

Motor Control for Vision Scientists program

Lunteren, January 7-11, 2004

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P *erception for*
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Program

Wednesday January 7

15:00	Coffee	Arrival	
16:30	Opening:	Eli Brenner (Rotterdam, NL)	Why motor control for Vision Scientists ?
17:00	Tutorial	Maarten Frens (Rotterdam, NL)	Measurement of eye movements
18:00	Drinks		
18:30	Dinner		
20:00	Technical note	Stefan Louw (Rotterdam, NL)	On data fitting
20:15	Technical note	Raymond Cuijpers (Rotterdam, NL)	On data smoothing

Thursday January 8

7:30	Breakfast		
8:45	Tutorial:	Peter Beek (Amsterdam, NL)	Measurement of limb movements
9:45	Break		
10:10	Tutorial:	John van Opstal (Nijmegen, NL)	Basic behaviour, eye movements
11:10	Break		
11:30	Tutorial:	Jeroen Smeets (Rotterdam, NL)	Basic behaviour, limb movements
12:30	Lunch		
14:00	Workgroups	all participants	Various topics
18:00	Dinner		
19:30	Coffee	poster session	

Friday January 9

7:30	Breakfast		
8:45	Tutorial:	Bert van den Berg (Utrecht, NL)	3D Kinematics of eye movements
9:45	Break		
10:10	Tutorial:	Stan Gielen (Nijmegen, NL)	3D Kinematics of limb movements
11:10	Break		
11:30	Tutorial:	Harold Bekkering (Nijmegen, NL)	Eye-hand co-ordination
12:30	Lunch		
14:00	Session	Visuomotor control I	
		Hemke van Doorn (Amsterdam, NL)	Catching and matching oriented bars
		Denise de Grave (Rotterdam, NL)	The Ebbinghaus figure is more than a size illusion
		Dirk Kerzel (Giessen, D)	Neuronal processing delays are compensated in the sensorimotor branch of the visual system
		Jacinta O'Shea (Oxford, UK)	Timing of Target Discrimination in Human Frontal Eye Fields
	Break		
		Holle Kirchner (Toulouse, F)	Using saccadic eye movements to determine visual processing speed: An analysis of saccade landing positions
		Bettina Friedrich (Glasgow, UK)	Interaction of motion perception and object localization

	Quoc Vuong (Tübingen, D)	Probing the role of motion in object recognition
18:00	Dinner	
19:30	Coffee	posters
20:00	Tutorial:	Alan Wing (Birmingham, UK) Co-ordination of hand movements

Saturday January 10

7:30	Breakfast	
8:45	Tutorial:	Hans van der Steen (Rotterdam, NL) Binocular co-ordination
9:45	Break	
10:10	Tutorial:	Stephan Swinnen (Leuven, B) Interlimb co-ordination
11:10	Break	
11:30	Tutorial:	Jos Adam (Maastricht, NL) Hand movements in complex environments
12:30	Lunch	
14:00	Session	

Visuomotor control II

	Simone Caljouw (Amsterdam, NL)	Goal-directed hitting: online adaptations to perturbed impact requirements
	Frank Zaal (Groningen , NL)	Canceling Optical Acceleration to Catch a Fly Ball
	Julian Wallace (Marseille, F)	Motion integration for Smooth Pursuit Eye Movements
	Catherine Dauxerre (Bron, F)	Criteria for Determination of a Trl versus Efficiency of Training: Goldmann Kinetic Perimetry, Eye-hand Coordination and Reading Speed in AMD Patients
Break		
	Angelika Lingnau (Braunschweig, D)	Reading and visual search with a pseudofovea
	Eugene McSorley (Egham, UK)	Distractor effects on saccade generation as revealed by saccade trajectory curvature.
	Marianne Biegstraaten (Rotterdam, NL)	Impact forces cannot explain the one-target advantage in rapid aimed hand movements

18:00	Dinner	
19:30	Coffee,	posters
20:00	Tutorial:	John Findlay (Durham, UK) Eye movements in complex environments

January 11

8:00	Breakfast
9:00	Depart

Fast reaction to a change in target size.

M. Pilar Aivar Rodríguez, E. Brenner, J.B.J. Smeets (Rotterdam, NL) (poster)

Previous studies have shown that varying the degree of difficulty of the second segment of a movement changes the performance and kinematics of the initial segment. This result suggests that it is possible to pre-program a whole sequence of movements. However, it seems necessary for an efficient control of actions to be able to respond quickly to changes that affect the targets of the movement. In the present study we examined whether subjects could respond to a change in size, or in size and position, of one of two targets while they were moving to each of them in a sequence. Subjects moved a stylus across a digitising tablet from a specified starting point to two targets in succession. The first of these targets was always at the same position but it could have one of two sizes. The second target could be in one of two different positions and its size was different in each case. On some trials one of the targets changed size, or size and position when the subject started to move. Results showed that there were no differences in movement time between trials without a change and those in which one of the targets was changed. This result suggests that the whole sequence of movements was programmed ahead of time and executed as planned. However, when the change affected the size of the first target there was a significant decrease in peak velocity and a significant increase in the duration of the deceleration phase. Since peak velocity was reached only about 150 ms after the change in size occurred this means that subjects can react very quickly to changes in size.

Pointing and saccading toward the Müller-Lyer illusion: common or separate mechanisms?

Paolo Bernardis, Nicola Bruno, Paul C. Knox (Trieste, I) (poster)

Using spatially identical displays (variants of the Müller-Lyer illusion), we compared the accuracy of spatial verbal judgments with that of saccadic (eye) and pointing (hand) movements. Verbal judgments showed a clear effect of the illusion. The amplitude of the primary saccade from one endpoint of the pattern (at fixation) to the other also showed an effect of the illusion, although qualitatively the pattern of this effect was not identical to that observed for verbal judgements. Conversely, movement amplitudes when pointing from one endpoint (initial finger position) to the other were significantly more accurate than both saccades and verbal responses. In several studies, systematic biases in conscious spatial judgments have been contrasted to accurate open-loop pointing in peripersonal space. It has been proposed (Post and Welch 1996) that such seeming dissociations between vision-for-action and vision-for-consciousness may be in fact due to a simple oculomotor strategy: saccade to the target before it disappears, then use the efference copy of the saccadic movement to drive pointing. The present data do not support the hypothesis in this simple form.

