Helmholtz Instituut

Utrecht University

Perception Day 2026

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Welcome!

We are happy to continue the tradition of Perception Day which started in 2006. After previous editions at TNO Soesterberg, Eindhoven University of Technology and Radboud University Nijmegen, it is now the third 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 Blauw/ Ruppert Paars
9:15	**Talk session 1A:** Arts & Aesthetics	Ruppert Blauw
9:15	**Talk session 1B:** (sub-)Clinical	Ruppert Paars
10:45	**Coffee break & Posters**	Ruppert Hall/ Ruppert B
11:45	**Talk session 2A:** Attention, Arousal & the Pupil	Ruppert Blauw
11:45	**Talk session 2B:** Space & Magnitude	Ruppert Paars
13:15	**Lunch**	Ruppert Hall
14:00	**Talk session 3A:** Prediction & Timing	Ruppert Blauw
14:00	**Talk session 3B:** Confidence & Metacognition	Ruppert Paars
15:30	**Coffee break & posters**	Ruppert Hall/ Ruppert B
16:30	**Helmholtz lecture Roland Fleming** “Visual Perception – past, present and future”	Ruppert Blauw
17:30	**Closing & drinks**	Ruppert Hall

Talks

Talk session 1A – Arts & Aesthetics
Chair: Sjoerd Stuit
09:15 – 10:45, Room Ruppert Blauw

9:15	Aesthetic Importance Guides Visual Exploration Across Art Styles and Viewing Goals	Maarten Leemans, KU Leuven
9:30	Looking Isn't Understanding: An Information-Theoretic Dissociation of Gaze and Semantic Ambiguity in Art	R Ravi Rao, Leiden University
9:45	Do individual differences in visual perceptual sensitivity generalize across features, tasks, and contexts?	Eline Van Geert, KU Leuven
10:00	Visual attention, aesthetic perception, sensory sensitivity and art expertise: A wearable eye-tracking study in an art gallery	Gijs Holleman, Tilburg University
10:15	The effect of re-lighting on the perception of materials in cultural heritage	Luan van Giezen, Delft University of Technology
10:30	Audiovisual emotional congruency modulates gaze dispersion and aesthetic evaluation of paintings	Funda Yilmaz, Donders Institute, Radboud University

Talk session 1B – (sub-)Clinical
Chair: Anika van der Klis
09:15 – 10:45, Room Ruppert Paars

9:15	Individual differences in sensory processing sensitivity and their relation to digital health communication	Tessa Van Leeuwen, Tilburg University
9:30	Peripheral Refractive Errors Are Associated With Reduced Peripheral Contrast Sensitivity in Pseudophakic Eyes	Dilce Tanriverdi, University Medical Center Groningen
9:45	ERP correlates of spared categorical visual attentional guidance but compromised memory search in cognitive ageing.	Gaspar Pérez-Ayora, Donders Insitute, Radboud University
10:00	Strategic blink timing supports the perception of task-relevant visual information and varies with age- and disease-related cognitive decline	Isabell Pitigoi, Queen's University, Canada
10:15	(Pseudo)neglect is associated with conservative decision rules on the weaker hemifield	Tessie Hamers, Utrecht University
10:30	Can adaptation to homonymous visual field defects be measured with SONDA eye movement perimetry?	Minke de Boer, University Medical Center Groningen

Talk session 2A – Attention, Arousal & the Pupil
Chair: Samson Chota
11:45 – 13:15, Room Ruppert Blauw

11:45	Attending to things you can't see	Ana Vilotijević, Utrecht University
12:00	Pupil Constriction Causes Activity in the Human Retina and Visual System	Sebastiaan Mathôt, University of Groningen
12:15	Larger pupils are linked to enhanced visual, but not auditory, detection.	Veera Ruuskanen, University of Groningen
12:30	The Effects of Interruptions on Stimulus-Driven Attention	Camilla Enwereuzor, Vrije Universiteit Amsterdam
12:45	Affective salience modulates learned suppression: Evidence for residual attentional priority at fear-associated locations	Junjie Huang, Leiden University
13:00	Affect in the Latent Space: Identifying Affect-Related Directions in the Latent Space of Unsupervised Variational Autoencoders	Fatih Deniz, Eindhoven University of Technology

Talk session 2B – Space & Magnitude
Chair: Krista Overvliet
11:45 – 13:15, Room Ruppert Paars

11:45	Visual Attention doesn't Travel, it Teleports	Kabir Arora, Utrecht University
12:00	Peripheral Ear-Specific Selective Speech Adaptation is Not a Location-Contingency Effect	Isar Syed, Tilburg University
12:15	The unique representation of zero in the human brain	Tianxin Shu, NIN Amsterdam
12:30	Functionality versus modality: finding the fundamental organizational principle of working memory storage	Yichen Yuan, Utrecht University
12:45	A third dimension of the V1 orientation manifold makes cardinality explicit	Radovan Vodila, Donders Institute, Radboud University
13:00	The size-weight illusion without deception	Jeroen Smeets, Vrije Universiteit Amsterdam

Talk session 3A – Prediction & Timing
Chair: Heleen Slagter
14:00 – 15:30, Room Ruppert Blauw

14:00	No evidence for proactive suppression of probable distractors: a RIFT-EEG study	Dan Wang, Utrecht University
14:15	Using Dynamic Neural fields in Human-Robot Joint Action	Raymond Cuijpers, Eindhoven University of Technology
14:30	Early visual cortex rapidly anticipates high-level information during naturalistic free viewing	Songyun Bai, Donders Institute, Radboud University
14:45	Foveal remapping of task-relevant features for peripheral stimuli	Eva Berlot, Donders Institute, Radboud University
15:00	Briefer than brief - Uncovering the true temporal resolution of the visual system	Joost de Jong, University of Groningen
15:15	Predicting What, Predicting When: A Layer-Resolved Study of Cortical Inference in Human Auditory Cortex	Ryszard Auksztulewicz, Maastricht University

Talk session 3B – Confidence & Metacognition
Chair: Joris Vincent
14:00 – 15:30, Room Ruppert Paars

14:00	Distinct Neural Codes of Past and Present Goals in Prefrontal Cortex	Damian Koevoet, Donders Institute, Radboud University
14:15	Dynamic regulation between internal storing and external sampling reflects costs tradeoffs	Tianying Qing, Utrecht University
14:30	Humans learn to distinguish imagination from reality with age	Andre Sahakian, Utrecht University
14:45	Faces in Focus - Decoding Emotion and Gender in Visual Processing	Lukas Kunz, Leiden University
15:00	Confidence emerges late in the cognitive-process sequence and is not domain-general	Rick den Otter, Utrecht University
15:15	Metacognition in Ensemble and Single-Object Perception	Yining Chen, BCBL, San Sebastián

