Helmholtz Instituut

Utrecht University

Perception Day 2024

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Welcome!

We are happy to continue the tradition of Perception Day which started in 2006. After previous editions at TNO Soesterbergs, Eindhoven University of Technology and Radboud University Nijmegen, it is now the second time for Utrecht University to welcome perception researchers active in the Netherlands and Flanders. As before, the goal is to bring together these researchers to acquire inspiration and exchange information across disciplines. We hope you enjoy the day!

The organizers

Program overview

8:15	**Coffee & Registration**	Ruppert Hall
9:10	Welcome to Perception Day!	Ruppert 040/ Ruppert 042
9:15	**Talk session 1A:** Attention & decision making *Chair: Leendert van Maanen*	Ruppert 040
9:15	**Talk session 1B:** Clinical groups *Chair: Renee Lustenhouwer*	Ruppert 042
10:45	**Coffee break & Posters**	Ruppert Hall/ Ruppert 005
11:30	**Talk session 2A:** Emotion, face perception & working memory *Chair: Samson Chota*	Ruppert 040
11:30	**Talk session 2B**: Eye movements and pupillometry *Chair: Freek van Ede*	Ruppert 042
13:00	**Lunch**	Ruppert Hall
13:45	**Talk session 3A:** Non-visual perception *Chair: Ben Harvey*	Ruppert 040
13:45	**Talk session 3B**: Visual perception *Chair: Chris Klink*	Ruppert 042
15:15	**Coffee break & posters**	Ruppert Hall/ Ruppert 005
16:00	**Helmholtz lecture Anil Seth** "*Consciousness in humans and in other things*"	Ruppert Blauw
17:00	**Drinks**	Ruppert Hall

Talks

Talk session 1A – Attention & decision making

Chair: Leendert van Maanen

09:15 – 10:45, Room Ruppert 040

9:15	Perceptual Decision Making Components And Times In The Human Brain	Gabriel Weindel, Utrecht University
9:30	Investigating The Applicability Of A Cueing Paradigm To Study Individual Differences In The Spotlight Of Attention	Beleke de Zwart, Utrecht University
9:45	Concurrent Multi-Target Search Is Possible, But Sequential Search Is Preferred	Alex Hoogerbrugge, Utrecht University
10:00	Overt And Covert Attention Are Qualitatively Similar But Quantitatively Distinct	Damian Koevoet, Utrecht University
10:15	Learning Alters Salience	Dock Duncan, VU Amsterdam
10:30	A Behavioural Marker To Dissociate Subjective Experience From Perceptual Decisions In A Detection Experiment	N Sánchez-Fuenzalida, VU Amsterdam

Talk session 1B – Clinical groups

Chair: Renee Lustenhouwer

09:15 – 10:45, Room Ruppert 042

9:15	Relying On The External World: Inspection Behavior Reveals Offloading Strategies In Visual Working Memory After Brain Injury	Sanne Böing, Utrecht University
9:30	A Non-Verbal Gaze-Based Assessment Of Cerebral Visual Impairments In Young Children	Marinke Hokken, Erasmus MC
9:45	Statistically But Not Clinically Significant Cortical Thinning In Age-Related Macular Degeneration	Lara Mentink, Tilburg University
10:00	Task-Specific Strategies In Visual Working Memory Use	Andre Sahakian, Utrecht University
10:15	Looking From Different Angles: Alternative Perimetry Methods Complement Each Other	Henning Schulte, UMC Groningen
10:30	The Effects Of Central And Peripheral Vision Loss On A Naturalistic Search Task: Shopping In Virtual Reality	K Veerkamp, VU Amsterdam

Talk session 2A – Emotion, face perception & working memory

Chair: Samson Chota

11:30 – 13:00, Room Ruppert 040

11:30	Dissociating Internal And External Attentional Selection	Kabir Arora, Utrecht University
11:45	Peripheral Visual Working Memory During Maintenance And Selection	Güven Kandemir, VU Amsterdam
12:00	Music And Emotional State Influence Visual Processing Speed	David Melcher, New York University Abu Dhabi
12:15	The Nose Knows: Capturing Facial Attractiveness With Functional Infrared Thermal Imaging	Erik Van der Burg, VU Amsterdam
12:30	Looking Into Working Memory To Verify Potential Targets During Search	Sisi Wang, VU Amsterdam
12:45	Statistical Learning Of Task Relevance, Rather Than Stimulus Prevalence, Improves Visual Working Memory Recall	Luzi Xu, Utrecht University

Talk session 2B – Eye movements and pupillometry

Chair: Freek van Ede

11:30 – 13:00, Room Ruppert 042

11:30	Uncovering Covert Attention In Complex Environments With Pupillometry	Yuqing Cai, Utrecht University
11:45	Does (A Lack Of) Visual Attention During Face-To-Face Conversations Influence People's Perceptions Of Feeling Heard?	Gijs Holleman, Tilburg University
12:00	Spontaneous Fluctuations In Pupil Size Shape Retinal Responses To Visual Stimuli	Sebastiaan Mathôt, University of Groningen (RUG)
12:15	Ganzfeld-Induced Perceptual Deprivation And Its Effect On Consciousness: The Interplay Between Abstract Cognition And Perceptually Grounded Thoughts	Eleftheria Pistolas, KU Leuven
12:30	The Effect Of Pupil Size On Near-Threshold Detection Is Not Modulated By Colour, Eccentricity, Or Adaptation-State	Veera Ruuskanen, University of Groningen (RUG)
12:45	The Effect Of Covert Visual Attention On Pupil Size During Perceptual Fading	Ana Vilotijevic, University of Groningen (RUG)

Talk session 3A – Non-visual perception
Chair: Ben Harvey
13:45 – 15:15, Room Ruppert 040

13:45	Soft Robotics For Haptic Interactions	Irene Kuling, Eindhoven University of Technology (TU/e)
14:00	Learning And Retention Of Vibrotactile Morse Code	Myrthe Plaisier, Eindhoven University of Technology (TU/e)
14:15	Prior Knowledge And Context Biases Visual Memory For Body Postures	Han Qiu, Utrecht University
14:30	Social Chemistry Science With Industry: A Decade Long Journey For Impact	Monique Smeets, Utrecht University
14:45	Decoding Auditory Working Memory Load From EEG Alpha Oscillations	Yichen Yuan, Utrecht University
15:00	Urban Air Mobility noise assessment and public acceptability	Naomi Sieben & Roalt Aalmoes, NLR

Talk session 3B – Visual perception
Chair: Chris Klink
13:45 – 15:15, Room Ruppert 042

13:45	Groundwork For Applying Rapid Invisible Frequency Tagging (Rift) To Study Neural And Cognitive Processing In Naturalistic Vision	Songyun Bai, Donders Institute, Radboud University
14:00	Population Receptive Field Size Across Cortical Depth Along The Visual Hierarchy	Mayra Bittencourt, UMC Groningen, Spinoza Centre for Neuroimaging
14:15	A Continuous Psychophysics Approach To Measuring The Spatio-Temporal Characteristics Of Visual Crowding	Dilce Tanriverdi, UMC Groningen
14:30	Multistable Grouping Beyond The Dot Lattice: Individual And Contextual Differences In Interactions Of Global Orientation And Local Shape	Elisabeth van der Hulst, KU Leuven
14:45	Using Gibbs Sampling With People To Characterize Perceptual And Aesthetic Evaluations In Multidimensional Visual Stimulus Space	Eline Van Geert, KU Leuven
15:00	Mapping The Importance Of Image Region Pleasure And Interest For The Perception And Appreciation Of Art Photographs And Paintings	Maarten Leemans, KU Leuven

Posters

Poster nr	Presenter	Title	Affiliation
P1	Fatemeh Behrad	Against All Odds: Randomness Outperforms Human-Inspired Methods In Identifying Aesthetically Important Areas.	KU Leuven
P2	Ilona Bloem	Examining The Precision Of Spatial Representations Within Visual Cortex	Netherlands Institute for Neuroscience
P3	Dominique Blokland	Individual Differences In Personal Wayfinding Preferences In People With Visual Impairments	Utrecht University
P4	Floortje Bouwkamp	Can We Use Ignored Spatial Predictive Context During Visual Search?	Donders Institute, Radboud University
P5	Caterina Trentin	Exogenous Covert Attention Modulates Foveal Processing Through Predictive Remapping	VU Amsterdam
P6	Katerina Christodouloux	The Role Of Mental Imagery And Sensory Sensitivity In Resolving Perceptual Ambiguity	Tilburg University
P7	Rick den Otter	Uncovering Cognitive Processes In Perceptual Decision-Making: Machine Learning Applied To The Speed-Accuracy Trade-Off In EEG Data	Utrecht University
P8	Fatih Deniz	Connecting Environmental Perception And Affect: Which Perceptual Visual Features Predict Affective Responses To Everyday Indoor Environments?	Eindhoven University of Technology (TU/e)
P9	Lasse Dietz	Investigating The Dynamic Interplay Between Visual Working Memory And Perception	Utrecht University
P10	Garmt Dijksterhuis	Oral Numerosity Estimation	Maastricht University, Utrecht University
P11	Elif Gecer	Hidden Impacts Of Light: Exploring Non-Image-Forming Responses Through Eeg And Metameric Stimuli	Eindhoven University of Technology (TU/e)
P12	Eva Postuma	Road-User Detection And Adaptive Scanning In Cyclists With Hemianopia: Insights From A Virtual Reality Study	University of Groningen (RUG)

P13	Meike Heldoorn	Investigating Recognition Of Pixelated Tactile Line Drawings	Eindhoven University of Technology (TU/e)
P14	Yayla Ilksoy	Learning To Suppress Distractors In Randomized Spatial Configurations	VU Amsterdam
P15	Robert Jertberg	Age, Not Autism, Influences Multisensory Integration Of Speech Stimuli Among Adults	VU Amsterdam
P16	Maëlle Lerebourg	Blinded By The Mind's Eye? Investigating Competitive Interactions Between Imagery And Perception	Donders Institute, Radboud University
P17	Marloes Mak	Associations Between Imagery Vividness, Sensory Sensitivity, And Divergent Perceptual Experiences	Tilburg University
P18	Jonathan Adams	Amodal Shape Completion In Humans And Generative Neural Networks	Erasmus University Rotterdam
P19	Ombretta Strafforello	Backflip: The Impact Of Local And Global Data Augmentations On Artistic Image Aesthetic Assessment	KU Leuven
P20	Taku Otsuka	Distributional Variability Influences Variability Of Mean Estimates	University of Groningen (RUG)
P21	Claire Pleche	An Expected Visual Location Biases Observers' Perceived Sound Location	Donders Institute, Radboud University
P22	Tianying Qing	Shifting Reliance Between The Internal And External World: A Meta-Analysis On Visual-Working Memory Use	Utrecht University
P23	Andrew Reid	Pupil And EEG Correlates Of Decision Making And Memory In A Naturalistic Driving Task	Tilburg University
P24	Siem Scholman	The Discovery And Interpretation Of Hidden Stages In Decision Making	Utrecht University
P25	Surya Selvam	Control Over Conscious Perception Through Meditation?	VU Amsterdam
P26	Margot Steijger	Exploring The Relationship Between Human Arousal And	University of Amsterdam

		Feedforward Vs. Recurrent Processing	
P27	Arne Stein	A High-Speed Oled Monitor For Precise Stimulation In Visual Perception, Eye-Tracking, And Eeg Research	University of Groningen (RUG)
P28	Kaj Stolle	Comparing Vibrotactile Feedback Modes For Navigation – An Extensive Pilot Study	Eindhoven University of Technology (TU/e)
P29	Daniel van der Meer	Cascading Transitions In Multistable Perception	University of Amsterdam
P30	Youp van Oosterhout	Percept Duration Of Light Flashes Induced With Microstimulation In Primary Visual Cortex As A Function Of Visual Adapdatation And Auditory Integration In Blind Subjects	Donders Institute, Radboud University
P31	Dan Wang	Prioritized And Non-Prioritized Features Maintained In Visual Working Memory Differentially Influence Early Visual Processing	Utrecht University
P32	Ningkai Wang	The Role Of Expectations In Visual Spatial Coding Across The Visual Hierarchy	VU Amsterdam, Spinoza Centre
P33	Yaniv Morgenstern	Automated Generation Of Perceptually-Uniform Circular Spaces For Novel Naturalistic Shapes	Erasmus University Rotterdam
P34	Liangyou Zhang	Attention Shifts The Numerosity Preferences Of Tuned Neuron Populations	Utrecht University
P35	Gu Zirui	Distinguishing A Central Selection Bias From A Central Fixation Bias: The Role Of Retinal Eccentricity In Selection Control	VU Amsterdam
P36	Samson Chota	Gaze Biases Can Reflect Task-Specific Spatial Memorization Strategies The Forgotten Early Wave Of Pupillometry Research	Utrecht University
P37	Ben Harvey	Transitions From Monotonic To Tuned Responses In Recurrent Neural Network Models During Timing Prediction	Utrecht University

P38	Krista Overvliet	Translating Colours To Materials: A Study On Cross-Modal Correspondences Between Vision And Touch	Utrecht University
P39	Sjoerd Stuit	Attentional And Perceptual Guidance In Visual Search: The When And What Of Emotional Superiority	Utrecht University
P40	Anna Bøthun	Optimizing Eye Movement Perimetry For The Pediatric Population	University of Copenhagen

Abstracts – Talks

Talk session 1A – Attention & decision making
9:15 – 10:45, Ruppert 040

Chair: Leendert van Maanen

9:15 – 09:30

Perceptual Decision Making Components And Times In The Human Brain
Breaking down the nature and speed of information processing operations that occur between a stimulus and a response (i.e. reaction time, RT), has been a problem in psychology and neuroscience for more than a century. In perceptual decision-making, the RT is classically considered as a composite measure of at least the times required to perceive the stimulus, to decide on the alternatives, and to execute a response.
In the present study, we used a manipulation that aimed at simultaneously decreasing this perception time and increasing the decision time, together with a speed accuracy trade-off manipulation. We then estimated the number of components in the task using the hidden multivariate pattern method on co-registered EEG data. This method assumes that neural time-series are composed of a trial-recurrent sequence of an unknown number of multivariate patterns. This assumption then allows the peak of these multivariate patterns to be estimated at the trial level.
We observed four distinct sequential neural signatures in the EEG of our participants. The signatures' spatial activations, positions in the RT and sensitivities to experimental manipulations allowed us to exclusively relate each signature to the cognitive processes of attentional orientation, stimulus encoding, decision initiation, and decision termination. This talk will show 1) the value of detecting single-trial events in neural time series for answering research questions in perception and 2) how by-trial estimates can change the representation and interpretation of typical components in neural time-series.