Impact forces cannot explain the one-target advantage in rapid aimed hand movements

Marianne Biegstraaten, Jeroen B.J. Smeets, Eli Brenner (Rotterdam, NL) (talk)

A pointing movement is executed faster when a subject is allowed to stop at the first target than when the subject has to proceed to a second target. Our hypothesis was that this is because the impact at the target helps to stop the finger when the finger does not have to proceed to a second target. If this explanation is correct, then the horizontal force at contact with the first target should be larger when there is only one target. Modelling smooth movements with larger forces at contact using a minimum jerk model with non-zero values for the deceleration at contact shows that the peak velocity is slightly higher, while its timing shifts to 60 % of the movement time instead of 50%. Although the one-target advantage was present in our experiment, the horizontal force at contact in the one-target condition was smaller than in the two-target condition. The time of the maximum velocity did not differ, but the maximum velocity was higher in the one target condition. Thus our hypothesis is rejected, favouring a non-mechanical explanation of the one-target advantage

Perceptual organisation: influence of previous perception

Lizzy Bleumers, Peter Claessens, Johan Wagemans (*Leuven, B*) (poster)

Visual percepts are characterised by a structure that is not present in the retinal information. The processes that lead to this structure, as well as the final product of these processes are called perceptual organisation. Stimuli that can be organised in several ways are useful instruments to study perceptual organisation. The rationale of research with such multistable stimuli is that if one of the possible interpretations is preferably seen, this informs us about the features of the covert processes that underlie perceptual organisation. Of course, the way we organise our perceptual environment at one moment in time, is not independent of the organisation that was previously made. Multistable stimuli can be used to study the influence of perceptual history. For instance, one can show an ambiguous stimulus, strongly biased in favour of one interpretation, and subsequently present a non-biased ambiguous stimulus. The resultant organisation of the second stimulus gives us an idea about how previous perceptual experiences influence subsequent perception. Studies that used this paradigm yielded inconsistent results. In some studies the tendency to perceive the same organisation, as the biased one, is reported (perceptual inertia or hysteresis). In other studies a tendency to perceive the alternative organisation is found (high-level adaptation). My research gives an overview of the literature on this issue and explores the effects of several timing conditions (in which duration of the first stimulus and of the interstimulusinterval are being manipulated).

Expansion plays a role in quickly determining whether a ball will land in front of you or behind you

Anne-Marie Brouwer, Joan Moliner, Eli Brenner, Jeroen Smeets (*Tübingen, D*) (poster)

Chapman (1968) proposed that ball catchers run backwards when they see the projection of an approaching ball accelerate, and forwards when they see it decelerate. However, the threshold for distinguishing acceleration from deceleration is too high to account for catchers' performance in selecting the appropriate running direction. We propose an alternative cue, which is based on a combination of estimates for the ball's horizontal and vertical speed. These estimates are based on the rate of expansion of the ball's projection, and its angular velocity, respectively. In order to test this alternative cue we simulated the first 300 ms of an approaching ball on a large screen. The rate of expansion was either simulated realistically, or else the simulated ball either expanded too fast or too slowly. Subjects indicated whether they expected the ball to land ahead of them or behind them. If subjects use the Chapman strategy, our manipulation of the rate of expansion should not make a difference, because the vertical acceleration of the projection was not varied. If they use the cue that we propose, they should be biased to respond 'ahead' when the rate of expansion is reduced and 'behind' when it was increased. We did find such biases. However, the difference between the conditions was not as large as we predicted. This may indicate that subjects use additional cues to estimate the ball's horizontal speed.

Goal-directed hitting: online adaptations to perturbed impact requirements

Simone Caljouw, Geert Savelsbergh, John van der Kamp (*Amsterdam, NL*) (talk)

The experiments to be reported examined how bi-phasic hitting movements in the frontal plane adapt depending on task circumstances such as the temporal precision (approaching balls of different speed) and required impact (different landing locations of the ball). In bi-phasic hitting (i.e. preparatory backswing and forward strike phase), the onset of the strike varied with ball approach speed both with and without impact requirements. When aiming for a specific landing location, variation in the movement path was found to complement variation in the initiation to keep the impact velocity rather constant. Onset patterns of the strike were only found to vary with ball approach speed, but not with impact requirements. To examine the ability of actors to adapt to changes in impact requirements, we perturbed the ball landing location from 80 cm to 160 cm. No adjustments were found when the perturbation occurred at the onset of the strike phase, but when the perturbation occurred at the onset of the preparatory phase, the onset of the strike phase occurred earlier before impact and the movement amplitude increased which resulted in a larger impact velocity. This suggests that the temporal characteristics are not solely regulated based on temporal precision requirements enforced by the

approaching ball. Both spatial and temporal characteristics can be adjusted in the final part of the preparatory phase, for slow as well as fast approaching balls.

The integration of grouping cues in the perceptual organization of lattice structures

Peter Claessens, Johan Wagemans (*Leuven, B*) (poster)

Perceptual organization, the process of parsing and combining of sensory primitives into perceptual units, involves the combination of many sources of visual information. While Gestalt psychologists have stipulated a number of principles that guide perceptual unit formation, they did not clearly specify expectations about how different principles integrate into a single perceptual organization. Our aim is to describe quantitative models for results obtained in psychophysical procedures centered around a type of stimulus in which elements are ordered in a lattice layout. In our experimental paradigm subjects are asked to indicate the dominant orientation after a brief stimulus presentation. In the design of these stimuli, several factors have been combined in concordant or discordant relationships, such as proximity and collinearity in dot lattices and Gauss blob lattices, and element alignment and contrast polarity in Gabor patch lattices. We relate our results to data obtained with other psychophysical procedures and to the literature on functional architecture of the primary visual cortex.

Distorted shape perception impairs grasping of real objects

Raymond Cuijpers, Eli Brenner, Jeroen B.J. Smeets (*Rotterdam, NL*) (poster)

It is known that visual shape perception is distorted in depth, but it is unclear how this influences grasping. We measured how subjects grasp real cylinders that are placed at eye height under normal lighting conditions. The cylinders were 10cm tall with an elliptical base. One principle axis was always 5cm, whereas the other was varied between 2cm and 8cm in steps of 1cm. The cylinders were placed directly in front of the subject, at a distance of either 15cm or 45cm. Their orientation was varied from 0° to 150° in steps of 30°. Grasping performance was compared with that in a previous study in which the cylinders were placed well below eye height so that subjects had no difficulty judging their shape. We found that subjects are less accurate at matching the orientation of their hand to that of the cylinders when the targets are at eye height. This often led to unstable grasps. Moreover the maximum grip aperture was about 2cm larger when the cylinders were placed at eye height. Nonetheless, the correlation between the hand orientation halfway through the movement and the final hand orientation was already about 70%. The correlation between the grip aperture during the movement and the final grip aperture was only 30% when half the distance was traversed, but it was still only 60% when reaching the object. These results indicate that the grasping movement uses incorrectly specified pick-up locations on the cylinder's surface. Uncertainty makes the subjects increase their grip aperture, but we did not find evidence for increased online control.