Posters

Poster nr	Presenter	Title	Affiliation
P1	Marleen Abbestee	The costs of resizing the attentional field	Utrecht University
P2	Dominique Blokland	Usage of auditory and haptic landmarks as directional cues by blind individuals in a route memory task	Utrecht University
P3	Floortje Bouwkamp	Does uncertainty reduction drive naturalistic, unconstrained visual sampling? A CityLab study	Donders Institute, Radboud University
P4	Eli Brenner	Intercepting accelerating targets with the help of sound	VU Amsterdam
P5	Evan Canny	Sensory Sensitivity and ERP Markers of Auditory Selective Attention in Neurotypical Adults	Utrecht University
P6	Olympia Colizoli	Simulating Synesthesia: A Computational Approach to Investigating the Effects of Grapheme-Color Representations on Visual Working Memory	Donders Institute, Radboud University
P7	Esra De Ruiter	From auditory perception to motor output: a novel approach to probing subcortical motor pathways	Radboudumc, Nijmegen
P8	Beleke de Zwart	Fixed across traits and states? The stability of the exogenous attentional spotlight across autism, ageing, and cue size.	Utrecht University
P9	Lasse Dietz	Temporal expectations facilitate perceptual performance by driving early visual processing	Utrecht University
P10	Martina Dossi	A Co-Design Approach to Visual Analytics for VR-Based Visual Rehabilitation	Utrecht University
P11	Jesse Feddema	The added value of a Virtual Reality restaurant simulation in the cognitive assessment of acquired brain injury	Utrecht University
P12	Zakaria Gefferie	Saccade Selection Predictably Changes With Load	Utrecht University
P13	Alicia Gonsalves	Extending Physiologically Informed Dynamic Causal Modelling with Interlaminar Connectivity for Laminar fMRI	Maastricht University

P14	Ana-Maria Gore	Resolving Corticothalamic Circuits in Human Auditory Selective Attention with 7T fMRI and Laminar iEEG	Maastricht University
P15	Gaia Mariavittoria Gragnolati	Interruptions and the Time Course of Goal Perseveration in Visual Search	VU Amsterdam
P16	Zirui Gu	Presaccadic information changes the dynamics of salience, relevance, and eccentricity	VU Amsterdam
P17	Jade Guénot	Exploring eye-hand coordination in central field loss with virtual reality	UMC Groningen
P18	Ben Harvey	Representational Tuning Models: Parametric Encoding Within Arbitrary Stimulus Domains	Utrecht University
P19	Meike Heldoorn	To fill or not to fill? That's the question for pixelated tactile images of different sizes	Eindhoven University of Technology
P20	Doreen Hii	"I / Eye" Like That! Explaining Individual Aesthetic Judgments Using Eye Movement Data	KU Leuven
P21	Felix Hofer	Tracking binocular rivalry without report: Toward neural decoding of the full perceptual stream	VU Amsterdam
P22	Alex Hoogerbrugge	Cost, then reward: saccade selection is a temporally integrated economic decision	Utrecht University
P23	Yayla Ilksoy	Object-Centered Spatial Learning in Dynamic Contexts: History-Driven Distractor Suppression and Target Enhancement	VU Amsterdam
P24	Suzanna Janssens	Binocular Saccadic Benefit Declines with Interocular Reliability Imbalance	Erasmus MC Rotterdam
P25	Kyle Sinan Taylan Kahraman	From perception to mental rotation: tracing spatial codes with MEG	Maastricht University
P26	Sanam Kazemi	Representation of Movement Direction and Eye-Movement Type Across the Visual Cortex and Cerebellum	Spinoza Centre for Neuroimaging Amsterdam
P27	Rozemun Khan	From 3D Ability to 2D Neural Profiles: Individual and Task-Driven Oscillatory Dynamics in Mental Rotation	Utrecht University

P28	Lisa Koßmannn	Revealing Mid-Level Factors in Rich Images: A Framework and Dataset for Perceptual Grouping and Composition	KU Leuven
P29	Areti Kotsolakou	Eyes on the Input: Combining Pupillometry and the Head-turn Preference Paradigm in Infant Pattern Detection	Utrecht University
P30	Yongxing Lu	Do the Math: A Behavioral Study of Human Arithmetic	Spinoza Centre for Neuroimaging Amsterdam
P31	Marloes Mak	Individual Differences in Perceptual Experiences: Exploring Associations between Imagery Vividness, Sensory (Processing) Sensitivity, Synaesthesia, and (Subclinical) Psychiatric Traits	Tilburg University
P32	Marnix Naber	The fusion illusion: explaining apparent standstills of overlapping transparent objects	Utrecht University
P33	Spencer Matei Olson	Quantifying Auditory Engagement to Naturalistic Stimuli During Auditory Attention	Maastricht University
P34	Leonie Oostwoud Wijdenes	Planning horizon of sequential reaching movements depends on target configuration	Radboud University
P35	Taku Otsuka	Neural traces of past stimulus reliability emerge during ongoing perception	University of Groningen
P36	W. Pan	From categorization to quantification: Stage-dependent neural and behavioral mechanisms of facial emotion recognition	Leiden University
P37	Myrthe Plaisier	Conveying visual shape and color with a single vibrotactile pattern	Eindhoven University of Technology
P38	Claire Pleche	Expected visual locations bias observers' perceived sound locations	Donders Institute, Radboud University
P39	Korosh Rajaei	Neural Representations of Body Awareness and Imagery in Depersonalization	VU Amsterdam
P40	Wieger Scheurer	Implicit spatiotemporal prediction in cortex and behaviour defaults to linear paths over physics intuition	Donders Institute, Radboud University
P41	Siem Scholman	Tracing Sensory Processing Across Cognitive Stages	Utrecht University

P42	Henning Schulte	Improving SONDA visual field reconstruction using Threshold-Free Cluster Enhancement	UMC Groningen
P43	Kaj Stolle	Spatial Learning During Walking with Vibrotactile Feedback	Eindhoven University of Technology
P44	Rutger Stuut	From training to practice: Effects of an eye movement modelling intervention on nautical operators' CCTV viewing behaviour	Rijkswaterstaat
P45	Yike Tang	Effector similarity warps visual feature space in working memory	VU Amsterdam
P46	Caterina Trentin	An eye for action: Do object affordances shape how we represent others' attention?	VU Amsterdam
P47	Anna Umurzakova	Colours of Consciousness: Using synesthetic training to identify the neural computations behind subjective experience	Donders Institute, Radboud University
P48	Joey van der Bie	Is Spatial Language Grounded in Perception? Language Usage In Persons With A Visual Impairment through Verbal Fluency Tasks	Utrecht University
P49	Maarten van der Smagt	Low-level influences on numerosity adaptation	Utrecht University
P50	Julian van Grondel	Benchmarking pupil perimetry in young children: finding visual field anisotropies	UMC Utrecht
P51	Jasmin Van Vliet	Physiologically and subjectively inferred costs are minimized during saccade selection	Utrecht University
P52	Huib Versnel	Linguistic and non-linguistic hearing performance with a cochlear implant and the role of residual cochlear function	UMC Utrecht
P53	Maarten Wijntjes	Distinguishing Rembrandt from his students: evidence for tacit perceptual learning in a connoisseur-level task	TU Delft
P54	Mengshi Yang	Pseudo-haptic perception across three movement conditions	TU Delft
P55	Jiayi Yao	Age-related Preservation of Statistical Learning in Distractor Suppression	VU Amsterdam
P56	Liangyou Zhang	Attention alters numerosity tuned responses in the human brain	Utrecht University