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9:30 – 09:45

Investigating The Applicability Of A Cueing Paradigm To Study Individual Differences In The Spotlight Of Attention

Our spotlight of attention helps us to select and filter relevant information from the world around us, and therefore influences how we perceive the world. However, it remains poorly understood whether there are, next to state-influences, also stable differences in the sharpness of the spotlight between individuals; 'trait-differences'. Therefore, the aim of our study is to investigate the validity of a cueing paradigm to assess both group differences and investigate the applicability of the measure for individual differences research. In an online experiment, we presented a cue to covertly direct attention to one side of the screen. This was followed by a target with varying distances from the cue (either in the valid or invalid hemifield) to map the sharpness of the gradient of the attentional spotlight. First, our results indicated that our task elicited the standard exogeneous cueing effects. Then, we fitted linear slopes to index performance and we demonstrate performance decline as a function of increasing target distance, thereby showing that attention modulates the sharpness of the spotlight. Test-retest analyses revealed that while the patterns observed at the group level are robust, performance on an individual level was weakly stable over a 2-week period, limiting the validity of the cueing paradigm for individual differences research. Whereas not suitable to detect variance in the neurotypical population, we discuss potential use of the task for future research in clinical populations where altered attentional functioning are hallmarks in the clinical diagnosis (e.g., autism spectrum conditions).

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09:45 – 10:00

Concurrent Multi-Target Search Is Possible, But Sequential Search Is Preferred
Many studies have investigated whether multiple visual working memory (VWM) representations can be used to guide top-down attention concurrently. Multi-target visual search is a particularly popular approach to study this, because participants can search for targets sequentially (one active VWM template at a time) or concurrently (two or more active templates). This allows us not only to ascertain how VWM interacts with top-down attentional guidance, but also which method of searching is preferred. In the present study, participants performed conjunction search for two or four distinctly coloured targets amongst an array which contained distractors of the same colour as the targets, as well as distractors of an additional irrelevant colour. In Experiment 1, participants were free to choose a search strategy. Oculomotor behaviour and target detection order revealed that participants generally opted to search targets sequentially. In Experiment 2, these effects were replicated and amplified under increased VWM load. In Experiment 3, participants were specifically instructed to either search all targets sequentially or concurrently in order to examine which factors contributed to the observed preference for sequential search in

the previous experiments. When concurrently searching for two targets, participants were able to mostly suppress stimuli of the irrelevant colour but worse than in sequential trials. When concurrently searching for four targets, participants were less able to suppress the irrelevant-coloured stimuli. In sum, our findings indicate that concurrent multi-target search is possible, but that top-down guidance of attention is limited. The decreased effectiveness of concurrent attentional guidance may explain the observed preference for sequential search.

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10:00 – 10:15

Overt And Covert Attention Are Qualitatively Similar But Quantitatively Distinct

Attention can be shifted with or without an accompanying saccade (overtly or covertly, respectively). Here, we investigated whether overt and covert attention employ similar neural mechanisms (i.e. qualitatively), and whether these shift types differ in terms of intensity (i.e. quantitatively). We capitalized on the high temporal resolution of electroencephalography (EEG) to compare overt and covert attention well before saccade onset. Multivariate neural decoding reliably discerned whether participants shifted covert attention or prepared a saccade. But how did these attentional shifts differ? The attended position could be decoded from one condition to the other, suggesting that overt and covert attention employed qualitatively comparable neural mechanisms. We then investigated whether overt and covert attention differed quantitatively. To this end, we used inverted-encoding modeling and observed spatially-tuned neural responses to the attended location during both overt and covert shifts. We observed that overt shifts were accompanied with sharper spatially-tuned neural responses compared to covert shifts, reflecting quantitively stronger attentional overt than covert shifts. This demonstrates that saccade preparation boosts the intensity of attention beyond solely shifting covert attention. Together, we conclude that presaccadic overt and covert attention are qualitatively similar but saccade preparation leads to stronger deployments of attention.

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10:15 – 10:30

Learning Alters Salience

Without the ability to ignore salient yet irrelevant stimuli, it would be impossible to accomplish even simple tasks. Previous research has shown that observers are better able to suppress distracting items via experience; yet how this learned suppression is achieved is largely unknown. The current study employed a psychophysical approach combined with computational modelling to examine how learned spatial suppression affects perception. The results show that items presented at suppressed locations are perceived as less bright than those in non-suppressed areas, suggesting that learned suppression affects the perceived saliency of items. To determine how this saliency change affects visual search, computational modelling approach was used to compare various models of attentional selection. The analysis favored a model in which learned suppression reduces the saliency of objects presented at suppressed locations. Since the saliency of these items is reduced, they are less able to compete for attentional processing and capture attention less often.

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10:30 – 10:45

A Behavioural Marker To Dissociate Subjective Experience From Perceptual Decisions In A Detection Experiment

A central goal in consciousness research is to determine what is consciously experienced and what is not. Unfortunately, behavioural measures are known to be sensitive to non-perceptual biases. Although signal detection theory (SDT) can separate sensitivity from bias, it cannot distinguish between bias effects that result from changes in conscious experience from those that have a non-perceptual cause. We have previously validated a new measure called ‘controlled reproduction’, which dissociates changes in conscious

experience from those arising from non-perceptual biases. However, our previous experiments rely on categorical judgments, while a key feature of consciousness is subjective detection (e.g., seen vs unseen). Here we present a new experiment in which we asked observers (N=397) to detect dim Gabor patches. We investigated three bias manipulations: an attentional cue (cf Carrasco et al., 2004), a pay-off scheme and an asymmetrical base-rate, combined with a standard detection measure and the controlled reproduction measure. While the proportion of 'seen' trials increased under all manipulations, only the attentional cue consistently affected observers' reproduced strength of stimulus contrast, suggesting that payoff and base rate are unlikely to affect conscious experience. Our findings suggest the existence of two distinct phenomena that operate in a detection context: (1) a signal reflecting the subjectively perceived strength of a stimulus and (2) a threshold process that is used to make present-absent decisions. We use a Hurdle-Gaussian model on the reproduction data to characterize the relationship between (1) and (2) and argue that that (1), but not (2) reflects changes in conscious experience.

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Talk session 1B – Clinical groups
9:15 – 10:45, Ruppert 042

Chair: Renee Lustenhouwer

9:15 – 09:30

Relying On The External World: Inspection Behavior Reveals Offloading Strategies In Visual Working Memory After Brain Injury

Memory concerns are common in the ageing population, and are often reported after acquired brain injury. Capacity tasks are generally used to differentiate between normative and deviant memory performance. However, capacity tasks fall short in mimicking actual memory usage in everyday life, where individuals can rely on the external world by (re)inspecting information as needed (i.e., offloading). Reluctance to use full memory capacity has been repeatedly found in healthy individuals. We hypothesized that those with impaired memory would rely even more on the external world to alleviate memory burden. Eye-movements were studied in patients with different levels of memory function (as measured by neuropsychological capacity tasks). We recruited individuals with severe amnesia (Korsakoff's syndrome; n=24), individuals referred to an outpatient memory clinic (n=29), individuals recovering from stroke (n=15), and matched healthy controls (n=38). We assessed how often participants inspected external information when performing a copy task.
Individuals with a memory impairment relied more on the external world, as shown by a higher number of inspections. Memory capacity was partly predictive of inspection behavior: lower capacity related to more inspections, but mere capacity could not fully account for the heavy reliance on the external world in patients and controls. In fact, participants generally did not memorize more than two items at once. Even when memory was intact, memory capacity was rarely fully used. Although there were some differences across patient populations that may be attributable to impairments in other cognitive domains, we conclude that offloading is common among all groups, and is more pronounced when memory is impaired. In summary, capacity tasks only partly translate to actual memory deployment, and disguise nuances in everyday memory usage. The (clinical) assessment of memory functioning should acknowledge these nuances and the use of strategies.

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9:30 – 09:45

A Non-Verbal Gaze-Based Assessment Of Cerebral Visual Impairments In Young Children

Cerebral Visual Impairment (CVI) refers to visual processing and perception deficits that result from abnormal brain development or early brain damage. Visual selective attention (VSA) deficits are a core characteristic for children with CVI. Therefore, search tasks are an important part of the neuropsychological assessment of CVI. However, these tasks require a certain level of verbal and motor skills, which complicates the assessment for children below 6 years of age.

In this multicenter study, we have adapted our previous visual test to a screening test for VSA deficits in children aged 1 to 5. Four gaze-based search tasks were executed on an eye tracker to exclude any necessary verbal instructions and verbal or motor responses. Here, we will present the results of 54 children at risk of CVI (Mean age: 49 ± 17 months) and 93 neurotypical children (Mean age 43 ± 16 months).

Preliminary data shows that neurotypical children develop visual search skills between 1 and 5 years of age with respect to target accuracy and reaction time. Compared to neurotypical children, an overall visual search impairment was found in children at risk of CVI, regardless of age, visual acuity or developmental levels.

These preliminary results are consistent with studies on older children with CVI and studies on daily symptoms in children with CVI. The study adds that non-verbal gaze-based visual search tasks may provide a new tool to assess VSA in children and are promising for early screening, and therefore early intervention, of children with CVI.

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09:45 – 10:00

Statistically But Not Clinically Significant Cortical Thinning In Age-Related Macular Degeneration

It is well-accepted that bilateral visual deprivation due to age-related macular degeneration (AMD) leads to decreased grey matter density and thickness in the visual cortex. However, it is unclear whether this effect is only measurable when comparing population means, or whether it could be used as a predictive biomarker for identifying patients that are less likely to benefit from treatments that are aimed at restoring vision at the level of the retina.

We used the large-scale population-based UK Biobank database. Applying stringent exclusion criteria, we included 21575 healthy participants and 71 participants with bilateral AMD, aged 44-82 years at time of imaging. T1-weighted MRI data were analysed to determine cortical thickness in V1, V2 and V3. Generalized linear models (GLM) were used to study group effects of cortical thickness and age. Normative models of cortical thickness against age were established using GAMLSS (generalized additive models for location, scale and shape) to study whether cortical thickness can be used as a biomarker at the individual level.
The GLMs show a significant main effect of group and group by age interaction in the left hemispheres of V1 and V2, between 0 and 10 degrees of eccentricity. These results are in line with previous research showing decreased cortical thickness in participants with AMD. However, individuals with AMD are firmly confined within the normative range of healthy participants, without any clear outliers. These results are independent of possible neurodegenerative changes in the adjacent white matter, as characterised by NODDI modelling. Thus, even though population differences can be detected, the amount of thinning is small and does not appear to push patients outside the normal healthy range. This is reassuring news for the most promising treatments of AMD that rely on the assumption that the cortex remains functionally intact.

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10:00 – 10:15

Task-Specific Strategies In Visual Working Memory Use
Visual working memory (VWM) allows to temporarily store visual information for imminent goal-directed behavior. VWM is typically studied through experimental paradigms that enforce a specific behavior (e.g., forced recall of a previously presented memorandum). There has been a recent surge, however, in the use of paradigms that naturally engage VWM. The copying task, for instance, requires participants to reproduce an arrangement of colored polygons, in an adjacent 'workspace' area, by dragging items from a pool stimuli (akin to a jigsaw puzzle). Completing such open-ended tasks draws upon VWM (to keep the example image available), but does not enforce any specific approach to accomplish the overarching goal. Items can be inspected multiple times, memorized simultaneously or consecutively, and in any order. In the current study we asked to what extent observers adhere to systematic behavior during open-ended VWM tasks, and whether systematicity benefits performance.
187 participants completed 10 different copying task arrangements in two different environments; a controlled lab environment, and a science festival venue. We observed a

striking similarity in copying task behavior across participants and environments, suggesting that different people tend to choose the same approach when facing the same task, regardless of the environment. Participants systematically copied the arrangements from left to right, and top to bottom. The extent to which they adhered to this systematic approach, however, did not predict completion time. We hypothesized that systematicity may be particularly beneficial when the task demands approach participants' memory limits. To test this, we reanalyzed published copying task data of 24 patients with severe memory impairments (Korsakoff syndrome). Here, using a systematic approach predicted better performance. These findings highlight the importance of considering the specific task-context in which VWM is engaged, to obtain a richer understanding of VWM, and provide applications both for the clinic and for everyday life.

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10:15 – 10:30

Looking From Different Angles: Alternative Perimetry Methods Complement Each Other

Introduction
Standard Automated Perimetry (SAP) is challenging for many patients and can yield unreliable results. The requirement for prolonged fixation and the need for button-press feedback often lead to repeated tests, placing a burden on patients and ophthalmological care units. Recently, several new perimetry methods have been developed to address these issues, each relying on different but potentially complementary types of information. This study aims to compare two novel approaches for visual field assessment in two participant groups, evaluating their effectiveness in detecting and reconstructing visual field defects.
Method
Participants watched 1-minute movie clips while their gaze and pupil size were recorded using an eye tracker. The study included 32 participants with glaucoma and 20 participants with hemianopia, alongside a control group of visually healthy individuals matched in number. Two distinct methods were applied to the collected data:
Saccade-Based Method: This approach focuses on the saccade characteristics, contrasting those of visually impaired participants with age-matched controls.
Pupil-Size-Based Method: This method uses the pupil data recorded during the same eye-tracking measurements.
The performance of each method was evaluated to determine their individual and

complementary effectiveness in detecting visual field defects.
Results
Preliminary results indicate that the saccade-based approach performed well in distinguishing participants with glaucoma from controls and reconstructing their visual field defects. However, its precision in reconstructing the visual field for hemianopic participants was limited, potentially due to adaptive viewing strategies. Conversely, the pupil-based method was unaffected by such strategies and reliably identified quarter- and hemifield damage. Nonetheless, it was less effective in differentiating glaucoma patients from controls.
Conclusion
Our findings suggest that these novel perimetry methods, based on movie-watching data, offer complementary strengths. Specifically, a data-driven combination of their visual field predictions could serve as a promising alternative to Standard Automated Perimetry for specific patient groups.