Criteria for Determination of a Trl versus Efficiency of Training: Goldmann Kinetic Perimetry, Eye-hand Coordination and Reading Speed in AMD Patients **C. Dauxerre, C. Corbé, F. Vital-Durand (*Bron, F*) (talk)**

Purpose: Patients with Age Related Macular Degeneration (AMD) have unstable fixation. They spontaneously use several Preferred Retinal Loci (PRL), resulting in poor visual efficiency. We applied procedures to determine the most efficient retinal locus for training (TRL) to optimize rehabilitation of reading, and improve the training. We investigated 1) the correlation between reading efficiency and localisation of TRL, 2) eye-hand coordination and stabilisation of the TRL, and 3) optimisation of the number of rehabilitation sessions.

Methods: 44 patients with bilateral AMD ($VA \leq 5 \log \text{Mar}$). Clinical and functional assessment : patients' goals, distance and near VA, contrast sensitivity, kinetic perimetry, goal-directed hand movement, multisensory, psychological and cognitive status, reading velocity and resistance. During training of an eccentric fixation, direction of gaze was controlled by the corneal reflex method. Eye-hand coordination exercises (crossing, tracing and circling) are done at home. After retraining of these spatial modalities, proper letters, words and texts are shown.

Results: 58% of the patients presented with absolute scotomas and 42% relative. Kinetic perimetry data determine the choice of a functional retinal zone fit for fluent reading. Patients develop appropriate

visual strategies of stable, unconscious eccentric fixation within 6 to 11 rehabilitation sessions. Reading speed rose as high as 100 words/min.

Conclusions: Training visually guided hand movement helps with the stabilization of a TRL for reading. We observed a strong correlation between acquisition of a stable TRL and hand pointing accuracy. Simultaneous use of sensory and motor modalities related to spatial tasks is helpful in fostering the strategies involved in reading and daily activities.

The Ebbinghaus figure is more than a size illusion

Denise de Grave, Biegstraaten, M., Brenner, E., Smeets, J.B.J. (Rotterdam, NL)
(talk)

In the last years there is a debate on how to interpret small effects of the Ebbinghaus illusion on prehension. One interpretation states that the effect on grip aperture is caused by obstacle avoidance. If this interpretation is correct, the effect of the Ebbinghaus illusion on prehension will depend on the positions of the flankers relative to the movement of the digits. The effect on size judgements should be independent of the exact flanker positions.

We used a display consisting of a central target disk (varying in size) surrounded by four large or small flankers. The array of flankers could be rotated by 45°. In one task subjects had to make a perceptual judgement of the size of the central disk. In another task they had to grasp the central disk.

For perceptual size judgements, the effect of the size of the flankers was independent of their spatial position. In grasping, the peak grip aperture showed an effect of the illusion, but this effect disappeared when an adjusted measure for the peak grip aperture was used. An effect of the spatial position of the flankers was found on the grip orientation at peak grip aperture as well as on the final grip orientation. We conclude that effect of the flankers on prehension is not o

Effects of background motion on hand movements in ball catching

Joost Dessing, Lieke Peper, Peter Beek (Amsterdam, NL) (poster)

The RRVITE model for hand movement control in catching (Dessing et al. 2002) uses (perceived) target velocity as an input. Since background motion (BM) affects perceived target velocity (and also hand movements: Masson et al., 1995; Smeets & Brenner, 1995), the RRVITE model predicts specific BM effects on lateral hand movements in ball catching; the current experiment tested these predictions. Participants started with their right hand at one of four initial positions and caught balls using only lateral hand movements. The balls approached along a variety of trajectories, defined by approach direction and lateral passing distance. On a rear-projection screen, behind the balls, a random dot pattern was presented, which was stationary, moving leftward, or moving rightward. With the hand initially positioned at the interception point, no hand movements were required to catch the ball. Nevertheless, in most trials the hand still moved away from the interception point and back again. These 'movement reversals' (MRs) occurred predominantly from left to right with amplitudes influenced by approach direction (larger MRs for balls approaching the interception point from the left), passing distance (larger MRs for larger sideward passing distances), and BM direction (smaller MRs for leftward BM). The observed main effects (except the asymmetric effect of BM) comply with an RRVITE model in which movement planning occurs in head-centered coordinates. The asymmetric effect of BM is possibly related to asymmetries in eye movements due to BM (Masson et al., 1995).

Joeri De Winter (Leuven, B) (poster)

My main research topic is the recognition of 2D shape. I mainly use outlines derived from line drawings of everyday objects (Snodgrass & Vanderwart, 1980). First I have looked at the visual information value of special points (i.e. extrema, salient points, inflections and midpoints - points halfway between two salient points) to test and expand Attneave's (1954) claim that not all the points on the outline have the same visual content. We tested this via several different experimental setups (marking points, straight line outlines, fragmented outlines and points). Not all of these give consistent results. We also looked for possible factors that influence the saliency of a point. The second line of my research has also to do with special points on an outline. When people look at shapes they automatically segment these into parts. We examined which special points are used when visually

segmenting shapes and which other factors are important, and we combined these in an integrative framework. We also analyzed this data in interaction with the spatial scale. Next I will test the different possible influences on segmentation further and test whether parts help shape recognition.

The use of visual information for motor actions: Data and methodological challenges.

Volker Franz (*Gießen, D*) (talk)

I will give an overview of my current work on the use of visual information for the guidance of motor actions. Topics will be: (a) Effects of visual illusions on the motor system: It is still unclear whether visual illusions as, for example, the Ebbinghaus illusion affect the motor system in a similar way as perception. I will present newer results which suggest that, indeed, the motor system is affected in a similar way as perception by visual illusions. (b) Dynamic versus stationary grasp-effects of visual illusions: Here, I ask whether the effects of visual illusions on the motor system decay or build up during the execution of a grasp movement. Some theories suggest a decay (Glover & Dixon), while others suggest a build up (Carey). Surprisingly, we found neither a decay, nor a build up, but pretty constant effects. (c) A little excursion into statistics: When investigating the question posed under topic b., we need to "correct" one empirical effect by another empirical effect. That is, we need to calculate the ratio of two empirical effects: Y/X . Contrary to current praxis, calculating confidence intervals for this ratio is not a trivial problem. I will present a new, simple, geometrical approach to the exact statistics for this situation (Fieller's theorem).

The OptotrakToolbox: Control your Optotrak from within Matlab.