Abstracts – Talks

Talk session 1A – Arts & Aesthetics
9:15 – 10:45, Ruppert Blauw

Chair: Sjoerd Stuit

9:15 – 9:30

Aesthetic Importance Guides Visual Exploration Across Art Styles and Viewing Goals

Images contain regions that differ in their importance for how viewers perceive and appreciate an image. In previous work, we introduced image aesthetic maps to quantify the local aesthetic importance of image regions and showed that they predict visual inspection of paintings and artistic photographs beyond low-level saliency. Here, we examine the robustness of this relationship across artistic styles and viewing goals by combining an eye-tracking study with an online image-region rating study. In the eye-tracking study, 132 participants viewed images from three artistic styles—figurative, identifiable, and abstract—while following one of three viewing instructions. Participants were either instructed to look at the image carefully (control), to prepare for a memorisation task, or to prepare for an aesthetic task. Art style was manipulated within participants, whereas viewing instruction was manipulated between participants. In the online image-region rating study, 339 participants rated a subset of regions from each image for their importance to the liking of the whole image. These ratings were aggregated to construct image-level maps of local aesthetic importance. We replicate our earlier finding that local aesthetic importance predicts fixation probability beyond low-level saliency, and show that this relationship generalises across artistic styles and viewing conditions. Viewing goals nevertheless also affected visual exploration: aesthetic instructions resulted in more global scanning and more focal inspection over time, without implying greater image coverage compared to the control condition. In contrast, non-figurative styles were associated with more global scanning and greater image coverage than figurative styles, potentially reflecting differences in the availability of recognizable content for detailed inspection. Finally, we are currently examining whether these shifts in scanning behaviour are related to the local aesthetic importance of the regions being inspected—for example, whether viewers inspect more aesthetically important regions more focally and whether this relationship changes over time.

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9:30 – 9:45

Looking Isn't Understanding: An Information-Theoretic Dissociation of Gaze and Semantic Ambiguity in Art

Viewing an artwork can be framed as visual communication, decoded through sequential sampling of the visual field. Artists often exploit the gap between signal and interpretation, producing artworks whose meaning resists stable resolution, termed semantic instability. Conventional metrics collapse viewing dynamics into static aggregates, and scanpath-comparison methods quantify between-viewer similarity rather than within-viewer uncertainty. Treating fixations as a stochastic process, an information-theoretic approach instead yields continuous within-viewer indices of how resolved exploration is, distinguishes facets of uncertainty (stationary entropy: spread of attention; transition entropy: predictability of gaze shifts; mutual information: sequential structure of the gaze channel), and, being feature-agnostic, allows gaze uncertainty to be decomposed into visual and semantic sources within one model.

Building on a prior rating study (n = 123) yielding semantic distance scores for 60 artworks, 38 participants freely viewed the same artworks while eye movements were recorded. We regressed artwork-level gaze entropy/mutual-information against VGG-19 visual features and semantic distance, isolating uncertainty attributable to semantic instability independently of visual complexity.

Mid-level CNN features best predicted gaze mutual information; CNN plus semantic predictors jointly explained substantial variance, while semantic distance alone explained almost none, adding little beyond visual features.

This decomposition separated visual from semantic contributions to gaze uncertainty, showing it was driven almost entirely by visual, not semantic, structure. In other words, viewers look at similar regions regardless of how ambiguous an artwork's meaning is, yet arrive at divergent interpretations: where the eyes travel and how meaning is resolved appear governed by separate processes. This suggests semantic ambiguity is not resolved through observable scanning behavior, motivating a follow-up study testing whether it is detectable neurophysiologically, via fixation-related potentials elicited while viewing artworks varying in semantic distance.

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9:45 – 10:00

Do individual differences in visual perceptual sensitivity generalize across features, tasks, and contexts?

To what extent do individual differences in visual perceptual sensitivity generalize across features, tasks, and contexts? We assessed threshold-level sensitivity for differences in lightness, chroma, hue, shape, orientation, and size in laboratory (N = 63) and online (N = 253) contexts, with large overlap in the participant sample (N = 58). Participants completed discrimination tasks using adaptive staircases in both contexts, and participants in the lab context additionally completed an adjustment task. Thresholds and psychometric functions were estimated using Bayesian hierarchical models, yielding sensitivity estimates for each feature dimension, reference value, and individual.

As expected, perceptual sensitivity was consistently higher in the controlled laboratory setting than in the online context, across all six feature dimensions. Importantly, individual differences in sensitivity showed substantial stability: sensitivity estimates were correlated across reference values and tasks within the same context, and, to a lesser extent, across contexts. Moreover, participants completed several questionnaires to characterize their perceptual and aesthetic processing abilities and experience. Higher perceptual sensitivity was associated with greater aesthetic sensitivity as measured with the VAST-R and stronger art interest as measured with the VAIAK.

Together, these findings provide evidence for shared individual differences in visual perceptual sensitivity across multiple feature dimensions, tasks, and contexts, while also showing associations with aesthetic sensitivity and art interest.

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10:00 – 10:15

Visual attention, aesthetic perception, sensory sensitivity and art expertise: A wearable eye-tracking study in an art gallery

Background: We investigated whether participants' visual attention and aesthetic experiences are influenced by individual differences in sensory sensitivity and art expertise. Previous studies have shown that observers tend to look longer at art works they find aesthetically pleasing, but little is known about how individual differences in sensory sensitivity and art expertise influence visual attention and aesthetic experiences in a real art-gallery.

Method: 59 participants equipped with a wearable eye-tracker looked at visual art works in an art gallery. Participants evaluated each artwork on five aesthetic dimensions and filled in the Glasgow Sensory Questionnaire (GSQ), a self-report measure of sensory sensitivity. Our participants consisted of people without a formal art education, students of the Utrecht Academy of Arts, and several of the artists who created the art works in the exhibition.