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10:30 – 10:45

The Effects Of Central And Peripheral Vision Loss On A Naturalistic Search Task: Shopping In Virtual Reality

Worldwide, over 200 million people have a visual impairment, with many having either central or peripheral vision loss. The consequences of these types of vision loss on daily visual functioning are not completely known, particularly because previous screen-based studies lacked real-life representativeness, both in terms of task demands and the degrees of freedom in participants' movements. Therefore, our aim was to investigate the effects of central and peripheral vision loss on search behaviour in a naturalistic visual search task, using simulated scotomas.
Participants (n=45; data collection ongoing) performed a search task in a 3D virtual reality (VR) supermarket environment, using a gaze-contingent display to simulate visual impairments. Participants were allocated to one of three conditions: full vision, central

vision loss (simulated by a six degree mask), or peripheral vision loss (simulated by a six degree window) in a between-subject design. Each participant performed four tasks, each consisting of a sequence of four product searches, on the basis of a memorised shopping list, and under different levels of contrast. We compared search performance, navigation, and gaze/head/body coordination between the three conditions.
Search times increased with central and peripheral vision deficits, but more so with peripheral deficit. Contributing factors to this slowing were that peripheral deficit resulted in a slower movement speed, and in more collisions with obstacles per travelled distance. While fixation rate did not differ, peripheral deficit resulted in smaller saccades, and central deficit resulted in shorter fixations. We also assessed orienting behaviour and visual selectivity as a function of search time.
Central and peripheral vision loss simulations both decreased search performance in a realistic search task in VR. The task provided detailed information on which behavioural aspects are, and which are not, affected by certain types of vision loss, contributing towards enhanced understanding daily functioning with a visual impairment.

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Talk session 2A – Emotion, face perception & working memory
11:30 – 13:00, Ruppert 040

Chair: Samson Chota

11:30 – 11:45

Dissociating Internal And External Attentional Selection

Just as attention can shift externally towards relevant objects in the visual environment, it can also shift internally towards currently relevant items within Visual Working Memory (VWM). Internal and external attentional shifts share a surprising majority of neural and behavioral correlates, suggesting fundamentally similar underlying neural mechanisms. Recent work has shown that spatial attention is automatically directed towards the previous location of an attended memory item, similar to how it is directed towards the locations of perceived stimuli during sensory processing. When attending memory items, however, there is no sensory information to be processed at the attended location. Thus, we asked whether internal attention – akin to external attention – enhances sensory processing. In two EEG experiments, we compared location-specific sensory enhancements during the attentional selection of external (perceived) versus internal (memorized) stimuli. Both cases showed biases in alpha-power and gaze-position towards locations of attended items, confirming an inherent spatial organization within VWM. Crucially however, Rapid Invisible Frequency Tagging (RIFT) revealed enhancement of sensory processing only during external attentional selection. Furthermore, we found no clear relationship across trials between alpha lateralization and sensory enhancement (measured through RIFT) during external attention, suggesting that these two metrics reflect distinct cognitive mechanisms. Our findings suggest that VWM is not blindly recruiting existing mechanisms of external attention for prioritization, but instead uses space as an organizational principle to store and select memories.

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11:45 – 12:00

Peripheral Visual Working Memory During Maintenance And Selection

Visual working memory (VWM) enables the retention of sensory information in an accessible state until it is required for behavior. Vision, however, changes with eccentricity in terms of both feedforward and feedback signals, and it remains unclear if and how these differences affect VWM. In a previous study, we found no significant differences in VWM representations between peripheral and foveal stimuli, as initially location-specific memory representations transitioned into generalized representations during maintenance and response preparation. In this study, we increased the item load to two and used a retro-cue to investigate how VWM handles the maintenance and the selection of peripheral stimuli, again focusing on the generalizability of memory representations. Participants (N=30) were presented with two sinusoidal gratings at 15 degrees of visual angle (dva), followed by a cue as to which one would be tested at the end of the trial. Following the cue, a high-contrast, task-irrelevant impulse was presented to trace potential changes in activity-silent memory representations. EEG and gaze position were recorded throughout the trials. Multivariate EEG analyses replicated earlier findings, showing location-specific encoding and maintenance in the initial phase, with no detectable signals while memory items were visually present. The results suggest that while representations of both items were location-specific before selection, they became more generalized after selection. Interestingly, representations of task-irrelevant items persisted, indicating that passive deselection is insufficient for their removal from VWM. These findings provide insight into how VWM manages peripheral memories during maintenance and selection.

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12:00 – 12:15

Music And Emotional State Influence Visual Processing Speed

A key challenge for sensory systems is to rapidly process the continuous stream of incoming information, segregating separate events over time. In some tasks, "seeing fast" can be helpful, while in other situations there may be a speed/accuracy tradeoff such that slow accumulation of evidence leads to better performance. In a series of online and in-person experiments, we have measured visual processing speed as a function of both the "state" of the participant (their emotional state, also influenced by mood induction procedures) and the "traits" of the participant.
As expected, we were able to shift the reported emotional state of participants using a musical mood induction procedure. Across studies, we found that reported mood influenced visual speed of processing. These effects were modulated by individual differences of the participants in terms of traits such as anxiety and sensory sensitivity. Overall, the pattern of results suggest that visual temporal acuity can fluctuate between fast visual segregation and slower, more integrative processing, with this being shifted by listening to music. Such fluctuations might depend on the efficiency of the visual system in

rapidly responding to sensory input, linked to alterations in arousal, or to a strategic need to balance between temporal integration and segmentation.

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12:15 – 12:30

The Nose Knows: Capturing Facial Attractiveness With Functional Infrared Thermal Imaging

Facial attractiveness plays a pivotal role in shaping first impressions, social interactions, and romantic relationships. However, objectively measuring experienced attractiveness remains challenging due to the subjective nature of beauty and the cultural variability in preferences. While factors such as facial symmetry, averageness, and proportions offer some insights, they fail to fully account for the complex mix of individual tastes, cultural influences, and intangible traits like charisma and charm. In this study, we explored the potential of using functional infrared thermal imaging (fITI) to objectively assess facial attractiveness. Participants rated the attractiveness of randomly selected faces using a slider, and we found that nose temperature significantly increased or decreased when participants rated faces as attractive or unattractive, respectively. Notably, significant temperature differences emerged four seconds after the images were displayed, with female faces' mean attractiveness positively correlating with changes in nose temperature. This study highlights the potential for using fITI as an objective measure of facial attractiveness.

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12:30 – 12:45

Looking Into Working Memory To Verify Potential Targets During Search

Finding what you are looking for is a ubiquitous task in everyday life that relies on a two-way comparison between what is currently viewed and internal search goals held in memory. Yet, despite a wealth of studies tracking visual verification behavior among the external contents of perception, complementary processes associated with visual verification among internal contents of memory remain elusive. Building on a recently established gaze marker of internal visual focusing in working memory, we tracked the internal inspection process associated with confirming or dismissing potential targets during the search. We show how we look back into memory when faced with external stimuli that are perceived as potential targets and link such internal inspection to the time required for visual verification. A direct comparison between visual verification among the contents of working memory or perception further revealed how verification in both domains engages frontal theta activity in scalp EEG, but also how mnemonic verification is slower to deploy than perceptual verification. This establishes internal verification behavior as an integral component of visual search, and provides new ways to look into this underexplored component of human search behavior.

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12:45 – 13:00

Statistical Learning Of Task Relevance, Rather Than Stimulus Prevalence, Improves Visual Working Memory Recall

Our visual environment often overwhelms us with more information than we can process. We can, however, enhance our processing efficiency by leveraging inherent regularities, such as prioritizing likely target objects over unlikely ones. Although there is some evidence that statistical learning improves visual working memory recall, it is unclear whether this improvement originates from the statistical learning of stimulus prevalence or task relevance. To distinguish between these hypotheses, we examined whether frequent appearance or frequent probing of target stimuli (or both) contributes to improvements in visual working memory recall. Participants were asked to recall and replicate the orientation of one of two previously presented Gabors as precisely as possible. In two experiments, we manipulated (1) stimulus prevalence by presenting Gabors more frequently on one side (either left or right), and (2) task relevance by probing Gabors more frequently on one side (either left or right). We found comparable orientation recall performance for to-be-remembered stimuli appearing at probable versus improbable locations, which suggests that regularities in stimulus prevalence did not improve memory recall. Contrastingly, we found better recall for to-be-remember items that were more versus less likely to be probed. Specifically, task relevance enhanced working memory recall, both by reducing the number of large/categorical errors (>45 degrees) and by

increasing fine-grained recall precision (smaller response variance <25 degrees). These findings highlight that statistical learning enhances visual working memory recall, where the improvement is driven by task relevance, but not by stimulus prevalence.

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Talk session 2B – Eye movements and pupillometry
11:30 – 13:00, Ruppert 042

Chair: Freek van Ede

11:30 – 11:45

Uncovering Covert Attention In Complex Environments With Pupillometry
Spatial visual attention prioritizes specific locations while disregarding others. It can be deployed by either moving the eyes (overt) or without eye movements (covert). Covert attention's spatial dynamics are exceptionally difficult to measure due to its hidden nature, especially when observers constantly shift attention, such as in dynamic environments. One way to implicitly index covert attention without overt responses is via pupillary light responses (PLR), as the strength of PLR is modulated by where attention is. However, such effects have only been studied using simplistic stimuli. Here we report on a novel pupillometric method that tracks covert attention with dynamic videos. Participants (n = 36) watched movie clips while they either passively viewed the movie, or they top-down shifted covert attention to the left, right, or both sides of the visual field. Using a recently published toolbox (Open-DPSM), we evaluated whether luminance changes in regions presumably receiving more attention would contribute more to the pupillary responses – and thereby reveal covert attention. Three independent effects of covert attention on pupil responses were found: (1) a bottom-up effect suggesting more attention drawn to dynamic regions in the movie, (2) a top-down effect showing shifted attention towards the instructed spatial direction, and (3) an overall tendency to deploy covert attention leftwards (i.e., pseudoneglect). These findings suggest that pupil responses can physiologically index covert attention, even in highly dynamic and complex environments, which presents the potential for measuring the spatial distribution of covert attention in real-life scenarios.

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11:45 – 12:00

Does (A Lack Of) Visual Attention During Face-To-Face Conversations Influence People's Perceptions Of Feeling Heard?
Feeling heard is a crucial factor in how people experience social interactions and shape their relationships. It encapsulates people's perceptions of feeling listened to and

understood by others. As gaze behavior during social interactions may signal people's interest, attentiveness, and liking toward others, we investigated whether being 'visually attentive' to others during face-to-face conversations would affect their perceptions of feeling heard. In total, 49 participants (student sample) engaged in two face-to-face interviews with interviewer-confederates. Both participants' and interviewers' gaze were measured with a wearable eye tracker. In one interview, the interviewer did not look at the participants' face most of the time–the 'ignore'-interview–whereas in the other interview the interviewer maintained normal levels of gaze towards the participant. After each interview, participants were asked whether they felt that the interviewer was being attentive, understood them, and listened to them; whether they felt heard. Participants' perceptions of feeling heard were, on average, significantly lower in the 'ignore'-interview ($M=3.87$, $SD=0.68$) than in the 'normal'-interview ($M=4.51$, $SD=0.36$, $t(48) = 6.44$, $p < .001$, $d = .90$). Finally, we investigated whether (a lack of) visual attention also influenced participants' gaze behavior at the interviewer's face. We found that participants' gaze behavior at the interviewer's face was not significantly different between the 'ignore'-interview and the 'normal'-interview ($t(48) = 1.62$, $p = 0.111$). Participants' perceptions of feeling heard were influenced by (a lack of) visual attention from the interviewer, but participants' gaze behavior at the interviewer's face was not influenced by (a lack of) visual attention from interviewer. This suggests that participants do not (try to) gaze more (or less) at the interviewer when they are being 'visually ignored' by the interviewer. Future research could focus on understanding when and for whom social gaze is related to perceptions of feeling heard.

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12:00 – 12:15

Spontaneous Fluctuations In Pupil Size Shape Retinal Responses To Visual Stimuli

Visual perception is shaped at the earliest stage by the size of the eye's pupil, which determines how much light enters the eye and how well this light is focused. But the exact role of pupil size in visual perception is still poorly understood. We recorded pupil size and electrical activity from the retina and brain while healthy human participants viewed full-screen flashes. We found that early retinal responses, which peaked ±25 ms after stimulus onset and predicted subsequent activity over visual cortex, were strongly affected by stimulus intensity. Importantly, pupil size, at least within the range of naturally occurring

fluctuations, did not affect the amplitude of these early retinal responses, despite resulting in substantial changes in retinal light exposure. However, the direction of pupil-size change at the moment of stimulus presentation did modulate the amplitude of early retinal responses, which were enhanced during phases of dilation as compared to constriction. Based on these results, we suggest that fast-acting adaptation processes may normalize early retinal responses with respect to changes in retinal light exposure that result from spontaneous changes in pupil size: an initial form of brightness constancy. These results shed new light on, and raise important and previously unasked questions about, the role of pupil size in visual perception.

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12:15 – 12:30

Ganzfeld-Induced Perceptual Deprivation And Its Effect On Consciousness: The Interplay Between Abstract Cognition And Perceptually Grounded Thoughts

Viewing a Ganzfeld (GF), i.e., a homogeneous visual field containing no shapes nor objects of focus but merely homogeneous field, results in a peculiar perceptual experience characterized by hallucinations and blackouts. These phenomena have been studied in the context of visual perception and consciousness, and have been used in artworks such as the light installations by James Turrell. Here, we focus on the perceptual effects and the elicited states of consciousness, using a mixed-method approach by combining behavioral and neural measures with questionnaires, rating scales, and interviews. First, 28 participants experienced an in-lab, cycloramic, red GF. Second, 45 participants experienced the in-lab GF with varying colors. Third, 67 participants experienced a GF artwork. In all 3 experiments, participants wore an EEG device and eye-tracking glasses, and they were given a dial to report occurrences of hallucinations and blackouts throughout the 25-minute GF session. A remarkable factor of the GF is the inward-directed thoughts it elicits. We found support for alterations in consciousness in all 3 experiments. Some participants described it as a "meditative" or "transcendental" experience, others stressed the elicited bodily sensations. This raises questions regarding the body's role and a potential interplay between abstract cognition (transcendental experiences) versus feelings and thoughts that are grounded perceptually, either directed inward (heart rate) or externally when experienced in relation with the external world (getting sucked into depth). The potential of vergence eye movements as a behavioral signature of internally directed cognition was explored and we found significantly more convergence of the eyes during hallucinations and blackouts compared to baseline. In addition, we found significant

positive relations between convergence and both alterations in consciousness and the occurrence of abstract cognition.