Volker Franz (*Gießen, D*) (technical note)

The Optotrak (Northern Digital Inc.) is a widely used and highly accurate 3D motion and position measurement system. Traditionally, it is controlled using an interface in the C programming language. Recently, I wrote a toolbox which allows to control the Optotrak from within Matlab. This has a number of advantages: (a) Matlab provides a flexible environment for high level mathematics, much more versatile than C. This is advantageous for the processing of the 3D data produced by the Optotrak. (b) There exist already a number of Matlab toolboxes for psychophysical experiments. Most importantly the PsychophysicsToolbox (mainly for stimulus presentation) and the EyelinkToolbox (controlling the SR research Eyelink Eyetracker). The OptotrakToolbox can be used to integrate the Optotrak with these other research tools. The OptotrakToolbox is tested under WindowsXP and Linux.

Interaction of motion perception and object localization

Bettina Friedrich, Pascal Mamassian (*Glasgow, UK*) (talk)

In our research we are looking for the influences of motion signals on the localization of objects. It has been known that when a moving carrier (Gabor patch in our case) is shown behind a stationary window, the window is perceived as being misplaced in direction of the motion. Mamassian and Adams (VSS, 2001) replicated this finding with moving Gabor patches shown at cardinal positions around a fixation cross - two Gabor patches were moving in clockwise, two in anti-clockwise direction. When targets were presented, they expected to find a masking effect for objects which were presented in front of the moving object, since there should be some sort of competition for space in this area due to the perceptual displacement of the moving Gabor. The masking effect could not be found - possible explanations for this offered by the authors were a) competing attentional shift to the area in the front-region of the stimulus or b) that the target was perceived as being misplaced as well. We replicated the observed motion shift and could find a masking effect for the cases when attention was drawn away from the critical region with a "wrong cue" (which had the validity of only 75%). The masking effect was strongest when the targets actual position was directly opposite from the cued region. Furthermore we found that the target itself does not seem to be misplaced (measured by using a second target in the behind-region of the Gabor as reference). To avoid the need a second target as reference we are testing at the moment the effect a motion and its aftereffect on a single target, when it is once shown during the motion and once the motion has stopped. We plan to do this for different positions around the Gabor, not only for front and back-positions.

Quantifying human eye movements

Julie Harris, L. Gareze, Y. Tadmor, C. F. Barenghi (*Newcastle, UK*) (poster)

To date, there are few formal quantitative techniques for analysing scanpath data. Usually, saccades and fixations are identified and then used to compute measures such as mean fixation time and saccade amplitude, which are analysed further. Our research aims to characterise patterns of eye movements during scene viewing using a new mathematical tool, based on knot theory and modern geometry. The tool we are developing will characterise the morphological complexity of an eye movement record or scanpath on the basis of ‘crossings’. These crossings occur when the scanpath crosses over itself in space, forming a loop. This analysis measures how ‘tangled’ an eye movement pattern is and will allow us to label a given scanpath quantitatively. We are currently investigating how robust this measure is and its usefulness in the analysis of scanpath data.

Here we present preliminary data, comparing the scanpaths obtained from a small number of participants viewing images of natural scenes for several seconds. Ten complex scene stimuli, depicting both city views and plant images, were selected from a larger natural image database. The resulting scanpaths were then analysed to produce numerical measures of the ‘crossings’ in the data. Our intention is to investigate whether our measures can distinguish between different scenes or different participants. If so, this would offer a convenient way to characterise different participants and different scenes.

Neuronal processing delays are compensated in the sensorimotor branch of the visual system

Dirk Kerzel, Karl R. Gegenfurtner (*Gießen, D*) (talk)

Moving objects have changed their position when signals from the photoreceptors arrive in the visual cortex. Nonetheless, motor responses to moving objects are accurate and do not lag behind the real-world position. A recent suggestion was that compensation for neuronal delays is achieved within the visual system by extrapolating the position of moving objects into the future. Contrary to this idea, we found that there was no extrapolation of final target position with perceptual judgments that involved a probe stimulus and “same-different” answers. However, the endpoints of reaching movements to the final target position were displaced in the direction of motion, suggesting that target position is extrapolated when retinotopic coordinates are transformed into egocentric space used for motor action. Sensorimotor extrapolation also occurred with illusory motion induced by context elements. The results suggest that the sensorimotor system compensates for neuronal delays by directing limb movements toward future target positions.

Using saccadic eye movements to determine visual processing speed: An analysis of saccade landing positions

Holle Kirchner, Karl R. Gegenfurtner, Dirk Kerzel, Simon J. Thorpe (*Toulouse, F*) (talk)

The processing required to decide whether a briefly flashed natural scene contains an animal can be achieved in 150 ms as demonstrated by event-related potentials [Thorpe, Fize & Marlot, *Nature*, 381, 520-522 (1996)]. However, when subjects are asked to move their eyes and precisely look at the animal, behavioural reaction times can be even faster. After a random fixation interval and a 200 ms gap period, two photographs were flashed for 600 ms on either side of fixation. Three expert participants showed remarkably good performance with a sharp latency distribution (median = 180 ms). A substantial proportion of trials involved reaction times for the onset of movement below 150 ms with the shortest latency responses occurring at 130 ms. These short reaction time trials were often associated with relatively imprecise localisation: Participants tended to saccade to the region close to the centre of the image rather than directly to the animal. Preliminary data in a second experiment varying stimulus duration between 20 and 300 ms revealed even larger variability in saccade landing positions, and mean saccade latencies increased when stimulus duration was below about 100 ms. The results suggest that the information available at the time when the visual system has detected the presence of an animal may be very imprecise with respect to the localisation of the target. Further experiments will be needed to determine how localisation accuracy develops over time and whether its time-course is different from that for object categorisation and classification.

Reading and visual search with a pseudofovea

Angelika Lingnau, Dirk Vorberg (*Braunschweig, D*) (talk)

With each fixation, critical features are projected to the part of the fovea with highest acuity. Patients with macular degeneration, however, direct their eyes in such a way that objects are mapped in an extrafoveal part, the so-called pseudofovea.

We are interested in the influence of the location of the pseudofovea on visual tasks. We used a gaze contingent display, blurring the whole screen, with only a small cut-out, depending on the current gaze position, showing a clear picture. With this set-up, it is possible to study the use of a pseudofovea in healthy subjects.

In reading, we found better performance with a pseudofovea right from fixation (in visual field coordinates). This superiority might be caused by the text direction. We assume, however, that visual tasks are superior whenever required direction of eye movements and the shift of the pseudofovea with respect to fixation are the same. In visual tasks, controlling the local gaze direction, we found exactly this relationship.