Results: We found that participants looked longer at art works they found aesthetically pleasing, emotional, interesting, and powerful. We also found that higher sensory

sensitivity levels correlated positively with longer total fixation durations and a higher number of fixations when looking at the artworks.
Discussion: We are currently exploring how art expertise (i.e., laypeople, formal art education, artists) associates with participants' visual attention and aesthetic judgements to art works, and how art expertise (i.e. formal art education, artists) associates with differences in sensory sensitivity. We also highlight the methodological challenges of wearable eye-tracking studies in real art gallery settings.

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10:15 – 10:30

The effect of re-lighting on the perception of materials in cultural heritage

The effect of re-lighting on the perception of materials in cultural heritage
Cultural heritage imaging is concerned with visually documenting objects for various purposes, e.g. for conservation research. A popular method to document and visually amplify 3D surface detail is Reflectance Transformation Imaging (RTI). This technique uses a series of photos, each taken with a different lighting direction, from the same vantage point. The typical RTI algorithm (a number of variants exist) creates a pixelwise interpolation of the reflection and surface geometry. Although the resulting interactive visualization indeed enhances surface detail, it is not known how it affects the perception of materials.
To investigate this, we compared RTI renders with a 'pseudo' variant that skips the interpolation by using a dense, 1-dimensional sampling along a circular arc with the object in the center. We scanned 14 objects that share material properties with typical objects from heritage collections, but themselves were 'daily' objects so we could let observers interact with them without potential risk of damaging heritage. Participants saw the objects first on a screen (one group saw the RTIs, the other group the pseudo RTIs) where they could manipulate the light source with the mouse. They rated the screen objects on four material dimensions: gloss, roughness, translucency and hairiness. Then, the observers were shown the actual objects and performed the same rating.
Linear mixed modelling revealed that gloss and translucency were better represented in the pseudo RTI but roughness and hairiness were not. Moreover, for gloss, the ratings were noisier in the RTI condition. This shows that RTI indeed fails to communicate the material complexity of a real object.

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10:30 – 10:45

Audiovisual emotional congruency modulates gaze dispersion and aesthetic evaluation of paintings

Audiovisual congruency shapes aesthetic experience, yet the role of visual exploration in this process remains poorly understood. Building on prior fMRI work demonstrating neural differences under audiovisual incongruency (Yilmaz et al., 2025), we investigated how pairing paintings with emotionally congruent or incongruent music affects gaze behavior and beauty ratings. Sixty-one participants viewed paintings accompanied by music that was either emotionally matched or mismatched. Eye movements were recorded and gaze dispersion, which is defined as the spatial variance of fixation patterns, was used to quantify exploratory viewing. Aesthetic evaluation was assessed via beauty ratings after each trial. The results showed that incongruent music significantly increased gaze dispersion, indicating broader, less focused visual exploration under emotional incongruency. Although the spatial distribution of fixations was largely stable across conditions, individual differences in dispersion reliably predicted aesthetic experience: people with more dispersed gaze reported lower beauty ratings. Importantly, audiovisual congruency moderated this relationship. A linear mixed-effects model revealed a robust negative effect of dispersion on beauty, which was significantly amplified under incongruent conditions. These findings can suggest that aesthetic experience is not determined solely by stimulus properties but depends on how people visually engage with the paintings. Future analyses will examine individual differences including arts and music experience, cognitive flexibility, personality traits, and emotional state to reveal how distinct participant clusters differ in their exploratory behavior. Furthermore, we will investigate the degree to which gaze patterns remain consistent within individuals.

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Talk session 1B – (sub-)Clinical
9:15 – 10:45, Ruppert Paars

Chair: Anika van der Klis

9:15 – 9:30

Individual differences in sensory processing sensitivity and their relation to digital health communication

Healthcare is increasingly transforming into the digital realm. The digital transformation of healthcare can introduce inequalities in the distribution, use, and effects of information to patients (the digital divide). Here, we focus on inequalities in the beneficial outcomes (effects) of digital healthcare in relation to perceptual neurodiversity. We assess how individuals low or high in sensory processing sensitivity (SPS) process digital medical information offered in different media formats. High SPS individuals notice more environmental details and process information deeper, but also report overstimulation or fatigue after information processing. We therefore investigated how different digital media formats of health information (text only, text and images, video only, video with subtitles; within-subjects manipulation) affected recall and understanding in groups of high and low SPS individuals. We additionally assessed media format preference, subjective reports of cognitive effort and fatigue, health literacy, and we measured attentional allocation with eye-tracking. As materials, medical information from the Elisabeth-TweeSteden Ziekenhuis (Tilburg) was used about four medical topics. Participants (N=91) were divided (median split) into low and high SPS individuals. There were no differences in recall and understanding across media formats for the high vs low SPS groups, nor an interaction of group x media format. There was a significant effect of medical topic, with certain topics scoring higher on recall and understanding, but this effect did not differ between SPS groups. Media format preference did not differ between SPS groups for the first preferred media format, but when asked about their second preference, there was a non-significant trend for high SPS individuals to choose non-video formats more often than low SPS individuals. We are currently analyzing the eye-tracking data to look into patterns of attention allocation. The outcomes have implications for the prevention of adverse effects of the digital transformation of healthcare for high SPS individuals.

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9:30 – 9:45

Peripheral Refractive Errors Are Associated With Reduced Peripheral Contrast Sensitivity in Pseudophakic Eyes

Peripheral vision is important for everyday visual function, supporting tasks such as navigation and object detection. However, peripheral refractive errors are not optimally corrected following cataract surgery, and pseudophakic eyes may exhibit increased peripheral blur and astigmatism. We investigated whether peripheral contrast sensitivity is reduced in pseudophakic eyes compared with phakic eyes and whether reduced peripheral contrast sensitivity is associated with peripheral optical errors.

Forty-eight participants (24 pseudophakic with monofocal intraocular lenses) completed two runs of monocular peripheral contrast sensitivity testing at 20° eccentricity in the nasal visual field. Participants performed a yes/no detection task for a Gabor patch (0.73°, 1.4 cpd, 500 ms), with contrast controlled using a Bayesian adaptive staircase. Peripheral refraction was measured from 30° nasal to 30° temporal eccentricity using an open-field autorefractor. Peripheral blur and astigmatism were calculated relative to central refraction. Fixation was monitored using eye tracking.

Phakic participants showed higher peripheral contrast sensitivity than pseudophakic participants (1.53 ± 0.18 vs. 1.30 ± 0.22 logCS; $F(1,44) = 23.02$, $p < .001$), after controlling for age. At 20° nasal, pseudophakic eyes showed greater blur (2.40 ± 1.29 D vs. 1.44 ± 0.95 D) and astigmatism (2.96 ± 1.89 D vs. 1.70 ± 0.86 D; both $p = .03$). Greater blur ($\beta = -0.07$, $p < .001$) and astigmatism ($\beta = -0.07$, $p = .002$) predicted lower peripheral contrast sensitivity when controlling for age. Peripheral contrast sensitivity was highly correlated between repeated measurements ($r = .92$, $p < .001$). Excluding trials containing fixation breaks did not meaningfully alter peripheral contrast sensitivity estimates.