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12:30 – 12:45

The Effect Of Pupil Size On Near-Threshold Detection Is Not Modulated By Colour, Eccentricity, Or Adaptation-State

Pupil size determines the amount of light that enters the eye, as well as how that light is focused. Consequently, pupil size shapes visual processing but the exact mechanisms are poorly understood. In humans, pupil size has been shown to influence detection performance, whereby large pupils improve the detection of faint stimuli. However, the retina is composed of multiple types of photoreceptors that differ in their distribution, their overall light sensitivity, and the specific wavelengths of light that they are sensitive to. This raises the question of whether pupil size influences detection performance in the same way under different light conditions or when targets differ in their colour or eccentricity (i.e., position on the retina).
Across a series of three experiments, we tested a total of 124 participants and systematically varied the lighting conditions and target properties in a near-threshold detection task. Light conditions ranged from dark to dim to bright, with the dark condition including a period of dark-adaptation prior to task performance. Possible target colours were blue and red on a black background (in the dark condition), blue and red on a grey background (in the dim condition), or yellow and cyan on a white background (in the bright condition). Finally, possible target eccentricities ranged from parafoveal to peripheral, either in a continuous manner (experiment 3) or as two predefined near and far eccentricities (experiments 1 & 2).
Across all experiments we show that larger pre-stimulus pupil size is associated with improved detection performance. Importantly, this large-pupil advantage is not modulated by the colour or eccentricity of the targets, the illumination of the testing room, or whether or not participants are dark-adapted. Based on this, we conclude that the phenomenon is robust, indicating that pupil size affects vision in a behaviourally relevant manner, regardless of the exact conditions.

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12:45 – 13:00

The Effect Of Covert Visual Attention On Pupil Size During Perceptual Fading

Pupil size is modulated by various cognitive factors such as attention, working memory, mental imagery, and subjective perception. Previous studies examining cognitive effects on pupil size mainly focused on inducing or enhancing a subjective experience of brightness or darkness (for example by asking participants to attend to/ memorize a bright or dark stimulus), and then showing that this affects pupil size. Surprisingly, the inverse has never been done; that is, it is still unknown what happens when a subjective experience of brightness or darkness is eliminated or strongly reduced even though bright or dark stimuli are physically present. Here, we aim to answer this question by using perceptual fading, a phenomenon where a visual stimulus gradually fades from visual awareness despite its continuous presentation. The study contains two blocks: Fading and Non-Fading. In the Fading block, participants were presented with black and white patches with a fuzzy outline that were presented at the same location throughout the block, thus inducing strong perceptual fading. In contrast, in the Non-Fading block, the patches switched sides on each trial, thus preventing perceptual fading. Participants covertly attended to one of the two patches, indicated by a cue, and reported the offset of one of a set of circles that are displayed on top. We hypothesized that pupil size will be modulated by covert visual attention in the Non-Fading block, but that this effect will not (or to a lesser extent) arise in the Fading block. We found that covert visual attention to bright/ dark does modulate pupil size even during perceptual fading (Fading block), but to a lesser extent than when the perceptual experience of brightness/ darkness is preserved (Non-Fading block). This implies that pupil size is always modulated by covert attention, but that the effect decreases as subjective experience of brightness or darkness decreases. In broader terms, this suggests that cognitive modulations of pupil size reflect a mixture of high-level and lower-level visual processing.

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Talk session 3A – Non-visual perception
13:45 – 15:15, Ruppert 040

Chair: Ben Harvey

13:45 – 14:00

Soft Robotics For Haptic Interactions
To interact with the world around us, we use haptic information, for example we touch and manipulate objects. It would be hard to imagine how a real world without haptic interaction would be. However, this is what we experience in most digital worlds nowadays; we can not feel an object in virtual reality or touch our family through a videocall.
Although some haptic interaction is being implemented in applications such as virtual reality and entertainment, it is not often being used as a method to unravel more complex processes in perception. This is partly because of the complexity of the haptic system combined with the limited hardware availability. However to design new hardware, we need to know more about the human perceptual system to facilitate the right input for the hardware for our experiments.
In this constant iterative cycle of developing hardware and studying human perception, the TU/e Reshape lab works on soft robotic haptic interfaces and uses these for perceptual studies, e.g. soft robotic thimbles for the perception of virtual button clicks, soft actuators for apparent motion studies and small soft pins for tactile displays.
We would like to show our recent work on soft haptic actuators, including the results of several perceptual experiments on apparent motion, perceptual intensity of vibration and preliminary results of an experiment run at a science festival about how it would feel to high-five with non-human animals.

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14:00 – 14:15

Learning And Retention Of Vibrotactile Morse Code
For people with a combined visual and hearing disability a tactile mode of communication is very useful. Morse code can be presented in a vibrotactile way using 1 or 2 vibration motors. This means that it can be displayed using a smartphone or smartwatch allowing for tactile communication via commercially available devices. However, users would need to learn vibrotactile Morse code. Extensive learning periods can hamper adoption of assistive tools by users. In a previous study we have shown that a large portion of the vibrotactile Morse code alphabet can be learned within a single training session of 30 minutes. Here we studied retention of the vibrotactile Morse code alphabet after 45 minutes training on the next day and a week later. Nine out of ten participants were able to learn the full alphabet

after two training sessions. A week later the minimum retention rate was 60% and the maximum retention rate was 100%. Participants were able to recognize words, but word recognition decreased with word length. This shows that vibrotactile Morse code can be learned with only little time investment and that retention after a week of not using Morse code can be as high as 100%. However, our results also suggest that vibrotactile Morse code is likely most useful for shorter messages.

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14:15 – 14:30

Prior Knowledge And Context Biases Visual Memory For Body Postures

We constantly infer the world's state based on prior knowledge and current observations, enabling us to better react to the environment. This inference can sometimes distort our memory. We aimed to probe the effect of prior knowledge and context on the memory of a category of familiar and socially relevant stimuli—human bodies. In a series of experiments using both change detection and adjustment tasks, we revealed how visual memory of body postures is biased by two types of body-related prior knowledge: 1) Lifted limbs were remembered as lower, likely due to an embedded understanding of gravity's influence; 2) Extreme postures, such as lifting the arm far behind the back, were remembered as the less extreme postures, reflecting the expectation that backward movement is constrained by body biomechanics. Furthermore, by contrasting lifting arms in a more effortful position with a less effortful position, we observed that more effortful postures led to a larger downward bias, suggesting observers flexibly adapt their predictions based on the immediate context rather than relying on a fixed prior. Last, we explored whether the gravity-based and biomechanics-based biases stem from the same underlying process. By manipulating the memory delay, we found that the gravity bias appeared quickly (within 250 ms) and remained constant, whereas the biomechanical constraint bias took time to emerge and increased over time. This dissociation indicates that the knowledge of gravity is activated quickly while the knowledge of body biomechanics requires controlled processing. Overall, our findings demonstrated that visual memory for body postures is shaped by prior knowledge and the understanding of other people's current state, with distinct time courses depending on the sources of knowledge.

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14:30 – 14:45

Social Chemistry Science With Industry: A Decade Long Journey For Impact
Unlike the life and technical sciences, the social sciences do not have a strong tradition of collaboration with industry R&D. In this presentation I intend to take you through 10+ years of experience working with industry as psychologist on the topic of social chemistry, which refers to our common quest for the chemical compounds in human body odour that carry socially meaningful messages.
The main messages are that 1) Industry can leverage from the state of the art in psychological science on perception, psychophysics and cognitive neuroscience to improve and lend credibility to its own science, 2) Academics can benefit from the multidisciplinary capabilities present in R&D to more easily work across boundaries of chemistry, microbiology and engineering for insights and scale, 3) Impact with industry has many forms and can range from building authority as partners, supporting product claims, method development and product design. The science of psychology can contribute to all of these domains which can help jumpstart a future tradition. In the presentation these messages will be illustrated by concrete research projects and results.

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14:45 – 15:00

Decoding Auditory Working Memory Load From EEG Alpha Oscillations
Working memory (WM) enables temporary mental retention of task-relevant information for imminent use. Prominent WM models ascribe canonically distinct storage modules for both auditory and visual storage. Yet, most WM research to date focused on the visual modality and identified neuro-markers of visual WM load (e.g., contralateral delay activity; CDA). However, whether these neuro-markers also reflect auditory WM load remains largely unknown. Here, we investigated load-dependent neuro-markers of auditory working memory using EEG. We employed an auditory delayed change-detection task, in which participants memorized 1, 2, 3, or 4 pure tones differing in pitch. These tones were presented to the left or right ear, with a different auditory stream presented to the other ear. Participants were instructed to memorize the tones presented to one ear, while ignoring the other. Analyses of behavioral response data showed that auditory WM capacity plateaued

between two and three tones. Using multivariate pattern analyses, we found that patterns of alpha-band oscillations during the retention interval in posterior channels reflected auditory WM load. Mirroring the behavioral data, these load-specific EEG responses allowed to distinguish between individual load conditions up until –but not above– individual capacity limitations, as established from the behavioral data. Next, we questioned whether auditory WM load is reflected in lateralized neural responses, akin to the CDA for visual WM load. We subtracted ipsilateral from contralateral EEG responses and analyzed whether this difference waveform differed between the four load conditions. Surprisingly, auditory WM load was not reflected in lateralized responses, neither in the time nor in the frequency domain. This implies that the CDA is a modality-specific rather than supra-modal marker for visual WM load. Our results show that patterns of posterior alpha-band activity provide a novel neuro-marker of auditory WM load.

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15:00 – 15:15

Urban Air Mobility noise assessment and public acceptability

People are constantly being exposed to different sounds in their environment. Some of these noise, mostly from human-made sources, can lead to annoyance which is associated with depression and anxiety and can lead to various negative health effects. Within NLR we research noise annoyance to different aerospace related sources, such as conventional aircrafts but also a new generation of sound sources, such as Urban Air Mobility (UAM), consisting of drones and electric vertical take-off and landing (eVTOL) aircrafts, also known as “air taxis”. We do this by looking at annoyance in relation to the sound source, but also looking broader than that by incorporating non-acoustic factors that may impact annoyance in our studies. To do so, we often use Virtual Reality, where we simulate a flyover of a drone or other type of aircraft in a pre-recorded environment. In this presentation we explain this method in more detail, as well as different case studies regarding sound perception toward Urban Air Mobility.

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Talk session 3B – Visual perception
13:45 – 15:15, Ruppert 042

Chair: Chris Klink

13:45 – 14:00

Groundwork For Applying Rapid Invisible Frequency Tagging (Rift) To Study Neural And Cognitive Processing In Naturalistic Vision

Frequency tagging is a widely used technique in EEG and MEG studies to investigate selective stimulus processing by embedding periodic signals into stimuli. Traditional frequency tagging relies on low-frequency signals (< 30 Hz), which can interfere with task-related processes and endogenous neural oscillations. Recently, Rapid Invisible Frequency Tagging (RIFT), a novel high-frequency method enabled by advanced projection technology, has been developed. RIFT uses high-frequency signals to leave endogenous oscillations intact while remaining undetectable, making it a promising tool for studying naturalistic vision.
However, previous RIFT studies have typically used simple and/or a limited number of stimuli in fixated designs, restricting naturalistic exploration. To fill this gap, we designed a paradigm where participants freely explored a scene containing four object stimuli at variable retinotopic locations, each tagged with a distinct frequency. MEG and eye-tracking data were recorded throughout the experiment.
When participants fixated at one of the four stimuli, the coherence of the corresponding frequency increased during the whole fixation, showing that RIFT can reliably used with short, variable, and transient fixation periods. Interestingly, coherence also increased before the fixation, suggesting pre-saccadic neural processing of to-be-fixated targets.
These preliminary findings demonstrate the feasibility of using RIFT in free-viewing visual experiments to track neural and cognitive processes. This opens new avenues for studying perception, attention and dynamic neural processing in naturalistic settings.

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14:00 – 14:15

Population Receptive Field Size Across Cortical Depth Along The Visual Hierarchy

In the visual cortex, population receptive field (pRF) size increases both with eccentricity and when moving up along the visual hierarchy. Previous functional magnetic resonance

imaging (fMRI) and neurophysiology studies found that in the primary visual cortex (V1), pRF size varies across cortical depth according to a U-shaped function, with the smallest pRF sizes in central layers. This U-shaped pattern is thought to reflect the hierarchical information flow across cortical depth, where the information arrives in central layers and is further processed in superficial and deeper layers. However, it is still unknown how pRF properties are organized across cortical depth in later visual areas.
Here, we use population receptive field modeling at ultra-high field (7T) functional MRI to investigate pRF size variation across cortical depth and along the visual hierarchy (i.e. V1-hV4, LO-1 and LO-2) at sub-millimeter resolution (0.8mm isotropic). Functional data preprocessing included thermal denoising, susceptibility distortion correction, motion correction and high-pass filtering. Both anatomical and functional data were upsampled to 0.4mm isotropic resolution. Anatomical images were co-registered to functional images, segmented into gray matter, and divided into eight equivolumetric cortical surface layers. Our results show that in V1, pRF size follows the expected U-shaped function with cortical depth. In V2 and beyond, our preliminary results did not reveal a clear U-shaped function potentially suggesting a different association between pRF size and cortical depth. This study brings new evidence on the laminar organization of pRF properties along the visual hierarchy that require further investigation.

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14:15 – 14:30

A Continuous Psychophysics Approach To Measuring The Spatio-Temporal Characteristics Of Visual Crowding

Visual crowding refers to the difficulty of recognizing objects when surrounded by clutter, particularly in the peripheral visual field. While traditional trial-based paradigms effectively measure the spatial aspects of crowding, they do not capture the temporal dynamics. In this study, we investigated the feasibility of a continuous psychophysics paradigm that measures the spatial extent and temporal processes of visual crowding.

Eight participants continuously tracked the orientation of a rotating Landolt-C while the distance between the target and its flankers varied systematically over time. Participants adjusted a reference stimulus to match the target's orientation. The paradigm also included 'jump-points', during which the target's orientation suddenly shifted, allowing us to measure how quickly participants recovered (recovery rate) from tracking errors after these shifts. We compared tracking accuracy between flanked and isolated conditions and used participants' report errors to assess both the extent of crowding and the temporal recovery rate from the jumps. These results were compared to those obtained from a conventional trial-based version of the paradigm. The recovery rate was determined by fitting an exponential decay function to participants' report errors following the jumps.
Our results showed that the crowding extent measured with the continuous paradigm was consistent with that obtained using trial-based methods and aligned with Bouma's rule. Furthermore, flankers reduced both tracking accuracy and the recovery rate following sudden orientation changes. These findings demonstrate that our continuous psychophysics paradigm is a feasible tool for measuring the spatio-temporal aspects of crowding.