Distractor effects on saccade generation as revealed by saccade trajectory curvature.

Eugene McSorley, Robin Walker, Patrick Haggard (*London, UK*) (talk)

It has been shown that the trajectories of saccadic eye movements curve away from distractors in some situations, while in other situations (such as visual search) saccades curve towards distractors. We examined the hypothesis that saccades made to predictable targets will curve away from distractors (due to the presence of top-down inhibition) while saccades made to unpredictable targets will be more likely to curve towards a distractor. It was found that the direction of curvature (towards or away from distractors) changed depending on prior knowledge of target location. Saccades curved towards distractors when target location was unpredictable and curved away from distractors when the target location was pre-cued. In further experiments the spatial extent of the presumed inhibitory process involved in producing curvature away from distractors was examined by systematically manipulating the target to distractor separation. Although there was an effect of side (saccades curved away from distractors) and hemifield (greatest curvature when distractor in target hemifield) there was no clear relationship between curvature and target to distractor separation. The findings are discussed in terms of competitive interactions operating in the saccadic system.

Luminance and color Gabor patches in grouping, contour integration, and object recognition

Geir Nygard (*Leuven, B*) (poster)

We have developed a tool for placing Gabor patches on the outline (outer contour) of a set of Snodgrass and Vanderwart line drawings. The Gabor patches may be varied in size, spatial frequency, phase, orientation, and elongation, and may be generated with a luminance or color profile (or both). The patches are placed on the contour with an orientation corresponding to the local orientation of the outline. They are distributed with a known mean distance between them, giving a “partial figure” where a certain percentage of the complete contour is displayed. This partial figure is then placed in a grid containing randomly oriented Gabor patches. Only one patch is allowed per grid cell, and the mean distance between the patches is the same as for the outline. Subjects are asked whether they can detect a contour and, if so, identify the object in question. According to a study by Beaudot & Mullen (How long range is contour integration in human color vision?, *Visual Neuroscience* (2003), 20, 51-64) contour detection depends on (among others) the distance between the patches and their color and luminance profile. We wish to systematically study the effects of Gabor patch parameters, distribution and color on grouping, contour detection, and contour integration for object recognition.

Timing of Target Discrimination in Human Frontal Eye Fields

Jacinta O'Shea, Neil M. Muggleton, Alan Cowey, Vincent Walsh (Oxford, UK)
(talk)

The frontal eye fields (FEF) have been implicated in the fronto-parietal system that subserves covert visual selection. Single unit work has shown that FEF neurons engage in target selection independently of their role in eye movement execution. We used transcranial magnetic stimulation (TMS) to investigate whether this is also true of human FEF.

In experiment 1, we used signal detection theory to compare subjects' performance on difficulty-matched visual feature and conjunction search tasks in which eye movements were neither useful nor required. Repetitive-pulse TMS (10Hz, 500ms) was applied over FEF and control sites, V5 and vertex. Performance was significantly impaired when TMS was applied over FEF during conjunction search. This finding confirmed the hypothesis that human FEF is important for target selection, regardless of the need to generate a saccade.

In experiment 2, we used double-pulse TMS to investigate the timing of TMS interference. Double pulses applied at 40 and 80ms after stimulus onset significantly impaired performance. The data match findings showing that FEF activity during this period predicts monkeys' behavioural reports on hit, miss, false alarm and correct rejection trials.

These findings de-couple target selection from eye movement execution in human FEF. They reveal a close correspondence between data from macaque neurophysiology and human TMS on the timing of target selection in FEF.

Using space and time to modulate categorisation of human movements

Helena Paterson, F.E. Pollick (Glasgow, UK) (poster)

Previous research (Pollick et al, 2001, *Cognition*, 81, B51-61) has suggested that humans differently use spatial and temporal properties of movement to recognise affect. In the current experiment we have investigated this topic by modifying spatial and temporal properties of movements with sad, angry and happy emotion and measuring the effect on categorisation of the movements. For two pairs of emotions (happy/angry and sad/angry) both spatial (frame-to-frame 3D limb position) and temporal (movement duration) properties were modified on a continuum from exaggerated spatial or temporal properties of one emotion to exaggerated spatial or temporal properties of the other emotion. There were 2 factors in the experiment, each with two levels. Angry movements were paired with either sad or happy and for these two conditions each the spatial properties were modified and the temporal properties were modified. Both original and modified movements were shown to 32 observers (8 in each experimental condition) in a two-alternative forced choice categorisation task. The proportion of times movements were categorised as „angry” show that by modifying temporal features, we could modulate categorisation of sad/angry to a large extent but only in a limited way for happy/angry. Spatial modifications showed modulation on both the conditions, but with different characteristics for the two conditions. We further discuss the data in terms of recent models of biological motion perception and the suggestion that spatial and temporal cues comprises independent channels that carry different aspects of the encoding of social content.

Object Substitution masking on “real objects”

William Sbrugnera, Filip Germeys, Karl Verfaillie (Leuven, B) (poster)

When 4 dots surround an unattended target and are delayed offset, they act as a mask as the subject is unable to identify the target object. This refers to the paradigm of object substitution masking (OSM) introduced by Enns & Di Lollo (1997) and developed by Di Lollo, Enns & Rensink (2000) in which the target is substituted by the mask when attention is directed to it. The OSM model proposes that the visual system asks for a confirmation for what is processed in the preattentive stage by the way of feedback connections, and if the target offset during this period, masking occurs. The main goal of the present study is to determine in which condition the OSM paradigm can be used with line drawing objects and what kind of information it can give us to study object recognition. In our experiment, we tried to replicate the masking effect of OSM by using eight different line drawing objects displayed in a circle for 26 ms or 75 ms. The duration of the trailing mask varied also from 0 (common offset) to 350 ms. The global results of the orientation task (the objects were presented either to the left or the right direction) replicate the classical findings when other kinds of stimuli were used (letters, Landolt C): As

the trailing mask duration increases, the performances of the subject decreased. This experiment constitutes a first step for the application of OSM in the study of object recognition.

Learning and transfer in the control of pointing movements

Thomas Schinauer, Karl Theodor Kalveram (*Düsseldorf, D*) (poster)

Action effects are typical for writing or pointing movements - a pen makes a trace, a laser pointer sometimes dithers en route to its goal. It is well known that target deviations of pointing movements decrease under conditions of such visual feedback. Not known, however, is the functional role of visual feedback for a tool transformation being adapted to some specific task demands. According to our model of control theory, visual and proprioceptive information are attuned "auto-imitatively" - a special case of adaptive control -, if the parameters of a neurally available inverse model have to be restated (Kalveram & Schinauer, 2002).