These findings demonstrate reduced peripheral contrast sensitivity in pseudophakic eyes and suggest that increased peripheral optical errors contribute to differences in peripheral visual performance following monofocal intraocular lens implantation.

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9:45 – 10:00

ERP correlates of spared categorical visual attentional guidance but compromised memory search in cognitive ageing.

When observers search the visual field for multiple targets held in long term memory, they engage in "hybrid" visual and memory search. Previous studies indicate older adults (OA) show reaction time (RT) costs of memory load comparable to younger adults (YA) in hybrid search, potentially because OA could rely on more global gist-like memory representations. However, we hypothesize that once precise memory representations are required, age related differences in hybrid search may emerge. In 3 Experiments we manipulated categorical similarity between targets and distractors. In Experiment 1, as memory load and target-distractor categorical similarity increased, OA showed longer RT and more mistakes than YA, particularly false alarms. In Experiment 2 we tested if these costs were a consequence of imprecise target representations, or a result of OA potentially compressing information at the basic category level, using distractors with perceptual and conceptual overlap, but from a distinct category (i.e., similar category). We replicated the costs for distractors from the targets' basic category observed in experiment 1, but not for distractors from a similar basic category, suggesting that these age-related differences are limited to discriminating targets and distractors from the same basic category. In Experiment 3 we tested whether OA would switch to a category-based template as memory load increased, as previously described in YA. While replicating the behavioural pattern found in experiments 1 and 2, we found that OA may have relied on coarser category-based templates even under low memory load (as indexed by N2pc amplitude). Furthermore, OA were slower and less accurate at rejecting distractors of the target basic category, compared to YA, despite recruitment of visual working memory resources. Our results suggest that OA, more than YA, rely on general basic-category attributes of the targets during hybrid search, impacting search efficiency when distractors share these attributes.

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10:00 – 10:15

Strategic blink timing supports the perception of task-relevant visual information and varies with age- and disease-related cognitive decline

There is growing evidence that spontaneous blinks are timed according to attentional demands to minimize the loss of critical visual input. We have shown that participants blink strategically during a structured interleaved pro-/anti-saccade task, likely to minimize anti-saccade errors (Pitigoi et al., 2024). However, the process through which this timing is learned was not previously investigated in detail. Here we present video-based eye-tracking data from 703 healthy participants (470 female, aged 5-95 years) performing the same pro-/anti-saccade task. Our findings show that blink timing is quickly modified over the first 40 trials such that blinks decrease in periods that would compromise anti-saccade execution and increase in others. We also found significant differences in blink adaptation between participants with low vs. high anti-saccade error rates. Together, these findings suggest that learning appropriate blink timing may be functionally meaningful for task performance by supporting the perception of task-relevant visual information. Furthermore, blink timing improved gradually from childhood to early adulthood, then declined into older adulthood. This suggests a possible link between blink adaptation within this task and age-related changes in learning capacity and inhibitory control. We will also share new data from neurodegenerative disease patients that suggest blink timing may be a promising behavioural marker for cognitive impairment.

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10:15 – 10:30

(Pseudo)neglect is associated with conservative decision rules on the weaker hemifield

Lateral attentional biases are widespread: young healthy controls show slight biases towards the left side of the visual field, populations with brain damage (most prominently in visuospatial neglect) show strong biases towards the ipsilesional side. Experimentally, lateral attentional biases can be quantified using cueing paradigms (Posner, 1980), or speeded detection paradigms (Bonato, 2010; Blini et al., 2016), most commonly using

accuracy as an outcome measure. While accuracy reflects the consequence and extent of a lateral bias, it does not disentangle how this consequence arises in terms of decision-making processes.
We disentangled this decision process by applying Signal Detection Theory (SDT) to a four-alternative speeded detection task (Bonato, 2010). We applied this approach in young healthy participants (Experiment 1: n = 58) and in two groups of stroke patients with left-hemispheric and right-hemispheric damage (Experiment 2: n = 18, Experiment 3: n = 46). Non-parametric SDT analysis and an according Bayesian mixed-effects probit model revealed that pseudoneglect (healthy controls) was not associated with differences in sensitivity between the left and right hemifield. Instead, it was reflected in a maladaptive criterion shift on the right (pseudoneglected) hemifield.
In contrast, stroke patients showed lower sensitivity shift on the contralesional (neglected) hemifield, as expected. Crucially, stroke patients failed to adjust their criterion according to the sensitivity decrease on the contralesional hemifield, effectively applying non-different criteria on both ipsilesional and contralesional hemifields. Effectively, this implies that accuracy on the contralesional hemifield is not only lower due to a loss of sensitivity but equally results from a suboptimally placed decision rule. Beyond better understanding how neglect affects perceptual decision making, this offers specific and testable routes for therapy. Unlike sensitivity, ample research in other fields shows that criteria can be moved through intervention. Our findings have the potential to substantially improve detection performance and thus reduced symptom severity.

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10:30 – 10:45

Can adaptation to homonymous visual field defects be measured with SONDA eye movement perimetry?

Standard automated perimetry is the gold standard for visual field (VF) assessment but can be challenging to perform. SONDA-EMP (Standardized Oculomotor and Neuro-Ophthalmic Disorder Assessment - Eye Movement Perimetry) simplifies the task to the tracking of a moving stimulus with the eyes. Our previous work showed that cases with VF defects due to acquired brain injury (ABI) have much higher tracking performance than glaucoma cases. The aim of the current study was to determine if improved V defect compensation through eye movements leads to improved SONDA-EMP tracking performance.
32 controls were trained to compensate for a simulated homonymous VF defect (selected from the previous sample of ABI cases) over 3 sessions using compensatory scanning training (CST). Some exercises were repeated in the fourth session as a refresher. SONDA-

EMP was performed before and after training and a third time after the refresher. We examined response times during CST and the SONDA-EMP tracking performance over time and in comparison to the ABI cases. Tracking performance was defined as the agreement between stimulus and gaze positions.
Preliminary data (n=28) show improved response times during CST at the end of training. Moreover, SONDA-EMP tracking performance improved after training and even more after the refresher. However, controls did not reach the same tracking performance as the ABI cases. This suggests that either more training is necessary, or that continued experience with a homonymous VF defect in daily life is necessary for compensation. Crucially, tracking performance without the simulated VF defect did not improve, suggesting that the improved tracking performance can be attributed to the CST and not repeated SONDA-EMP exposure.
Our preliminary findings suggest that learning to compensate for a homonymous VF defect is possible in a relatively short time and that such compensatory behavior can be measured with SONDA-EMP.