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14:30 – 14:45

Multistable Grouping Beyond The Dot Lattice: Individual And Contextual Differences In Interactions Of Global Orientation And Local Shape

Previous research on perceptual grouping has focussed on discovering and understanding grouping principles and their interactions on both a group and individual level. However, the studied set of grouping principles does not consider the complexity of interactions between the local and global level. In this study, dot lattices were adjusted to have various oriented shapes as elements (i.e., circles, squares and triangles). In isolation, equilateral triangles are inherently ambiguous, perceptually pointing in one of three possible directions. However, a clustered presentation alters this ambiguity, leading to a "pointing bias" (i.e., in case of "axis-alignment" in the direction of the axis, in case of "base-alignment," orthogonally to this shared base). In addition to proximity, the use of triangles as elements in the lattice provides a direct (i.e., alignment of the shape's side and the global orientation promoting good continuation) as well as an indirect grouping cue (i.e., perceived pointing in local triangles as a result of its global reference frame) promoting global groupings. Using hierarchical Bayesian modelling, we replicated the well-studied proximity effect. In addition, the introduction of shapes as elements resulted in a dampening of the proximity effect, regardless of the nature of the shape. The grouping effect of triangles, however, was dependent on the grid characteristics and differed between individuals. In a grid with small elements, most participants adhered to grouping by

pointing. When the size of the elements was increased, resulting in higher element density, there was a shift towards grouping by base-alignment. In both grid types a relatively large group of participants did not exhibit consistent grouping by alignment nor pointing. These results confirm that oriented shapes can function as grouping cues in both a direct (i.e., alignment) and indirect (i.e., pointing) manner. Moreover, it emphasizes the importance of studying individual differences in perceptual grouping.

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14:45 – 15:00

Using Gibbs Sampling With People To Characterize Perceptual And Aesthetic Evaluations In Multidimensional Visual Stimulus Space

Aesthetic appreciation is intrinsically multidimensional: our aesthetic experiences are influenced by a variety of stimulus dimensions (e.g., colors, shapes, sizes). However, the majority of empirical aesthetics studies used either parametrically controlled unidimensional or non-parametrically controlled multidimensional stimuli, which prevented insight into the relative contribution of each stimulus dimension or any potential interactions between them to perceptual and aesthetic evaluations. To fill this gap, we combined two recent developments: the Order & Complexity Toolbox for Aesthetics (Van Geert, Bossens, & Wagemans, 2023), which generates multidimensional parametrically controlled stimuli, and Gibbs Sampling with People (Harrison et al., 2020), which efficiently characterizes subjective evaluations in multidimensional stimulus space. In five studies, we used this innovative technique to estimate multidimensional probability distributions for both perceptual (order and complexity) and aesthetic evaluations (pleasure and interest) in various visual multidimensional parametric stimulus spaces. In contrast to unidimensional or non-parametric approaches, our multidimensional parametric approach enabled us (a) to provide richer results and interpretations, (b) to assess the relative contributions of different stimulus aspects, and (c) to determine whether interactions between stimulus dimensions were important. This investigation taught us, for example, that when studying appreciation, both absolute and difference values must be considered, and that the different feature dimensions studied (i.e., colors, shapes, sizes) acted relatively independently on appreciation.

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15:00 – 15:15

Mapping The Importance Of Image Region Pleasure And Interest For The Perception And Appreciation Of Art Photographs And Paintings

Images often contain details that invite further exploration. To study their impact on perception and appreciation, we define 'details' quite broadly as all possible image inhomogeneities and acknowledge that they can differ widely in size and importance. Some image regions contain more of these details than others. We investigate whether viewers inspect these image regions more frequently or for longer durations compared to other image regions. To address this question, we have developed image aesthetic maps as a technique to map the importance of local image regions across the whole image. We will present preliminary findings of two experiments. In the first experiment, we used image aesthetic maps to map the local aesthetic density of 80 images of paintings and artistic photographs selected based on a previous validation study. The images were first decomposed into rectangular-shaped patches, which were then rated by 432 online participants on their importance for the pleasure of, and interest in, the whole image. These ratings were pooled, averaged, and smoothed, resulting in one pleasure density map and one interest density map per image. In the second experiment, we recorded eye-movements of 43 participants inspecting the same images, followed by an aesthetic rating task, to investigate whether the local aesthetic density of an image predicts the visual inspection and aesthetic appreciation of that image. Pleasure and interest maps both significantly predicted visual attention to images. Moreover, a semi-partial correlational analysis indicated that both explained visual attention beyond low-level saliency (but not Deep Gaze IIe) and that interest explained slightly, but significantly more unique variance in visual attention than pleasure maps. A time-binned analysis indicated that these findings were similar throughout the viewing time. We are currently exploring whether visual attention to important image regions is also predictive of the aesthetic rating ascribed to that image.

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Abstracts – Posters

P1

Against All Odds: Randomness Outperforms Human-Inspired Methods In Identifying Aesthetically Important Areas.

Computational aesthetics aims to create computational models capable of appreciating aesthetics based on the underlying aesthetic principles. As aesthetic judgment is inherently human-centric, emulating the human visual system offers a promising avenue for enhancing aesthetic assessment models.

Vision transformers, known for their ability to capture global features and process variable-size images, have demonstrated compelling efficacy in image aesthetic assessment. However, their performance can be compromised by downscaling and cropping images to small sizes for computational efficiency and batch processing. To address this limitation, we propose a method inspired by the human visual system that prioritizes complex, visually interesting areas and sharp details by preserving them in high resolution while downscaling less relevant regions. These regions are identified using frequency, entropy, gradient, and saliency maps.

We compare our proposed approach to random region selection and fine-tune a vision transformer on the AVA and AADB aesthetic datasets. This allows us to investigate the impact of different methods for selecting important image regions for aesthetic assessment. Surprisingly, random selection consistently outperforms deterministic methods. This can be attributed to the susceptibility of vision transformers to overfitting, requiring large datasets for effective generalization. The small size of existing aesthetic datasets exacerbates this overfitting issue, making randomness a pivotal factor in mitigating it. Additionally, random sampling of aesthetic-related regions can better capture the subjective and often unpredictable nature of beauty by providing a more representative representation of the entire image.

Our findings challenge the prevailing assumption that human-like approaches are essential for machine perception of aesthetic quality. Future research could explore alternative methods for selecting important regions, such as using proto-objects, to potentially improve performance.

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P2

Examining The Precision Of Spatial Representations Within Visual Cortex

The representation of information across space is fundamental to visual perception. It is well known that the visual field is not uniformly organized within visual cortex. How does the organization of visual cortex contribute to the precision in spatial representations? In the present study, we aim to extend the current understanding of spatial representations, by examining the precision of these representations along the continuum of angular location. Participants viewed a

small checkerboard (0.5 degree visual angle) briefly presented (500 ms) at random locations along an iso eccentric circle (2.5 degree eccentricity). After a short delay, participants reported the target's location by moving a probe along the circle to the perceived location as precisely as possible. Analysis of the behavioral results shows that this simple spatial localization task resulted in large, systematic misrepresentations of angular location (up to ± 10 degrees mean angular error), consistent with prior reported categorical biases. In order to examine the precision in these behavioral judgements, we removed these location-dependent repulsive biases from the data, grouped trials into bins based on the presented location, and computed the variance of the behavioral errors across trials within each bin. We found that behavioral variability varied as a function of angular location: behavioral judgements had the greatest precision at the horizontal meridian, and the least precision, or largest perceptual uncertainty, in angular position at off-cardinal locations. In ongoing work, we will investigate the degree to which these behavioral values of precision can be linked to fMRI measures of precision in the visual cortex. Together, these findings will provide insights into the neural implementation of spatial representations in the human visual cortex.

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P3

Individual Differences In Personal Wayfinding Preferences In People With Visual Impairments

People with visual impairments (VIPs) often participate in orientation and mobility (O&M) training to learn how to navigate to their chosen target locations. We investigated individual differences in navigational strategies and preferences during route-learning. For this purpose, interviews were held with 11 VIPs and 11 O&M trainers. We concluded from our thematic analysis that, depending on the severity of the visual impairment, VIPs tend to choose and fall back on one the following strategies: a strategy with a focus on hearing (e.g., using echo-localization), a focus on haptics (e.g., using a cane to identify landmarks), a focus on sight (e.g. using contrast), or a combination of cues. We also found differences in personal preferences regarding level of independence (e.g., frequency of asking for asking for help, or amount of preparation for the journey) and level of confidence (e.g., attitude towards making errors while navigating).

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P4

Can We Use Ignored Spatial Predictive Context During Visual Search?

The brain can learn and exploit statistical regularities, or predictive context, to guide our perception and behavior. Within visual search, spatial predictive context reliably improves behavioral performance, a phenomenon known as contextual cueing. While both learning and exploitation appear to take place outside of the searcher's awareness, the role of attention in this process is not fully understood.
We tested the role of feature-based attention in contextual cueing. Participants (N=99) searched visual search scenes containing distractor L shapes in two colors (black and white). The target letter T was either black or white, alternating per block and indicated to the participant. Participants could therefore ignore the irrelevant color. We manipulated which scene context (i.e., distractor configuration) was repeated and could therefore be learned: either the attended context, the ignored context, both, or neither was repeated. After several blocks of learning, we switched the color of the target, without participants being aware of this transfer. Effectively, context that was previously ignored became relevant, thus attended, and vice versa.
Our results show that not only attended, but, surprisingly, also ignored visual context was learned and used to improve search behavior, but only when the attended context was unproductive. Additionally we see no sudden increase or decrease in search behavior after transfer. Instead, previously attended context is slowly ignored. We hypothesize these results are indicative of a tug of war between automatic extraction of predictive spatial context on the one hand, and the goal-driven suppression of irrelevant context on the other.

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P5

Exogenous Covert Attention Modulates Foveal Processing Through Predictive Remapping

Covert attention to peripheral items has consistently been linked to improved perceptual processing of visual information, such as enhanced contrast sensitivity. Despite extensive research over the years, the mechanisms behind these perceptual improvements remain unclear. In this study, we tested a novel hypothesis: that enhanced visual perception during covert attention results from a neural remapping from peripheral retinotopic brain areas to the foveal visual cortex. To test this, we examined whether covert attention to a peripheral stimulus affects the perception of a stimulus presented at central fixation, while strictly controlling for eye

movements. In two experiments, participants indicated whether the orientation of a centrally presented Gabor patch was tilted clockwise or counterclockwise. Four peripheral Gabor patches were briefly presented (for 30 ms) either before, during, or after the central Gabor. An exogenous cue was used to direct covert attention to one of the peripheral patches. Our findings revealed that, when the cued peripheral Gabor was presented before the central one, the perceived orientation of the central Gabor was systematically repelled from the orientation of the cued peripheral patch. Uncued peripheral items had a significantly lower influence on the perception of the central Gabor. Overall, these findings reveal that covertly attending a peripheral object impacts foveal perception, in line with the idea that covert attention is sustained by predictive foveal activity that mimics the potential consequences of an eye movement.

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P6

The Role Of Mental Imagery And Sensory Sensitivity In Resolving Perceptual Ambiguity

Individual differences in mental imagery and sensory sensitivity are proposed to influence the balance between top-down and bottom-up processes in perceptual inference, potentially leading to divergent perceptions in conditions like autism and schizophrenia (Reeder et al., 2023). Recent evidence suggests that pupillometry can serve as an objective physiological marker for visual imagery of simple shapes. We aim to extend these findings to more complex visual stimuli while controlling for sensory sensitivity. We piloted line-drawings of everyday objects, widely used in object recognition literature, assessed for visual complexity and familiarity, and aim to show that these stimuli are sufficiently imaginable for inclusion in our pupillometry experiment. Following the paradigm of Dijkstra & Fleming (2023), participants recruited from a public event imagined one of two previously learned objects while viewing dynamic noise; complexity of the objects was varied. The first three trials contained only noise, familiarizing participants with the imagery task. In subsequent trials, an object gradually appeared in the noise during the imagery phase, either the requested object (congruent), a different object (incongruent), or no object (control), at average detection thresholds. After each trial, participants rated the vividness of their imagery. We hypothesize that individuals with stronger trait imagery will more accurately detect the imagined object in congruent trials but will make more errors in incongruent and control conditions, with these outcomes expected to also correlate with trial-by-trial vividness ratings. This result will determine the suitability of our stimuli for imagery tasks and what the influence of stimulus complexity is on imagery vividness ratings. We also discuss the design of the pupillometry task for which the stimuli are intended. This study ultimately aims to clarify how imagery strength affects perceptual ambiguity, with implications for understanding conditions like aphantasia and how internally generated signals can influence perceived reality.

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P7

Uncovering Cognitive Processes In Perceptual Decision-Making: Machine Learning Applied To The Speed-Accuracy Trade-Off In Eeg Data

In perceptual decision-making, a common assumption is that task execution consists of a sequence of discrete processing steps, starting with pre-attentive attraction of attention and sensory information processing, which is then followed by a decision process and completed by motor execution. However, whether these discrete processes are indeed present when executing a task, and whether these are the same for each trial, is unknown.
To test our hypotheses that (a) there are discrete processes in a perceptual decision making task; but (b) these may vary from trial to trial, we use existing data from a speed-accuracy trade-off experiment where participants had to decide which of two Gabor patches had higher contrast under either a speed or an accuracy instruction. Previous research has shown that, when instructed to be accurate, there is evidence for an additional processing step. We reason that during some trials under speed stress, this additional step is performed as well. However, existing analysis methods constrain the amount of steps per condition.
We propose a method that uses multiple machine learning methods, namely Hidden multivariate patterns (HMP) and selective state space models to firstly: Detect onset probabilities of cognitive processes, and secondly: Learn the relationship between these probabilities and the raw EEG data, generalizing this information across condition. Preliminary results indicate that this method, when trained on both the speed and accuracy conditions, predicts the presence of the additional step in some speed trials. This indicates that the additional process does occur, showing in a bottom-up manner that perceptual systems may flexibly engage or disengage additional processes based on task demand. Additionally, we believe this method can be used for a more fine-grained analysis of experimental data, and be broadly applied to analyse mental processes in cognitive tasks.

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P8

Connecting Environmental Perception And Affect: Which Perceptual Visual Features Predict Affective Responses To Everyday Indoor Environments?

