 3 to estimate the slant in which the target was going to end. In Chapter 5, I studied whether other stereoblind people are able to use this difference as well, and if so, on what basis they know which motion in the left eye to match with what motion in the right eye to calculate this difference. I found that stereoblind subjects could indeed use interocular differences in motion to judge the direction of the motion in depth. Interestingly, subjects with normal binocular vision were not able to use this difference. The stereoblind subjects corresponded the motion between the eyes by matching the velocities based on relative direction. So next to the normal correspondence of positions between the eyes, people can also learn to match velocities independent from position, that is, based on their relative direction. This implicates that motion and position can be processed independently from one another in the brain.