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Talk session 2A – Attention, Arousal & the Pupil
11:45 – 13:15, Ruppert Blauw

Chair: Samson Chota

11:45 – 12:00

Attending to things you can't see

Pupil size is modulated not only by physical luminance, but also by cognitive factors such as attention and subjective perception. Yet it remains unclear what happens when physical input and visual experience become dissociated. Can attention still modulate pupil size when we attend to something that is physically present but fades from awareness? Or when we attend to something that is no longer physically there but remains visible as an afterimage? We addressed these questions across two studies using perceptual fading and negative afterimages. Participants fixated centrally while bright and dark peripheral stimuli were presented, and a central cue directed covert attention to one of them. With prolonged viewing, the stimuli perceptually faded due to adaptation, allowing us to examine attentional modulation of pupil size when physical luminance remained present but its subjective perception was weakened. The stimuli were subsequently removed, producing negative afterimages and allowing us to examine attention when visual experience persisted in the absence of corresponding physical input. Pupil size tracked the brightness of the attended stimulus across both situations. During perceptual fading, attentional modulation remained present but was reduced compared with when the stimuli were clearly visible. During afterimages, pupil size tracked the brightness of the attended negative afterimage, reversing relative to the preceding physical stimulus. Together, these findings show that attention can modulate pupil size when the usual correspondence between what is physically present and what is consciously seen breaks down, suggesting that the pupil provides a window into how attention operates across different levels of visual representation.

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12:00 – 12:15

Pupil Constriction Causes Activity in the Human Retina and Visual System

Pupil responses shape the earliest stages of visual perception by regulating the amount of light that enters the eye. How this affects visual processing is still poorly understood. Here we present evidence that pupil constriction causes activity in the human retina and visual system, independently of visual stimulation. Healthy human participants (N=119) viewed brief visual stimuli (light increments or decrements) while pupil size, retinal activity

(electroretinogram), and brain activity (electroencephalogram) were recorded. As expected, visual stimulation triggered an initial burst of retinal activity followed by pupil constriction (the pupil light response). Importantly, we used trial-to-trial variability in constriction latency to reveal a previously unknown retinal response that is locked to pupil constriction, rather than to visual stimulation. Presumably, and in line with similar findings in mice, this constriction-locked retinal activity is a response to the sudden decrease in retinal light exposure that accompanies pupil constriction (although contribution of iris muscle activity is not conclusively ruled out). A similar constriction-locked response emerged later over visual cortex. Given these findings, an important open question is how the visual system maintains brightness constancy despite pupil-induced retinal and cortical activity.

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12:15 – 12:30

Larger pupils are linked to enhanced visual, but not auditory, detection.

In visual detection tasks, larger pre-stimulus pupil size is associated with improved performance. This improvement is attributed to both optical and arousal-related effects. The optical effect refers to the improved sensitivity that follows from an enlarged pupil allowing more light to enter the eye. The arousal effect refers to the improved performance that follows from a more optimal level of arousal, which is also reflected in the size of the pupil. In a recent EEG experiment, we discovered that these effects may be partially distinct. To dissociate these effects, we explored the impact of pupil size on detection performance across different sensory modalities (visual and auditory).

We hypothesized that in the visual condition the relationship between pupil size and accuracy would be roughly linear, reflecting the combination of arousal and an optical effect. Conversely, in the auditory condition, this relationship was expected to follow an inverted-U shape, representing only the arousal effect. We collected pupil size data while participants performed a task consisting of detecting faint visual and auditory stimuli. Stimulus parameters (opacity and volume) were adjusted using a staircase procedure to maintain a performance level of 75% accuracy in both modalities.

We found a significant interaction between pupil size and task modality in determining accuracy. As expected, in the visual condition pupil size showed an approximately linear relationship with accuracy, such that larger pupils were associated with improved detection performance. Conversely, in the auditory condition the relationship more closely resembled an inverted-U shape, with larger pupils being associated with decreased performance

relative to intermediate pupils. We conclude that in the visual condition performance is determined by a combination of a pupil-related optical effect and fluctuations in arousal, while in the auditory condition performance is mainly determined by fluctuations in arousal.

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12:30 – 12:45

The Effects of Interruptions on Stimulus-Driven Attention

Task interruptions are very common but costly, as they can slow down performance and increase errors. Existing cognitive models of interruptions chiefly explain these costs in terms of memory lapses; however, these accounts do not consider if and how interruptions may also affect selective attention. In an effort to bridge this gap, we investigated the effects of task interruption on stimulus-driven selective attention. Healthy adults performed a visual search task with a left- or right-tilted target among a field of uniformly tilted background items, and an oppositely tilted distractor. Critically, depending on the tilt of the background items, the target could be more or less salient than the distractor. On a subset of trials, at semi-regular intervals, search was interrupted by a brief math task. Results showed a larger salience effect post-interruption on reaction time, as well as on the number of fixations and time needed to find the target. In terms of selection behaviour, interruptions slowed down overall saccade latency and made eye movements more salience-driven. Detailed time-series decomposition of these two measures revealed that the effect of salience on selection was both stronger and more protracted in time after an interruption, and that this was independent of relevance-driven processes. These findings suggest that the effects of interruptions are not limited to memory: interruptions also interact with stimulus-driven attention, making visual search slower, less efficient, and more susceptible to stimulus salience.

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12:45 – 13:00

Affective salience modulates learned suppression: Evidence for residual attentional priority at fear-associated locations

Efficient visual search requires suppressing task-irrelevant distractors. Statistical learning of a distractor's likely location typically reduces its interference, even when it's visually salient. It remains unclear, however, whether this learned suppression is uniform across distractors or is instead modulated by a distractor's affective saliency. We addressed this question using an additional singleton task in which participants searched for a unique shape while either a fearful or neutral face served as distractors at separate, equally frequent high-probability locations (HPFearL, HPNeutralL) versus low-probability locations (LPLs). Behavioral results showed that neutral as well as fear distractors were suppressed at both HPLs compared to LPL. However, neutral distractors were suppressed equally at HPFL and HPNL, while fear distractors produced reliably slower responses at HPFL than at HPNL. This pattern may indicate that, relative to HPNL, fear distractors at HPFL captured more attention, held attention for longer, or both. Computational modeling supported a reduced-capture account for both distractor types, indicating that learned suppression operated primarily by reducing the probability of initial capture rather than by speeding disengagement. Critically, model-derived capture probability was higher at HPFL than at HPNL for fear distractors, but did not differ for neutral distractors, suggesting that the behavioral asymmetry was due to enhanced capture of the fear distractor. Together, these results suggest that affectively significant distractors retain residual attentional priority at their own learned location, such that statistical learning fails to fully suppress initial capture by fear-related distractors even after extensive location-based learning.