Our initial response to any environment is affective, driven by its perceptual characteristics. Despite the importance of this relationship, we know very little about which visual perceptual characteristics in everyday indoor environments influence affective responses, even though we spend 90% of our time in these environments. Recent advancements in scene perception research showed that a multitude of perceptual visual features in the environment, across a range of different dimensions were required to categorize the environment. However, it remains unclear which specific perceptual visual features influence affective responses to indoor environments. To examine this relationship, we quantified a large set of low (color, edge, spatial frequency), mid (objects, contour, spatial layout), and high-level (functions, scene category) visual features from images and explored their relationship with affective responses. To this end, 60 participants viewed 360 images from four everyday indoor environments (living rooms, office rooms, restaurants, and stores) and rated these images based on valence, energetic arousal, and tense arousal. Bootstrapped stepwise regression was conducted to identify variables with the most predictive power. Individual models (i.e., a model with only low-, mid-, and high-level features) and combined models with selected predictors from all three visual perception levels were tested. Individuals models with low-, mid-, and high-level visual features accounted for a substantial amount of variance in valence (29%,60%,62% respectively), tense arousal (11%,54%,45% respectively), and energetic arousal (45%,42%,54% respectively) responses. The combined model explained 66%, 57%, and 54% of the variance in these responses, respectively. Combining visual features from multiple perception levels resulted in better-predicting models. However, most explained variance was shared between the three levels. Our findings provide strong evidence of intricate relations between perceptual visual features that influence our affective responses in environments and show the strong relationship between environmental perception and affect.

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P9

Investigating The Dynamic Interplay Between Visual Working Memory And Perception

Visual Working Memory (VWM) is used to keep relevant information available in the absence of visual input. VWM usage is commonly studied as a static process. However, our environment and behavioural goals are highly dynamic and therefore necessitate dynamic VWM use. To support goal-oriented behaviour, such as visual search, we often compare visual input to the content of our VWM. However, the relevancy of VWM contents may change over time. It is, therefore, vital to investigate the interplay between VWM and concurrent visual processing as a dynamic process. Here, we asked whether observers can flexibly (de)prioritize visual processing in anticipation of (ir)relevant visual input, during concurrent VWM maintenance. Participants were instructed to memorize an oriented grating, followed by a cue ("1" or "2"), and two more oriented gratings, all at the same location and at predictable time points. The cue instructed participants to which of the two subsequent gratings (first or second) the memorized grating should be compared (same/different judgement). By doing so we manipulated the (ir)relevancy of visual input during concurrent VWM maintenance. We recorded EEG throughout and sinusoidally modulated the luminance of the screen at the location of the gratings at 60 Hz (so-called Rapid Invisible Frequency Tagging). While not perceptible, this rapid luminance modulation evokes a 60Hz response in the posterior channels of the EEG. Importantly, the amplitude of this response is known to increase when the 'tagged' region is attended, compared to when it is not. This allowed us to measure how participants' attention to the stimulus location changed over time, depending on whether the upcoming stimulus was relevant (target) or not (distractor) for the memory comparison task. Preliminary results show that the 60Hz coherence indeed changes with relevancy over time. The coherence magnitude is lower in the time window preceding a distractor, compared to that same time window when it is preceded by a target. These results are in line with the hypothesis that participants enhance visual processing at the stimulus location when a target is expected. We tentatively conclude that participants preemptively up or down-regulate the number of resources devoted to visual processing, depending on whether the upcoming information should be compared to a concurrent VWM representation or not.

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P10

Oral Numerosity Estimation

Numerosity estimation has been studied in a range of senses and contexts. Oral numerosity estimation is a yet unexplored field. Given the tongue's active role in oral manipulation and its high sensitivity, we hypothesise that humans can accurately estimate the number of items in their mouths, even though this is not natural behaviour.
Two experiments were conducted. In the first study 25 participants were presented with 1 to 9 candies in a cup. They were, while blindfolded and wearing noise suppressing earphones, asked

to put the candies in their mouth, and immediately guess the number. Subsequently, they were asked to enumerate the candies a second time without time pressure. Participants were able to subitise up to and including 3 candies. Higher numbers were underestimated, with larger underestimation for immediate responses compared to later responses. In the second study, with a similar procedure as study 1, 44 participants were presented with 4, 6, 8 or 10 small (9 mm diameter) or large (14 mm diameter) candies. Participants were accurately guessing the number of large candies and accurately enumerating small and large candies (no difference between these three conditions). However, we found underestimation for guessing the number of small candies. Enumeration in the mouth seems to tally with what is found in other modalities, and in other tasks. This may point at a low level, generic, ability for counting, irrespective of the modality or specific task. However, smaller items lead to more underestimation than bigger items, so stimulus properties will affect the ability.

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P11

Hidden Impacts Of Light: Exploring Non-Image-Forming Responses Through Eeg And Metameric Stimuli

Light is known to elicit non-image-forming (NIF) responses in the brain, particularly through intrinsically photosensitive retinal ganglion cells (iPRGCs) that mediate melanopic photoreception. However, current research lacks objective daytime markers for these effects, and subjective bias due to visible differences in lighting conditions often complicates findings. To address this, we conducted an EEG study using metameric light conditions, designed to stimulate different retinal photoreceptor types without being perceptibly different to participants. By employing a silent substitution method and ensuring similar illuminance and correlated color temperature (CCT) levels, we created light stimuli that appear visually identical but vary in their melanopic contrast. This controlled manipulation is delivered through a custom-built LightBox with 11 dimmable LEDs, providing a uniform, Ganzfeld-like light exposure. Participants in a within-subjects design are exposed to three light conditions: dim light, low-melanopic, and high-melanopic photoreception. The primary aim is to assess whether EEG functional connectivity can serve as a sensitive measure of NIF effects on the brain, alongside spectral power density and event-related potentials (ERPs). We hypothesize that the high-melanopic condition will lead to significantly different connectivity patterns in frontal, parietal, and occipital regions, as well as

changes in alpha, delta, and theta power compared to the other conditions. Secondary objectives include examining physiological measures of autonomic nervous system activity (ECG, EOG), subjective sleepiness (KSS), and cognitive performance (PVT, Oddball Task) across the different lighting conditions. This study highlights the potential of metameric light and EEG metrics to objectively quantify the brain's response to light, independent of visual perception, advancing the understanding of NIF pathways.

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P12

Road-User Detection And Adaptive Scanning In Cyclists With Hemianopia: Insights From A Virtual Reality Study

Introduction

Cyclists with homonymous hemianopia (HH) may face considerable challenges with the timely detection of hazardous road-users, particularly in unpredictable situations. Adequate scanning behavior may help to maintain their cycling ability, yet it is unclear which specific behaviors aid road-user detection. This study examines the effect of HH on road-user detection in a virtual cycling environment, and compares scanning behavior between high and low performers.

Method

Individuals with HH (N=12) and unimpaired vision (N-12) complete two virtual cycling routes using a head mounted display. They were instructed to use the hand-brakes upon detecting road-users on a collision course during predictable versus unpredictable events (i.e. cross road present or absent). Time-to-contact was measured at braking onset to assess the detection performance. Scanning behavior was analyzed by computing the horizontal gaze interquartile range and the horizontal scanpath length per minute.

Results

Overall, individuals with HH did not deviate from those with unimpaired vision in their time-to-contact. However, at unpredictable events, the time-to-contact decreased more in the HH group, leading to lower time-to-contacts compared to those with unimpaired vision. High performers in both groups had a broader interquartile range and longer scanpaths. Yet, these effects were more pronounced in individuals with HH, resulting in a slightly broader interquartile range and longer scanpath in high performing individuals with HH compared to their unimpaired counterparts.

Conclusion

Individuals with HH can match the road-users detection abilities of those with unimpaired vision, but are more affected by unpredictable events. Expanding the horizontal range gaze and increasing scanpath length, may help them to improve road-user detection. Consequently, these scanning behaviors may be trained during rehabilitation practices to uphold cycling abilities in

individuals with HH.

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P13

Investigating Recognition Of Pixelated Tactile Line Drawings

Touchscreens are an integral part of human life. However, their current use relies on visual information, making these displays difficult to use for people with a visual impairment. In this project, we aim to create a refreshable, tactile display. Refreshable tactile displays, such as pin displays, are usually pixel based. By using pixels that can change height, it is possible to display graphical information. While several studies have investigated recognition of relief drawings, few studies have focused specifically on tactile drawings which are based on pixels.
We performed two pilot studies to investigate whether people could recognize tactile 2D representations of geometrical shapes created as regular line drawing (pilot 1) and on a matrix of 8 by 8 pixels (pilot 2). In both studies, four participants were asked to haptically explore 8 tactile drawings created using swell paper (a square, a circle, a triangle, an arrow, a diamond, a plus, a minus, and a cross). All shapes were presented five times. Participants were shown visual representation of the 8 shapes and were asked to indicate which shape they had felt.
On average, participants were correct in 88% of the cases for both pilot studies. For the line drawings, most confusions were between a square and diamond. This suggests that orientation of the shapes was difficult to judge. For the pixelated drawings, most confusions were between a triangle and an arrow and a plus or a cross.
The results of these pilot studies suggest that recognition of pixelated drawings of simple shapes is similar to recognition of line drawings. These preliminary findings will be the starting point for future studies investigating pixelated tactile drawings.

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P14

Learning To Suppress Distractors In Randomized Spatial Configurations

Our attention is influenced by past experiences, and recent studies have shown that individuals learn to extract statistical regularities in the environment, resulting in attentional suppression of locations that are likely to contain a distractor. It is noteworthy that most studies on statistical learning use search tasks where stimuli are presented in fixed configurations. In this study, we investigated whether a stable configuration is necessary for learning to suppress a likely distractor location. Participants searched for a tilted line among vertical lines, with a colored distractor appearing more often in one location than others. Critically, the stimuli were presented in random configurations on each trial. Our findings demonstrate that participants successfully suppressed the frequent distractor location, even without repeated configurations. In a follow-up study, we will examine whether consistent configurations further enhance distractor suppression or have no effect on it.

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P15

Age, Not Autism, Influences Multisensory Integration Of Speech Stimuli Among Adults

Vision (in the form of lip-reading) can greatly enhance our ability to understand speech. However, among autistic individuals, imprecise and inflexible representations of the temporal relationships between sights and sounds are theorized to underlie difficulties in integrating relevant sensory information. These, in turn, are thought to contribute to problems with speech perception and higher level social behavior. However, the literature establishing this connection often involves limited sample sizes and focuses almost entirely on children. To determine whether these differences persist into adulthood, we compared 496 autistic and 373 non-autistic adults (aged 17 to 75 years). Participants completed an online version of the McGurk/MacDonald paradigm, a multisensory illusion indicative of the ability to integrate audiovisual speech stimuli. Audiovisual asynchrony was manipulated, and participants responded both to the syllable they perceived (revealing their susceptibility to the illusion) and to whether or not the audio and video were synchronized (allowing insight into temporal processing). In contrast with prior research with smaller, younger samples, we detected no evidence of impaired temporal or multisensory processing in autistic adults. Instead, we found that in both groups, multisensory integration correlated strongly with age, and participants were able to adapt to differing degrees of asynchrony from trial to trial in a process called rapid temporal recalibration. This contradicts prior presumptions that differences in multisensory perception persist and even increase in magnitude over the lifespan of autistic individuals. It also suggests that the compensatory role multisensory integration may play as the individual senses decline with age is intact. These findings challenge existing theories and provide an optimistic perspective on autistic

development. They also underline the importance of expanding autism research to better reflect the age range of the autistic population.

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P16

Blinded By The Mind's Eye? Investigating Competitive Interactions Between Imagery And Perception

Visual mental imagery relies on the top-down activation of visual cortex representations, representations that are also activated during the perception of external visual stimuli. These internally and externally generated signals are often simultaneously present in visual cortex. Given that both imagery and perception draw on similar and capacity-limited neural resources, we hypothesized that they compete for representation, mutually degrading their individual representations as a function of their representational similarity. To test this hypothesis, we decoded multivariate EEG activity patterns evoked by visual stimuli while participants (N=34) engaged in vivid visual imagery of naturalistic scenes containing objects from one of two domains (buildings or animals), each drawn from one of four categories. During the imagery delay, task-irrelevant intervening objects appeared, belonging to either the same domain (and potentially the same category) or the other domain. We densely sampled (eight objects per trial) neural responses to intervening visual stimuli, comparing the responses to visually identical object stimuli as a function of matching or mismatching imagery content. This allowed us to separately assess imagery-perception competition at the category and the domain-level. Results showed that the representations of the identity and the location of intervening stimuli were degraded within 200 ms after stimulus onset when participants were imagining an object of the same category. Imagery-related interference was specific to the category-level. These results indicate that imagery interferes and competes with the perceptual representation of categorically similar objects, shedding light on interactions between internally and externally generated representations in visual cortex.

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P17

Associations Between Imagery Vividness, Sensory Sensitivity, And Divergent Perceptual Experiences

Perception is shaped by both bottom-up input from the senses and by prior information that exerts a top-down influence. A disrupted balance between top-down drive and bottom-up input is hypothesised to underlie divergent perception, e.g., hallucinations, or synaesthesia. An important top-down process is mental imagery, which is seen as perception in the absence of direct sensory input. The weighting of bottom-up sensory input during perceptual processing, is theoretically associated with sensory sensitivity (increased sensitivity to and enhanced processing of subtle perceptual stimuli). Both mental imagery and sensory sensitivity vary among individuals and extremes in these have been associated with divergent perception.

Here, we used survey data (N=141) to test the associations between mental imagery vividness (VVIQ), sensory sensitivity (SPSQ, GSQ) and divergent perceptual experiences (i.e. schizotypy as measured with the O-LIFE; attention to detail in autism, AQ). Positive associations were found between VVIQ and hallucination-proneness (O-LIFE) and between VVIQ and proportion sensory issues reported on the AQ. However, these associations disappeared after controlling for individual differences in sensory sensitivity. Additionally, a Principal Component Analysis revealed that a distinction can be made between different aspects of sensory sensitivity and how these are related to divergent perception and (subclinical) psychiatric traits. For example, positive consequences of sensory sensitivity (SPSQ) were associated with high imagery vividness, whereas negative consequences of sensory sensitivity were associated with low imagery vividness.

The data suggest that stronger sensory sensitivity is related to a stronger tendency to experience divergent perception, but mental imagery is not. However, imagery vividness seems to play a role in the sensory-richness of these experiences. Currently, we seek to link our findings to self-reported experiences of synaesthesia, and replicate the results in two new cohorts. Thus far, we have collected 233 additional datasets, which will be included in our presentation in November.