Here we tried to examine, whether pure visual feedback of the effector trajectory is a sufficient requirement for the control of inverse kinematics by combining two experiments (real movement and force control). The results prove a common attunement of dynamic and kinematic parameters in which the transfer from learning to open loop control is only possible when proprioceptive feedback is not being constrained. This means that visual feedback seems to fulfil a double function: state feedback is for both endpoint control and for tuning the pattern generator(s).

Kalveram, K.Th., Schinauer, Th. (2002) The problem of adaptive control in a living system - or - How to acquire an inverse model without external help. In: M. Verleysen (ed) 10th European Symposium on Artificial Neural Networks (ESANN 2002), Bruges, April 24-25-26. Evere (Belgium): Mommaerts, pp.89-94.

Visual Attention Mediates Object Control

Adriane E. Seiffert (*Princeton, USA*) (poster)

Visual attention has a finite spatial resolution that limits the ability to track an object moving amongst identical distractors (Intriligator & Cavanagh, 2001, *Cog Psych*, 43, 171-216). This limitation on spatial attention is much coarser than the visual acuity limit suggesting that there are two stages of spatial delineation in visual processing. Here, we tested whether controlling the motion of an object was limited by visual attention or visual acuity. Participants performed two tasks. In the tracking task, participants were asked keep track of the target, which was one out of nine identical disks moving randomly about a square display. In the controlling task, participants were asked to use a joystick to control the target's direction of motion. At the end of each 16-second trial in both tasks, participants had to judge whether a cued disk was the target or not. We used small visual displays (2.5 to 0.32 degrees of visual angle) to test beyond the spatial attention limit. Results showed that participants were better able to report the target at smaller display sizes after controlling than after tracking. These results might have suggested that visually-guided action uses a representation with finer resolution than visual attention. However, in a second experiment, we found that the advantage of controlling disappeared when the target's direction of motion was given (visually) during tracking. It seems that visually-guided action may be limited by the resolution of visual attention, though additional cues from manual control are also available to improve performance.

The role of kinesthetic input from neck muscles in localization of objects in a rich visual environment

Tatjana Seizova-Cajic, Ian Curthoys (*Sydney, AU*) (poster)

Vision relies on 'hidden' input from other senses. There is empirical evidence about kinesthetic contribution to vision: transcutaneous vibration of the extraocular muscles or neck muscles results in the illusory motion of visually perceived objects (e.g., Biguer et al, *Brain* 111, 1988; Velay et al, *Vis Res* 34, 1994). This is explained by the vibration-induced activity of muscle spindles, which normally indicate that the muscle is extending. This vibration-induced (false) signal, combined with the retinal input, results in an illusory motion of an isolated point seen in complete darkness. In a rich visual context, however, neck vibrations fail to result in illusory motion (Biguer et al, 1988). In spite of this, it is possible that kinesthetic input contributes to body-centric localization of objects in a rich environment, because motion and position signals can be dissociated (Goodwin et al, *Brain* 95, 1972). This possibility will be investigated using vibration of the dorsal left or right neck muscles. It will

create the false signal that the head is moving and displacing laterally. Head movements will not necessarily be consciously perceived, nor will there necessarily be perception of motion in the environment. About 10 seconds following the onset of vibration, participants will indicate the position of a visually perceived target using pointing with an unseen hand. It is expected that pointing responses will be biased in the direction of head motion that is consistent with the false kinesthetic signal, showing the significance of kinesthetic input for visual localization in a rich visual environment.

The role of attention in manual pointing tasks

Joo-Hyun Song, Ken Nakayama (*Harvard, USA*) (poster)

In recent studies, it has been shown that eye movements are tightly coupled with the sequences of motor actions in everyday activities, such as food preparation (Land, 1999, Land & Hayhoe, 2001). Other studies have also shown that eye movements preceded the deployment of focal attention (Kowler, Anderson, Doshier & Blaser, 1995; Deubel and Schneider, 1996). Given the fact that there are one link between eye movements and motor actions and the other between eye movements and attention, we raise the question of whether attentional deployment also affects motor actions. We specifically examine whether task conditions that facilitate rapid attentional deployment in cognitive tasks also affect motor actions. To address this issue, we choose three well-known characteristic properties of focal attention, which have been consistently revealed in previous studies. Thus, we ask whether pointing speed would vary as a function of distractor number, whether it would show the “gap” phenomenon and whether it would show short term priming. In all experiments, displays were presented on a touch screen and subjects were asked to touch their index finger as quickly as possible to an odd colored target among distractors. We find all three of the attention manipulations significantly affected manual pointing reaction times. Further study where the whole finger trajectory is recorded shows that the facilitation effect of manual pointing is due to a latency decrease rather than overall speed changes in a given condition. In conclusion, we reveal a parallel between those conditions that facilitate the deployment of focal attention in cognitive tasks and those which speed finger pointing.

Quality of smooth pursuit eye movements at low stimulus contrast

Miriam Spering, Dirk Kerzel, Karl R. Gegenfurtner (*Gießen, D*) (poster)

The perception of speed and the ability to exhibit smooth-pursuit eye movements was shown to depend on stimulus contrast [Hawken & Gegenfurtner, *J. Opt. Soc. Am., A*, 18, 2282-96 (2001)]. Most experiments in this regard have employed stimuli well above detection threshold. We studied pursuit eye movements elicited by targets with contrasts ranging from just below individual thresholds to 100% contrast. Stimuli were Gabor patches with three target speeds (1, 8, 16°/s) and four spatial frequencies (1, 2, 4, 8c/deg). For stimuli above threshold, the quality of pursuit eye movements depends slightly on contrast. However, below a contrast level of two times the threshold, pursuit is severely impaired: Steady-state gain is low, pursuit latency is long, and position error is high. We can conclude that, in general, the computation of velocity does depend on contrast. Poor signal quality at contrast levels around perceptual threshold makes it impossible for the pursuit system to compute a reliable velocity estimate.

Chromatic mechanisms for the perception of global and biological motion

Marco Tommasi, Karl R. Gegenfurtner (*Gießen, D*) (poster)

We investigated the contributions of color to the perception of globally moving random dot kinematograms and of biological motion. In both experiments, the stimulus consisted of signal dots and noise dots. In the global motion task, the signal dots were defined by a uniform global motion in one of four possible directions. The noise dots were moving incoherently in a random direction. In the biological motion task, the signal was defined by 104 points from the surface of a walking person. The noise dots were chosen randomly from a set of walkers moving in a variety of different directions. In both tasks, the color of signal and noise dots was independently varied in the isoluminant plane of DKL color space. For each color combination, the signal-to-noise ratio was determined by an adaptive staircase procedure where the subjects could reliably identify the direction of motion of the signal dots. In both tasks, there was a significant contribution of color to the identification of the direction of

motion. The contribution increased with the chromatic difference between signals and noise dots. The resulting tuning function for biological motion was narrower than the one observed for global motion. We conclude that color can play an important role in motion perception and even more so in perceiving shape from motion.