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13:00 – 13:15

Affect in the Latent Space: Identifying Affect-Related Directions in the Latent Space of Unsupervised Variational Autoencoders

Most of our lives are spent in indoor environments, which in turn shape our emotions and behavior. Yet we know little about which visual characteristics drive our responses to these environments, regarding both affect and theoretical constructs such as mystery. This work introduces a framework to extract interpretable affect-related dimensions from unsupervised machine learning models, combining visual perception, environmental psychology, and machine learning. We used the Image Database for Everyday Affective Spaces (IDEAS): 1,800 photographs of the six most frequented indoor environments (living rooms, dining rooms, kitchens, bedrooms, offices, restaurants) rated on valence, tense, and energetic arousal. Images were encoded with five variational autoencoders

(VAEs), and partial least squares (PLS) regression predicted affective responses using VAE latent representations. The PLS components per affective dimension are termed Affective Control Vectors (ACVs): latent space directions along which predicted ratings change. We evaluated PLS models with 1–10 components using 5-fold cross-validation, selecting model with the lowest Bayesian Information Criterion. For all dependent variables, high-dimensional latent space was reduced to only two or three PLS components, while retaining strong predictive power. Latent representations of the best-performing VAEs explained 45%, 55%, and 60% of variance in valence, tense arousal, and energetic arousal, respectively, and substantial variance in constructs central to environmental psychology: 46% in mystery, 45% in prospect–refuge and 77% in perceived naturalness. Furthermore, decoding latent representations along an ACV produced continuous, controlled image variations, revealing which low- and mid-level visual features, including previously unreported ones, co-varied most with each affective dimension. Our findings show that VAE models encode affect-relevant information despite lacking affect-related supervision, supporting the view that affective responses are rooted in perceptual processing. Our framework provides a simple, scalable method for probing the latent space of VAEs and generating controlled image variations that systematically shift along affective dimensions.

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Talk session 2B – Space & Magnitude
11:45 – 13:15, Ruppert Paars

Chair: Krista Overvliet

11:45 – 12:00

Visual Attention doesn't Travel, it Teleports

Attention forms a key, yet elusive component of visual processing. We shift attention constantly across the visual field to enhance processing of relevant locations or stimuli in service of goal-directed behavior. Here, we investigate a fundamental property of attentional shifts: when covertly shifting from one location to another, does visual attention "travel" (enhance processing at intermediate locations) or "teleport" (not interact with intermediate locations)? While most shifts of information or movement "travel" (e.g., eye and body movements, neuronal signalling), for attentional shifts such intermediate processing enhancement might not be necessary, nor functional. To answer this question while tackling the difficulty of tracking covert attentional dynamics, we conducted an EEG-eyetracking experiment (n=24) paired with Rapid Invisible Frequency Tagging (RIFT). This let us track attentional enhancement during covert attentional shifts with high temporal and spatial precision. We successfully registered covert shifts, but found no evidence for any attentional modulation in-between the start and end-point of an attentional shift. Additional in-silico modelling of attentional shifts confirmed that our method was sensitive enough to pick up on these modulations had they been present. Our results support a "teleporting" model of attention, suggesting that attention is implemented in a fundamentally different manner compared to overt visual behaviours such as eye movements.

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12:00 – 12:15

Peripheral Ear-Specific Selective Speech Adaptation is Not a Location-Contingency Effect

Prolonged exposure to speech can induce selective speech adaptation (SSA), which is sub-served by an early peripheral (ear-specific) and a later central mechanism. However, SSA

can be made contingent on particular stimulus features, and we investigated whether peripheral ear-specific SSA can be explained via a location contingency. As a starting point, we exposed participants to monaural left-right alternating Dutch vowels /ø/ and /e/ via headphones, followed by monoaural testing with sounds from an /ø/-/e/ continuum. This procedure induced substantial and relatively long-lasting peripheral SSA (Experiment 1). In Experiment 2, we presented dichotic/simultaneous adapters and tested participants with headphones or via loudspeakers. SSA was about four times larger for headphones than for loudspeakers, providing a first indication that peripheral ear-specific SSA (obtained with headphones) is not a mere location contingency effect (obtained with loudspeakers). In three control experiments, we showed that (i) the typical SSA effect with stereo stimuli was similar for headphones and loudspeakers, (ii) the ability to actually locate the left/right exposure vowels in the alternating and dichotic/simultaneous exposure stimuli was similar for headphones and loudspeakers, and (iii) identification of the (individual vowels of) in the dichotic/simultaneous stimuli was also similar for headphones and loudspeakers. The larger SSA effect for headphones in Experiment 2 is thus not related to critical differences between headphones and loudspeakers and is unlikely to be explained via a location contingency. Instead, the full separation of the headphone input channels allowed for an optimal engagement of peripheral SSA mechanisms, that are likely driven by the acoustics of the exposure sounds.

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12:15 – 12:30

The unique representation of zero in the human brain

Zero is a cornerstone of numerical processing and higher-order abstract numerical representations. Some studies suggest that neural responses to zero in the frontal cortex and hippocampus share a continuous representation with those to other numbers. Conversely, other evidence suggests that some neurons exhibit distinctive response patterns to zero, supporting a partially distinct representation of zero. Therefore, it remains unclear how zero's neural representation is organized in the human brain. We have previously found neural population responses to numerosity following logarithmic Gaussian tuning functions, with numerosity preferences gradually varying in topographically organized numerosity maps. We therefore asked whether zero processing is also as part of these tuning functions and topographic numerosity maps. To address this question, during ultra-high field 7T fMRI we presented participants with numerosity 0 and the countable numerosities 1–5 in a random order, with an even-odd number judgment task. This random order allowed us to estimate response amplitudes for each numerosity independently using

a general linear model (GLMsingle). We then fit population receptive field (pRF) models to the response amplitudes for each numerosity. Our results showed numerosity-tuned neural populations in locations consistent with previous numerosity mapping studies, though topographic map organization was less clearly visible compared to traditional pRF experimental designs. A combined model incorporating a Gaussian function to predict responses to numerosities 1-5 and a separate response to zero identified neural populations exhibiting distinct responses to zero. These populations were relatively independent of those showing tuned responses to countable numerosities. Overall, our findings suggest that zero is processed in neural populations near countable numerosities yet is not integrated into topographic numerosity maps. Instead, zero may be encoded by a distinct nearby cortical representation, reflecting both its special numerical status among numbers and its nature as an abstract representation of sensory absence.