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P18

Amodal Shape Completion In Humans And Generative Neural Networks

Shape processing holds a crucial role in our judgments of higher level visual processes, such as object recognition. Previous efforts to explore high-level vision, independent of shape influence,

involved meticulous measurements to control for perceptual shape similarity across distinct stimulus sets. However, there is a compelling need for a more efficient approach to automatically synthesize perceptually uniform spaces of novel shapes. In this pursuit, we present an image-based method that autonomously generates numerous perceptually uniform and circular shape sets, eliminating the need for extensive psychophysical measurements. Our method employs a search for circular shape sets correlated with ShapeComp, an image-computable shape similarity metric based on over 100 descriptors, highly predictive of human shape similarity. Using multi-arrangement methods, we demonstrate that human similarity arrangements for circular and uniformly spaced shape sets, as defined by ShapeComp, align with human shape similarity judgments and approximate circularity. Notably, shape sets chosen for uniformity and circularity in alternative shape spaces (e.g., Generative Adversarial Networks or Radial Frequency patterns), but not meeting these criteria in ShapeComp, did not necessarily register as perceptually uniform and circular. Therefore, leveraging ShapeComp, we introduce an automated method for generating extensive sets of perceptually uniform and circular shape spaces. We provide five newly validated circular shape sets derived from intricate naturalistic shapes, along with MATLAB code facilitating the creation of a limitless number of such sets. This advancement empowers cognitive scientists to construct large sets of perceptually uniform stimuli, allowing for a nuanced exploration of the impact of higher-level factors on object perception.

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P19

Backflip: The Impact Of Local And Global Data Augmentations On Artistic Image Aesthetic Assessment

Assessing the aesthetic quality of artistic images presents unique challenges due to the subjective nature of aesthetics and the complex visual characteristics inherent to artworks. Basic data augmentation techniques commonly applied to natural images in computer vision may not be suitable for art images in aesthetic evaluation tasks, as they can change the composition of the art images. In this paper, we explore the impact of local and global data augmentation techniques on artistic image aesthetic assessment (IAA). We introduce BackFlip, a local data augmentation technique designed specifically for artistic IAA. We evaluate the performance of BackFlip across three artistic image datasets and four neural network architectures, comparing it with the commonly used data augmentation techniques. Then, we analyze the effects of components within the BackFlip pipeline through an ablation study. Our findings demonstrate that local augmentations, such as BackFlip, tend to outperform global augmentations on artistic IAA in most cases, probably because they do not perturb the composition of the art images. These results emphasize the importance of considering both local and global augmentations in future computational aesthetics research.

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P20

Distributional Variability Influences Variability Of Mean Estimates

Bayesian models of time perception suggest that humans represent the statistical regularities of stimulus durations as internal priors. Evidence for this primarily comes from studies showing that traces of past stimuli influence the perception of current durations. In many real-world scenarios, however, we not only adapt to these temporal contexts but also need to extract and retain the summary statistics (e.g., mean and variance) of a temporal distribution. In our experiments, participants reproduced durations drawn from different temporal distributions with varying levels of variability and subsequently estimated the mean of these distributions. We demonstrated that humans can accurately estimate the mean of temporal distributions and that the distributions' variability affects the variability of mean estimates. Furthermore, we found that the effect of variability on mean estimation is reflected in the preparation-related CNV component of EEG signals. These results suggest that humans can extract summary statistics from temporal distributions to guide the preparation for subsequent behavior.

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P21

An Expected Visual Location Biases Observers' Perceived Sound Location

To interact effectively with the multisensory world the brain combines noisy sensory signals with prior knowledge weighted by their precisions into a coherent percept. While integrating information from multiple sources reduces observers' uncertainty about the current state of the world, it can introduce perceptual biases, e.g., the Ventriloquist illusion. This study investigated whether prior expectations about the location of a visual stimulus biases an observer's perceived sound location. Participants were presented with a ball moving diagonally on the screen from top to bottom then continued its trajectory behind a wall. At the expected landing time, a sound was presented alone or in synchrony with the ball's reappearance at the expected location. The sound was played from one of three possible conditions: the ball's (i) expected location, (ii) final location before the occlusion or (iii) an unexpected location. Observers indicated their perceived

sound location via a keypress. When the ball reappeared after the occlusion, we observed a shift of observers' perceived sound locations towards the ball's location. When the ball did not reappear, the perceived sound location was shifted towards the ball's final location before the occlusion and most importantly also to the location where it was expected to reappear after the occlusion. Our results demonstrate that not only a visual input but also an expected visual location can influence and bias where observers perceive sounds. From a Bayesian perspective, they show that the brain forms prior expectations based on inputs in one sensory modality that at least to some extent affect perceptual inference of stimuli in another modality. Moreover, analysis of concurrently acquired EEG data will delineate the neural mechanisms underlying the formation of spatial priors and their influences on perceptual inference within and across the senses.

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P22

Shifting Reliance Between The Internal And External World: A Meta-Analysis On Visual-Working Memory Use

Visual working memory (VWM) is a fundamental cognitive capacity that allows us to temporarily hold visual information, but storage is effortful and content-fragile. Rather than loading VWM to the maximum, individuals usually rely on the external world and access information just in time. However, participants do rely on VWM more as access costs to external information increase. This phenomenon is commonly investigated with so-called copy tasks, that differ across paradigms, manipulations, and dependent variables. We here present findings of a meta-analysis into the reliability and consistency of shifts in the assumed trade-off between storing and sampling across manipulations and dependent variables, using data from 28 experiments. We found that all cost manipulations led to substantial shifts from external sampling to storage in VWM. Cost manipulations did not differ in their effect across studies even though such differences are reported within studies. All dependent variables were associated with clear but different strong effects. We argue that the differences observed between indicators are not only due to sensitivity differences but also due to differential aspects of behavior that are measured. New variables and techniques might now pave the way to understanding the trade-off between storing and sampling more in-depth. Collectively, our findings suggest that the reliance on VWM or the external world shifts consistently as access cost is increased, is largely irrespective of cost manipulations, and expresses itself reliably across dependent variables. With this work, we seek to help establish standards and comparability across this growing body of work.

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P23

Pupil And Eeg Correlates Of Decision Making And Memory In A Naturalistic Driving Task

Global release of norepinephrine (NE) is proposed to subserve the execution of cognitively demanding decisions, and is a potential marker for the onset of perceived stimuli relevant to such decisions. Typical tasks to study these roles include trial-based designs such as oddball, flanker, or image encoding paradigms, but the behaviour of this system under naturalistic conditions is less well understood. In this study, we used pupil diameter (PD) as an (imperfect) estimate of NE release, combined with EEG in a naturalistic highway driving task. Participants were asked to make decisions in realistic scenarios requiring them to perceive the speed and location of traffic vehicles, while simultanously encoding road sign information for later retrieval. Luminance-corrected PD was higher for high versus low traffic and, when locked to overtake decision events, began to dilate 10s prior to the decision and peaked 1s afterwards. We also found an "error-related negativity" EEG potential locked to overtake onset, which was modulated by outcome valence (negative > positive). For retrieval of road-sign information, PD occurred while participants were asked to recall the direction of specific place names, but was not dependent on confidence or accuracy. Our results suggest that NE activity is important for anticipating upcoming cognitive demands, including using spatiotemporal perception to time responses, and highlight the feasibility of investigating NE under simulated naturalistic conditions.

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P24

The Discovery And Interpretation Of Hidden Stages In Decision Making

Revealing and interpreting the neurophysiological markers of cognitive processes is crucial for understanding the relationship between brain activity and behaviour. Recently, Weindel et al. developed a method to extract trial-by-trial sequences of multivariate neural markers assumed to signify the onset of distinct processing stages, from multivariate time-series recordings. They applied this hidden multivariate pattern analysis (HMP) to electroencephalographic (EEG) data

from participants performing a decision-making task with a speed-accuracy trade-off (SAT) manipulation. HMP identified a three-event sequence in trials where participants were instructed to respond quickly, and an additional event when accuracy was prioritized. In an attempt to replicate these findings and further investigate the nature and functional significance of these events, the present study combines HMP with other analytical techniques, such as time-frequency analysis and hidden Markov models, and applies them to newly recorded EEG data from participants performing a SAT-manipulated decision-making task, with particular emphasis on the additional event observed in the accuracy-focussed condition. The results replicate Weindel et al.'s findings and suggest that the additional event is associated with stimulus differentiation. Furthermore, the additional event is proposed to be present in all conditions but obscured in the speed-focussed condition due to several factors. These findings are then related to established cognitive models of decision-making, such as the drift diffusion model and the dual-process theory.

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P25

Control Over Conscious Perception Through Meditation?

Perceptual content is substantially colored by prior beliefs according to the predictive processing perspective. Some priors are particularly 'stubborn', as exemplified by bistable perception paradigms such as binocular rivalry: a phenomenon triggered when two distinct stimuli appear to overlap spatio-temporally, resulting in rapid perceptual alternation rather than veridical continuous mixed percept. Eastern contemplative traditions propose a range of techniques to reduce the influence of priors and expand the boundaries of conscious perception. In this ongoing study, we examine whether volitional control over rivalry is possible via meditation-induced attention modulation using behavioral, neural, and phenomenological measures. Expert meditators were exposed to flickering rivalry stimuli in three conditions: no-meditation, focused attention (FA) and open monitoring (OM) meditation. Each condition consisted of self-report, no-report, and localizer blocks. We hypothesized that FA – by upweighting attention to the currently perceived stimulus – would increase the duration of individual percepts, and OM – by being attentive equally to all aspects of experience – would induce longer mixed percepts. This, in turn, should decrease perceptual switches in both meditation conditions. Indeed, preliminary behavioral results from seventeen meditators suggest fewer perceptual switches in both FA and OM conditions. We employed two complementary approaches to objectively track perceptual content from EEG: Steady-state visual evoked potentials using rhythmically entrained source separation (RESS), and pattern-classification on RESS-filtered data. No effect of meditation on RESS-derived switches is seen in self-report blocks. In the no-report blocks, an increase in perceptual switches is observed with FA but not OM meditation. Pattern-classification in a subset of participants reveals high decoding accuracy in the no-meditation condition and a high correlation between estimated switches and self-reports, demonstrating that this method could serve as a potent tool for rivalry-tracking. Results from a larger sample will be presented to illuminate the extent to which control over conscious perception is possible through meditation.

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P26

Exploring The Relationship Between Human Arousal And Feedforward Vs. Recurrent Processing

The Yerkes-Dodson law famously describes an inverted U-shaped relationship between arousal and performance, where optimal performance occurs at intermediate levels of arousal. While recent studies have provided more evidence for the connection between pupil-linked arousal and behavioral performance, the link between arousal fluctuations and the neural processes underlying this performance remains relatively underexplored, particularly in humans. This study aims to bridge this gap by examining the relationship between pupil-linked arousal and neural processing in humans, using EEG and pupil data.
Participants engaged in a detection and discrimination task with masking, requiring them to either detect the Kanizsa illusion or discriminate the rotation of an image. Arousal levels are measured through pre-stimulus pupil size, and these are linked to the decoding of different visual features (rotation and illusion), which serve as indicators of distinct neural processes (feedforward and recurrent processing, respectively). The relationship between these neural processes and arousal are evaluated using polynomial regressions.
Data analysis is still in progress at the time of writing, but we hypothesize that feedforward processing will remain unaffected by arousal fluctuations, displaying a flat linear relationship. In contrast, we expect an inverted U-shaped relationship between arousal and recurrent processing, paralleling the arousal-performance relationship.

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P27

A High-Speed Oled Monitor For Precise Stimulation In Visual Perception, Eye-Tracking, And Eeg Research

The recent introduction of organic light-emitting diode (OLED) monitors with refresh rates of 240 Hz or more opens new possibilities for their use as precise stimulation devices in research on visual perception. These affordable high-speed monitors, targeted at video gamers, promise several advantages over the cathode ray tube (CRT) and liquid crystal display (LCD) monitors commonly used in these fields. Unlike LCDs, OLED displays have self-emitting pixels that can show true black, resulting in superior contrast ratios, a broad color gamut, and good viewing angles. More importantly, the latest gaming OLEDs promise excellent timing properties with minimal input lags and rapid transition times. However, OLED technology also has potential drawbacks, notably Auto-Brightness Limiting (ABL) behavior, where the local luminance of a stimulus can change with the number of currently illuminated pixels. This study characterized a 240 Hz OLED monitor, the ASUS PG27AQDM, in terms of its timing properties, spatial uniformity, viewing angles, warm-up times, and ABL behavior. We also compared its responses to those of CRTs and LCDs. Results confirm the monitor's excellent temporal properties with CRT-like transition times (around 0.3 ms), wide viewing angles, and decent spatial uniformity. Additionally, we found that ABL could be prevented with appropriate settings. We illustrate the monitor’s benefits in two time-critical paradigms: Rapid "invisible" flicker stimulation and the gaze-contingent presentation of stimuli during eye movements. Our findings suggest that the newest gaming OLEDs are precise and cost-effective stimulation devices for visual experiments with several key advantages over CRTs and LCDs.

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P28

Comparing Vibrotactile Feedback Modes For Navigation – An Extensive Pilot Study

Wearable vibrotactile displays have the potential to serve as navigational aids. This is useful for individuals with a visual impairment, or in scenarios with poor visibility and high cognitive load. A limitation of studies on this topic is a lack of standardization. Studies often design their own vibrotactile equipment and feedback modes. This makes it difficult to compare studies directly to each other and draw generalizable conclusions.

This project seeks to compare different vibrotactile feedback modes, adapted from the literature, on a commercially available vibrotactile vest (bHaptics). In an extensive pilot study, participants (N = 9) traversed different virtual environments whilst vibrotactile feedback informed them of otherwise invisible obstacles.

Three modes of vibrotactile feedback were compared: (1) vibration depending on the distance between the participant and surrounding obstacles; (2) vibration depending on where the participant pointed a hand-held controller; or (3) vibration in the direction of a pre-defined path.

In a fourth control condition participants had full vision of the obstacles. Three types of virtual environments were traversed: a maze, a hallway, and an open space with obstacles.
Overall, participants understood the vibrotactile feedback and successfully completed the trials. There were some problems with interpreting the third feedback mode. Informal observations also suggest that participants adapted their behavior and developed navigational strategies suited to their current form of feedback.
Preliminary results suggest the most suitable feedback depends on the complexity of the environment. Based on completion times, the environments by descending difficulty are the maze, hallway and obstacle space. Between the first two feedback modes, completion times were similar for the hallway and obstacle trials; however, the maze took twice as long to complete with the hand-held controller.
Together, this work served as a first step to directly compare different vibrotactile feedback modes for navigation.