The origin of variability in eye position during visual fixation

Rob van Beers (*Rotterdam, NL*) (poster)

During fixation of a visual target our eyes make small movements. We assumed that such variability in eye position is caused by noise in the oculomotor system. We analyzed the variability during fixation to examine the origin of this noise.

We presented 81 visual targets in different directions with eccentricities up to 25 degrees. Eye position was recorded with scleral search coils. We selected fixation intervals of 150 ms immediately following a saccade to be sure that the observed variability was due to noise in the oculomotor system and not to feedback-driven control of eye position.

The results show that the variability during these intervals is generally smaller than 0.5 minarc (standard deviation). The variability in both the horizontal and the vertical component of eye position increased with eccentricity. We also analyzed the correlation between the small movements of the two eyes. This correlation was much larger for vertical than for horizontal movements.

The observed correlations match the fact that horizontal position is controlled by unilateral areas, whereas vertical position is controlled bilaterally. We therefore conclude that variability in eye position is at least partly due to noise in motor commands. Our finding that the variability increases with eccentricity suggests that the noise level in the motor command increases with the magnitude of the command. This follows from the fact that, in order to compensate for the elastic forces of the orbital tissues, muscle torques and their control signals increase with eccentricity.

Egocentric Visuomotor Adaptation

John J van den Dobbelsteen, JBJ Smeets, E Brenner (*Rotterdam, NL*) (poster)

Previous research has shown that humans generalise perturbations of visuomotor feedback in terms of egocentric rotations. We investigated whether this adaptation involves changes in visual localisation (relative to the eyes) or changes in proprioceptive localisation (relative to the shoulder). We asked subjects to align an unseen cube with a 5 cm side with a simulation that they saw via a mirror. Subjects made successive movements between target locations in a sequence of adaptation and test phases.

During adaptation phases, subjects received either veridical or perturbed visual feedback about the real cube. The perturbations were consistent with a change in azimuth either relative to the eyes or relative to the shoulder. During test phases, subjects received no visual feedback. We compared test movement endpoints after perturbed feedback with ones after veridical feedback. Despite the similarity between the perturbations, the spatial layout of the shifts in endpoints clearly reflected the small differences between the two perturbations. In a second experiment we investigated intermanual transfer of adaptation to determine whether the shifts in endpoints were due to changes in visually perceived location or to changes in the proprioceptively perceived location of the hand. Changes in visual localisation are not specific to either arm and should transfer to the arm that was not exposed to the perturbed feedback. We found that the transfer of adaptation to the unexposed arm was substantial but incomplete for both types of perturbations, indicating that the adaptation to both types of perturbations was not specifically linked to either visual or proprioceptive localisation.

Catching and matching oriented bars

Hemke van Doorn, John van der Kamp & Geert Savelsbergh (*Amsterdam, NL*) (talk)

The accuracy with which we perform actions seems not to be in agreement the fact that visual perception of physical space is distorted. This paradox between action and perception may be explained by the existence of two anatomically and functionally distinct visual streams for action and perception (Milner and Goodale, 1995) which can be distinguished on the basis of their use of different optical information (e.g., spatial reference frame used). In the present study it is investigated if perception enslaves action. Two conditions are presented to the participants. In the first condition,

participants had to match manually the orientation of a reference bar placed at different distances in the frontoparallel plane, whereas in the second condition participants had to catch differently oriented bars which disappeared at different locations from the interception point. If, on the one hand, vision for perception enslaves vision for action, errors in the catching movements of bars are expected to be related to errors in the matching task. If, on the other hand, vision for perception and vision for action are distinct processes, errors in both tasks are expected not to be related. It is found that the systematic errors made during matching are different from the systematic errors made during catching. These results seem to favour the Milner and Goodale model.

Probing the role of motion in object recognition

Quoc C. Vuong, Michael J. Tarr (*Tübingen, D*) (talk)

There has been a recent shift in studying how an object's movements contribute to its recognition. Most studies have used highly familiar and potentially over-learned body and facial motions. Here we examined how rigid depth rotation affected the recognition of novel 3D objects. The act of recognition requires that the appropriate information for the task at hand be extracted from the visual input. For an object rotating in depth, there are three potential sources of information that can be recovered from the object's motion and used for its recognition: 3D shape, 2D views, and dynamic information that specifies how image features unfold over time. Traditional theories of object recognition have focused on the first two sources. To test the hypothesis that dynamic information is also used for recognition, we varied the direction in which objects rotated in depth. This manipulation changes the available dynamic information but maintains shape and view information. Moreover, we randomly selected a rotation direction on a trial-by-trial basis so that observers could not learn to associate a direction with particular objects. We found that performance on a same/different discrimination task was affected by the rotation direction irrespective of object discriminability and without learning. Overall, we conclude that the visual system automatically recovers dynamic information from motion for recognition purposes, rather than using motion only as a precursor to shape or view information.

Motion integration for Smooth Pursuit Eye Movements

Julian Wallace, Guillaume Masson (*Marseille, F*) (talk)

We measured smooth pursuit eye movements to two types of translating line diamond stimuli. For type I stimuli, the direction of motion was consistent between the true object motion and the vector average of the local motions of the lines. For type II diamond stimuli the vector average of the local motions was not consistent with the object motion. We found that for these stimuli eye movements initially deviated in the direction of the vector average and were corrected to the correct object direction over a period of ~200ms. The effect is dependent on speed, is maximal at low contrasts, depends on the relative amount of 1D and 2D information in the stimulus, and does not appear to be affected by high-level processes. The combined results suggest that motion integration is a dynamic process involving an interplay between ambiguous and unambiguous information, consistent with a range of psychophysical evidence.