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P29

Cascading Transitions In Multistable Perception

One of the oldest phenomena investigated by psychologists is multistable perception. This mysterious phenomenon intrigues philosophers, cognitive scientists and neuro-biologists alike because it promises to hold valuable insights about the integration of sensory signals into coherent higher order perception. From a mathematical perspective, the typical perceptual shifts that occur while being exposed to bistable stimuli can be well described using complexity science. Specifically, a branch from complexity science named catastrophe theory. With our project, we want to emphasize the importance of cascading transitions in higher order multilevel complex systems as a driver for large-scale changes. With the final aim to formalize the theory of perceptions of multifigure, multistable stimuli, we currently investigate possible methods of decoding the subjectively experienced percept using eye-tracking and EEG. While it is crucial to obtain objective measures of individual percepts to obtain precise data of any underlying events, the pursuit of the ideal physiological correlate of subjective perception has been shown to be difficult. Our approach focuses on stroboscopic alternative motion (or the motion quartet), an apparent motion stimulus, which can be easily manipulated to bias the preferred of two percepts. Based on an extensive literature review, we are confident that we can accurately classify participant's perception using data from eye-movement, pupillometry and EEG. Data which is currently being collected shows the expected catastrophe flags by showing bimodality, an inaccessible region, sudden jumps, divergence and hysteresis. Building from this, and with the accurate measurement of percepts as a solid foundation, we plan to formalize and test a precise

description of perceptual dynamics involving ambiguous sensory input. This will ultimately contribute to the understanding of our perception and cognition.

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P30

Percept Duration Of Light Flashes Induced With Microstimulation In Primary Visual Cortex As A Function Of Visual Adapdatation And Auditory Integration In Blind Subjects

Intracranial microstimulation of the human visual cortex often induces light sensations called phosphenes, which could potentially be used to restore some form of vision in blind individuals. This study explores the minimum interval required for a subject to perceive two separate phosphenes from consecutive microstimulations (each lasting 167 ms) at various interstimulation intervals. We employed a 96-channel microelectrode system implanted in the occipital cortex of two blind subjects. The subjects were tasked with reporting whether they perceived zero, one, or two phosphenes while microstimulating, with one electrode, once or twice at different time intervals. We also examined the effect of adaptation by comparing perceptual discrimination and neural responses during the initial and subsequent trials within a block. Additionally, the influence of bimodal stimulation was investigated by pairing the electrical stimulation with zero, one, or two simultaneous auditory signals. Our findings reveal that the shortest interval needed to distinguish two phosphenes is approximately 300 ms for a stimulation duration of 167 ms, suggesting that the induced phosphene percepts persist beyond the microstimulation period. Moreover, neural responses diminished over time, indicating adaptation, and this decrease was associated with the necessity for longer intervals between stimulations to discern two phosphenes. No significant differences in neural or perceptual responses were observed when microstimulation was accompanied by varying numbers of auditory stimuli. These results will be discussed in relation to their implications for the development of neural prosthetics using phosphene vision to aid blind individuals.

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P31

Prioritized And Non-Prioritized Features Maintained In Visual Working Memory Differentially Influence Early Visual Processing

Items held in visual working memory (VWM) can influence early visual processing by favoring visual input that matches the contents of memory. Recent studies have shown that memory items can have differing priorities within VWM depending on current task demands and that prioritized and non-prioritized memory items might rely on distinct storage mechanisms.
Here, we aimed to investigate how the influence of VWM content on early visual processing depends on the priority state of the memory items. We utilized a double serial retro-cuing task to manipulate the priority of memory items and measured their influence on two distinct hallmarks of early visual processing—access to visual awareness and exogenous attention. This was done in three different experiments (total 72 participants) employing different perceptual tasks: the breaking continuous flash suppression task (Experiment 1), the attentional capture task (Experiment 2), and a visual search task (Experiment 3).
Across all experiments we found that participants could flexibly de-prioritize and re-prioritize items in VWM, thereby directly influencing the extent to which early visual processing is affected by VWM content. That is, stimuli matching prioritized VWM items gained access to consciousness faster and attracted attention more than stimuli matching non-prioritized VWM items. Interestingly, stimuli matching non-prioritized memory items also showed a perceptual advantage over stimuli that were unrelated to VWM content. When considering the experimental paradigms individually, non-prioritized memory items primarily accelerated conscious access of memory-matching stimuli (Experiment 1), while having a negligible influence on the allocation of attention (Experiments 2 and 3)
These results suggest that both prioritized and non-prioritized memory items can influence early visual processing, with certain perceptual tasks showing greater sensitivity than others. This finding implies that non-prioritized memory items (akin to prioritized memory items) might be stored as sensory-like representations, thus allowing for interactions with concurrent visual input.

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P32

The Role Of Expectations In Visual Spatial Coding Across The Visual Hierarchy

Predictive processing theorizes that the brain predicts events based on prior experiences. Mismatches between the predictions and input lead to prediction errors (PEs). Despite the theory's popularity, our understanding of the role of PEs in visual spatial perception remains limited. Here, we investigated predicted and unpredicted coding of visual locations across the visual hierarchy, utilizing the predictability of the standard population receptive field (pRF) mapping paradigm while sampling BOLD responses at ultra-high field fMRI. Our experiment featured different conditions in which unpredictable stimulus omissions and/or violations (different bar location and orientation) were either embedded in the standard stimulus sequence, or presented separately. These conditions serve to produce prediction errors, both of stimulus presence and of stimulus location. We fit a spatial divisive normalisation (DN-pRF) model to the BOLD timecourses in the standard pRF stimulus sequence, and tested whether bold timecourses in conditions with unexpected stimuli follow this model, which is linear in time. This analysis indicates that PEs drive high-level visual cortex responses more than low-level visual cortex. These findings suggest that prediction error responses in visual cortex follow the evolution of temporal scales of integration, from fast to slow, along the visual hierarchy. This hints at a tight relationship between temporal divisive normalization and predictive processing.

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P33

Automated Generation Of Perceptually-Uniform Circular Spaces For Novel Naturalistic Shapes

Shape processing holds a crucial role in our judgments of higher level visual processes, such as object recognition. Previous efforts to explore high-level vision, independent of shape influence, involved meticulous measurements to control for perceptual shape similarity across distinct stimulus sets. However, there is a compelling need for a more efficient approach to automatically synthesize perceptually uniform spaces of novel shapes. In this pursuit, we present an image-based method that autonomously generates numerous perceptually uniform and circular shape sets, eliminating the need for extensive psychophysical measurements. Our method employs a search for circular shape sets correlated with ShapeComp, an image-computable shape similarity metric based on over 100 descriptors, highly predictive of human shape similarity. Using multi-arrangement methods, we demonstrate that human similarity arrangements for circular and uniformly spaced shape sets, as defined by ShapeComp, align with human shape similarity

judgments and approximate circularity. Notably, shape sets chosen for uniformity and circularity in alternative shape spaces (e.g., Generative Adversarial Networks or Radial Frequency patterns), but not meeting these criteria in ShapeComp, did not necessarily register as perceptually uniform and circular. Therefore, leveraging ShapeComp, we introduce an automated method for generating extensive sets of perceptually uniform and circular shape spaces. We provide five newly validated circular shape sets derived from intricate naturalistic shapes, along with MATLAB code facilitating the creation of a limitless number of such sets. This advancement empowers cognitive scientists to construct large sets of perceptually uniform stimuli, allowing for a nuanced exploration of the impact of higher-level factors on object perception.

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P34

Attention Shifts The Numerosity Preferences Of Tuned Neuron Populations

Humans, along with many animals, possess the ability to rapidly and accurately perceive numerosity——the number of objects in a visual image. Numerosity perception is a vital aspect of numerical cognition, but recent studies indicate that it primarily relies on sensory processing rather than a high-level cognitive conception of number. In the brain, numerosity-tuned neural populations located in frontoparietal areas exhibit peak responses when passively viewing specific ranges of (preferred) numerosities. In day-to-day behavior, however, numerosity perception is likely more goal-oriented: participants may actively attend one numerosity over the other, to support imminent behavior.

In the spatial (rather than numerical) domain, response preferences are attracted to the location of visual attention. Recent study also showed indirectly attending to numerosities increased the numerosity-tuned response. We therefore asked whether neural numerosity preferences are also directly attracted towards a specifically attended numerosity. During ultra-high field (7T) fMRI, we presented stimuli of varying numerosity to map neural numerosity tuning preferences. In alternating scan runs, participants were asked to either count the occurrence of displays with numerosity 2 (“attend low” condition) or with numerosity 6 (“attend high” condition), or count how often items changed color (a non-numerical feature, serving as a baseline attention condition). Numerosity preferences were lowest when attending to low numerosity displays, highest when attending to high numerosity displays and intermediate when attending to non-numerical features. These findings show that the responses of numerosity-tuned neural populations are modulated not only by the numerosity of the stimulus itself, but also by the behavioral goal of the observer.

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P35

Distinguishing A Central Selection Bias From A Central Fixation Bias: The Role Of Retinal Eccentricity In Selection Control

The eyes preferably select stimuli close to the center of fixation over stimuli further away, suggesting the existence of a central selection bias. However, so far investigations of this central selection bias have confounded close to the center of fixation with close to the center of the stimulus display, leading to potential overlap with what is known as the central fixation bias in image perception. Our study aimed to dissociate the central selection bias from the central fixation bias. In two experiments, participants were instructed to make a single eye movement to one of two simultaneously presented singletons. Importantly, the singletons were always presented at the same distance from the center of the display but their eccentricity relative to initial fixation varied across trials and experiments. The results show that participants favor selecting the item closest to fixation. This selection bias is thus distinct from the central fixation bias, occurs rapidly and transiently, peaking around 200 ms and lasting until approximately 300 ms after display onset. Together, these results suggest retinal eccentricity as a major factor when multiple objects compete for selection.

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P36

Gaze Biases Can Reflect Task-Specific Spatial Memorization Strategies

Previous work has suggested that small directional eye movements not only reveal the focus of external spatial attention towards visible stimuli, but also accompany shifts of internal attention to stimuli in visual working memory (VWM)(van Ede et al., 2019). When the orientations of two bars are memorized and a subsequent retro-cue indicates which orientation needs to be reported, participants' gaze is systematically biased towards the former location of the cued item (Figure 1AB). This finding was interpreted as evidence that the oculomotor system indexes internal attention; that is, attention directed at the location of stimuli that are no longer presented but are maintained in VWM. Importantly, as the location of the bars is presumably not relevant to the

memory report, the authors concluded that orientation features in VWM are automatically associated with locations, suggesting that VWM is inherently spatially organized. This conclusion depends on the key assumption that participants indeed memorize and subsequently attend orientation features. Here we re-analyse Experiment 1 by van Ede et al. (2019) and demonstrate that this assumption does not hold. Instead of memorizing orientation features, participants deployed an alternative spatial strategy by memorizing bar endpoints. Although we do not call into question the conclusion that internal attention is inherently spatially organized, our results do imply that directional gaze biases might also reflect attention directed at task-relevant stimulus endpoints, rather than internal attention directed at memorized orientations.

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P37

Transitions From Monotonic To Tuned Responses In Recurrent Neural Network Models During Timing Prediction

The brain exhibits a gradual transition in responses to visual event duration and frequency through the visual processing hierarchy: from monotonically increasing to timing-tuned responses. Through the visual processing hierarchy hierarchies, properties of both response types are progressively transformed. Here, we implement simulations based on artificial neural networks to investigate the requirements of neural systems for the emergence of such responses and their properties' transformations. We find that deep recurrent networks traing to generate the next input in sequences with predictable timing develop monotonic responses whose properties' progressions over network layers resemble those over brain areas. Furthermore, tuned responses and a gradual transition between monotonic and tuned neurons emerge in recurrent networks trained to reproduce predictable sequences of events. Specifically, after training on predictable sequences, the tuned properties' progressions resemble those observed in the brain. These results suggest that the emergence of visual timing-tuned responses and the subsequent hierarchical transformations of these responses result from recurrent neural computation and predictive processing of sensory event timing.

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P38

Translating Colours To Materials: A Study On Cross-Modal Correspondences Between Vision And Touch

This study aims to investigate cross-modal correspondences between vision (hue of a colour) and touch (materials). Two studies were performed: first, a two-part vision-focused survey, in which - in the first part- participants were asked to give free associations to a range of colours. In the second part, they were asked to match grey-scale photographs of various non-organic materials to a range of colours. In the second study, a lab experiment was conducted in which participants tactually explored the most frequently matched materials from study 1 and were asked to match a colour to each material. Results show overlapping colour-material combination patterns between both studies. Neutrals (black, white, grey) were more frequently and consistently matched than other colours. Additionally, the physical property of roughness seems to be associated with warmer and darker colours. These findings could be partially explained by implicit associations, but mostly through object identification and previously learned associations.

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P39

Attentional And Perceptual Guidance In Visual Search: The When And What Of Emotional Superiority

Emotional facial expressions are thought to attract attention differentially based on their emotional content. While anger is thought to attract the most attention during visual search, happy superiority effects are reported as well. As multiple studies point out confounds associated with such emotional superiority further investigation into the underlying mechanisms is required. Here, we tested visual search behaviors when searching for angry faces, happy faces, or either happy or angry faces simultaneously using diverse distractors displaying many other expressions. We teased apart visual search behaviors into attentional and perceptual components using eye-tracking data and subsequently predicted these behaviors using low-level visual features of the distractors. Results show an overall happy superiority effect that can be traced back to the time required to identify distractors and targets. Search behavior is guided by task-based, emotion specific search templates that are reliably predictable based on spatial frequency content. Thus, when searching, we employ specific templates that drive attentional as well as perceptual elements of visual search. Only the perceptual elements contribute to happy superiority. In conclusion, we show that template guided search underlies perceptual, but not attentional, happy superiority in visual search.

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P40

Optimizing Eye Movement Perimetry For The Pediatric Population

Purpose: To evaluate different objective methods for examining visual field healthy children and children with visual field defects due to central nervous system tumors.
Relevance: Visual fields are commonly assessed using standard automated perimetry such as Humphrey Field Analyzer (HFA) or Octopus 900. These methods require active participation and gaze fixation which can be challenging, especially for children. Adding to the importance of good methods for pediatric examination is the fact that progression in visual field defect is an important indication for treatment with chemotherapy in children with inoperable in the optical tract. New methods are needed.
Methods: Participants and patients were tested with standard ophthalmological tests including visual acuity, slit lamp examination, optical coherence tomography (OCT) and standard visual field examination as well as two eye movement based perimetry options developed by external companies (Reyedar and Bulbitech).
Results: Gaze following is poor in amongst healthy children under the age of 10 (cosine similarity 0.77 (0.64-0.85)). Fixation dependent paradigms are not feasible. Uncalibrated eye trackers should be avoided.
Conclusion: Performance on eye movement based perimetry is age dependent and individual. Adaptations of the tests must be made to accompany the needs of children.

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