How the West was won: intentional vs. reactive actions

Andrew Welchman (*Tübingen, D*) (poster)

In the Wild West, legend has it that the guy who draws his gun first is the one who gets shot. The idea behind this is that intentional actions are slower to execute than reactive actions. To see if there is any truth in this notion we staged mock duels in the laboratory. Initially 12 observers were trained to make a speeded sequence of button presses for three keys located in front of them. After subjects had become proficient at the task (40 minutes training), we paired them up and they duelled against each other. The two subjects in a duel had different roles: one was the initiator and the other the reactor. A computer randomly determined which subject was the initiator on every trial. Initiators were free to start their movement sequence when they wanted. Subjects played against each other to be first to complete the movement sequence. The first person to complete the sequence scored points off the other player. Reactors rarely beat initiators (i.e. reactors normally got shot); however, the within-subject analysis of movement times made when the subject was the reactor versus the initiator suggested an average of a

20ms advantage for reactive movements. These preliminary results suggest that even though the guy who draws second gets shot, reactive movements may be faster than intentional ones.

Effect of orbital eye position on the characteristics of congenital nystagmus

Debbie Wiggins (*Cardiff, UK*) (no presentation)

Purpose: Congenital nystagmus, an ocular-motor disorder present at birth or soon after, is characterized by a bilateral, conjugate and predominately horizontal involuntary oscillatory movement of the eyes. I will be looking at the effect of orbital eye position on the basic properties of the nystagmus oscillations, namely amplitude, frequency, intensity and slow-phase velocity.

Methods: The eye movement behaviour of the nystagmats will be recorded using the Skalar IRIS system

Results & Future Directions: Data collected to date confirm that the null position (orbital eye position corresponding to minimum oscillation intensity) corresponds with the patients' chosen eye position in normal viewing situations. However, some patients display equally low intensities at other more eccentric eye positions. We propose to test the hypothesis that people with nystagmus choose a null position that corresponds to the minimum intensity at least excursion from the straight-ahead position. We will also explore the visual acuity of people with nystagmus at the null position and other minimum intensity zones.

Secondly, our findings show that some patients exhibit a brief 'settling' period after a change of fixation during which the amplitude of oscillations reduces, suggesting that a person with nystagmus may require longer to make visual discriminations after a saccadic eye movement. In 'normals' the accuracy of saccadic eye movements are greater on moving towards the primary position than away from, and the error is proportional to the size of the saccade. We propose to explore whether the 'settling' time of the nystagmus amplitude varies with the size of the saccade, and with the direction (taking the null position as the centre).

The potential use of optical acceleration in the judging and catching of fly balls

Frank T.J.M. Zaal (*Groningen, NL*) (talk)

Catching a fly ball requires that the catcher arrives at the interception location at or before the time the ball arrives there. The strategy of running such that the optical speed of the ball is constant (the so-called Chapman Strategy) brings the catcher at the interception location, without a need to know about that location or the ball flight time. In a series of recent experiments, we used virtual reality techniques to assess the use of the Chapman strategy, which implies the ability to detect optical acceleration (i.e., a change in optical speed). I will take these experiments as a vehicle to discuss the state of the art in the understanding of the use of optical acceleration in catching fly balls, a task that has received quite some attention in the recent scientific literature. Among other things, I will discuss differences in the characteristics of head movements in the judging of future passing side versus in actual running to catch. In this context, I will also argue that recent findings that thresholds to detect optical acceleration, based on data from experiments in which observers judged moving objects on a computer screen, may not be generalized safely to the situation of the baseball field.

Workgroup discussion questions

I collected some questions and answers on how one should treat movement data. The aim of the discussions in the workgroups is to supply me with the answers (and their limitations). These conclusions will be posted on the workshop's web-site.

What is your favourite way to remove measurement noise from your data?

- A second-order Butterworth filter bi-directionally.
- A high order (e.g. 100) filter. Choose cut-off frequency based on known spectral content of data (e.g. Bahill et al., 1981).
- A moving average.
- Convolution with a Gaussian (or its derivatives to obtain velocity and acceleration).
- Fitting of a polynomial to a few (e.g. 7) samples around the point of interest. The fit-parameters give the position speed and acceleration.
- Prefer not, always fit model movements (sinusoids) to raw data.
- Prefer not, use enough subjects/trials.

The answers vary widely; probably each method is the optimal solution for a specific situation. The question for the discussion groups is: for which situation is a method suited, and for which not?

What is your favourite way to find the onset/offset of a movement/saccade?

- A fixed threshold value of acceleration.
- The last/first zero-crossing of a component of velocity before/after its peak.
- A fixed threshold value of speed.
- A threshold value as a proportion of peak speed.
- A threshold value of spatial distance from startpoint/endpoint.
- Movement of target object => offset.
- Those samples for which the difference with the previous/next sample was more than 90° from the main movement direction.
- Combine detection algorithm with known properties of movement (e.g. saccade duration of above 15 ms).
- Semi-automatic: based on one of more of the above, manually adjusted by experimenter

Again, the answers vary widely; probably each method is the optimal solution for a specific situation. The question for the discussion groups is: for which situation is a method suited, and for which not?

Other questions to discuss:

- How do you average movements that have different durations?
- How do you average movements across subjects?
- What are the best (most informative/reliable) parameters to describe a movement?
- How to deal with drift between trials
- How do you describe a curved trajectory effectively?
- Choosing sample frequency (aliasing, temporal resolution)
- How to calibrate eye movements
- How should you present data: individual trials, average trajectories, average parameters?

Examples of how well-established data-analysis methods can yield erroneous results?

Averaging samples of records with saccades in them

Computing the mean of a distribution (e.g. trajectory of the hand or saccade) before checking that the distribution is uni-modal is a pretty silly thing to do.

The dependent variable (DV) is significantly different from zero in condition A, but not in condition B. The researcher concludes that the values of the DV are different between condition A and B. Clearly, this is wrong. The researcher should test the difference directly. This is a trivial problems, but I see it quite often.

Using a (linear) regression to describe data with measurement errors in the independent variable. As a regression assumes that a deviation from the fitted curve is caused purely by errors in the dependent variable, this gives erroneous results (e.g. figure 2 in Smeets & Hooge, 2003)

Fitting a line through discontinuous data. Example: study where ocular counter roll and subjective vertical during static torsional tilt were reported to be correlated. However, they showed two clouds of data, one in the second quadrant and one in the fourth. What this tells you is that both OCR and the subjective vertical change during static tilt oppositely to the head tilt (which has been known for long). It does not mean they are correlated. (I replotted the absolute values, they did not)

To quantify the variability in 2D movement endpoints by the area of the confidence ellipse. A much cleaner measure is the trace of the covariance matrix, which measures the true variance: the mean squared error about the mean. Especially in the case when the variability in one direction is much larger than in the other, the area of the ellipse produces an underestimate. In the extreme case when the variability in one direction is zero, the area is zero, even when the variability orthogonal to that can be appreciable. Even worse (and used by some people) is to quantify the 2D variability by $\pi \cdot SD_x \cdot SD_y$, which depends on how the axes are chosen!