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12:30 – 12:45

Functionality versus modality: finding the fundamental organizational principle of working memory storage

Working memory (WM) is commonly described as a modality-specific storage system, as proposed by influential theories such as the multicomponent model and the sensory recruitment hypothesis. These frameworks have encouraged the view that visual and auditory information are maintained in separate sensory systems. However, recent work has suggested that the modality of WM content can be changed to match the modality of the recall task. Here, we go beyond that and hypothesize that certain types of information are inherently better suited for one modality than the other. Specifically, auditory storage may be functionally better suited for temporal information, while visual storage may be functionally better suited for spatial information, irrespective of the encoded modality. Across two experiments (N=72), participants performed a delayed reproduction task with stimuli that were either dispersed in time or in space (i.e., temporal versus spatial memory task). Targets were presented auditorily or visually, followed by either an auditory interference task (repeating words out loud), a visual interference task (following dots with eye movements), or no interference during the delay. Participants then reproduced the memorized temporal or spatial memory content via mouse clicks, excluding response modality confounds. A clear interaction emerged: temporal sequences were reproduced

more accurately when encoded auditorily, whereas spatial patterns were reproduced more accurately when encoded visually. Although both interference tasks reduced overall performance, this impairment was neither selective to the modality (auditory versus visual) nor to the functionality (temporal versus spatial) of the memory content. These findings suggest that WM storage is neither strictly organized by modality nor by functionality, but may instead rely on a more abstract or flexible format that adapts to interference.

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12:45 – 13:00

A third dimension of the V1 orientation manifold makes cardinality explicit

Orientation is encoded as a circular variable in primary visual cortex (V1), but the geometry of its population representation remains incompletely understood. Behavioural and neuroimaging studies report differences between cardinal (horizontal and vertical) orientations, and obliques. Existing accounts relate these anisotropies to neuronal tuning, shaped by environmental statistics, and perceptual priors. Accounts anchored at the level of local precision, however, do not uniquely determine the representational geometry of population responses. Representational format constrains the computations through which downstream circuits can extract encoded information. Following the principle of representational untangling, we asked whether the macaque V1 population code makes cardinality linearly explicit: accessible to a common linear readout across category-preserving changes in orientation.

Using demixed Principal Component Analysis of macaque V1 multi-unit responses to natural images, we identified an additional cardinal-phase coordinate accompanying the orientation ring manifold. In responses to held-out images, the ring coordinates supported readout of orientation identity, whereas the cardinal coordinate supported a linear readout of cardinality across orthogonal orientation pairs. Cardinality was also recoverable through a nonlinear transformation of the ring coordinates, showing that the additional coordinate made existing category information accessible to a linear readout.

A CNN-based encoding model, fit to predict the recorded multi-unit responses from its internal representations, reproduced both the orientation ring and the cardinal coordinate. We then used it to synthesize images that steer the population state to target locations in latent space, yielding maximally oriented images for each orientation and cardinality.

In sum, these findings support cardinality as an explicit, linearly accessible feature of V1 population activity, and provide an image-computable model for targeting this geometry with synthetic stimuli.

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13:00 – 13:15

The size-weight illusion without deception

The size-weight illusion makes the smaller of two objects of the same mass feel heavier. In textbooks, this illusion is often explained in terms of objects inducing prior expectations: an object can be expected to be heavier than another if it is larger, especially when they are made of the same material. Typically, the illusion is studied with deceptive pairs of objects. For instance, by removing material from the inside of the larger object so that it is equally heavy as the smaller one, the size difference leads to incorrect expectations of a weight difference. And indeed, such objects induce clear misjudgments of weight after lifting: the larger object feels not only lighter than expected, but also lighter than the smaller object. Based on this reasoning, one would predict the illusion to be reduced when objects are not deceptive. We tested this using two dense objects (made of brass), each judged relative to familiar reference object of considerably lower density that consequently were larger (a tennis ball and a filled liter carton). Thus, the objects were not manipulated to deceive observers, but differed in material, size, and weight. As the brass objects are expected to be lighter due to their size, but heavier due to the difference in material, one might expect to see very little misjudgment of weight. Instead, we found a very strong illusion: on average, the weight of the brass objects was overestimated by more than a factor of 2 relative to the reference objects. The size-weight illusion is thus not reduced by removing the deception, which provides strong evidence against explanations of weight illusions that are based on incorrect expectations.

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Talk session 3A – Prediction & Timing
14:00 – 15:30, Ruppert Blauw

Chair: Heleen Slagter

14:00 – 14:15

No evidence for proactive suppression of probable distractors: a RIFT-EEG study

Attentional capture by salient but task-irrelevant distractors can be reduced through statistical learning of their spatial regularities, but whether this suppression is proactive (occurring before stimulus onset) or reactive (occurring only after) remains debated. We addressed this question by combining Rapid Invisible Frequency Tagging (RIFT) with EEG, allowing us to track neural responses to targets and distractors continuously across both pre- and post-stimulus periods. Participants (N = 24) performed an additional singleton task in which a salient color-singleton distractor appeared more frequently at one location (high-probability, HP) than at others (low-probability, LP). Behaviorally, distractor interference was reduced at HP relative to LP locations, suggesting that the learned suppression of probable distractors. RIFT responses showed that distractor-evoked coherence was reduced at HP relative to LP locations, but only following stimulus onset, with no evidence of modulation during the prestimulus period. This result indicates that distractors at predictable locations are suppressed reactively, rather than proactively. Converging ERP results showed a reduced late, but not early, distractor positivity (Pd) for HP relative to LP distractors, while prestimulus alpha lateralization did not differ between conditions. Together, these findings indicate that statistically learned distractor suppression unfolds reactively, after stimulus onset, challenging accounts in which predictable distractors are proactively suppressed in advance.

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14:15 – 14:30

Using Dynamic Neural fields in Human-Robot Joint Action

As robots become more integrated in our professional and everyday environment, the need for human-like collaboration increases. Joint action is a concept of collaboration characterized by aspects of joint attention, shared task knowledge, action anticipation, joint collaboration and goal inference. Dynamic Neural Fields (DNF) are a biologically inspired

method of implementing necessary precursors of joint action like action anticipation, shared task knowledge and goal inference. However, whether such cognitive skills of the robot improves user experience remains unclear. Previously, we have shown that action anticipation can greatly benefit user experience. The aim of this study was to determine whether the same is true for action goal inference. To do so, we developed a joint sorting task in VR, where participant and robot had to put long and short, blue and yellow objects in a bin. Long objects had to be carried together and short ones could be carried individually. A DNF model was implemented that could automatically decide whether to jointly carry a long object or use a complementary action depending on the inferred goal of the user. We validated experimentally (n=20) the effect of using goal inference on user experience by comparing conditions where the goal of the action was either known/unknown/inferred. Results indicated no effect of using goal inference on user experience and task performance compared to the unknown condition, although goal inference did improve perceptions of competence and intentionality. A possible explanation is that participants did not notice much change in behaviour of the robot between conditions. Thus, the DNF model was implemented successfully and was able to infer action goals and switch between collaborative and complementary actions. The presumed positive effect of this capability still needs to be demonstrated.

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14:30 – 14:45

Early visual cortex rapidly anticipates high-level information during naturalistic free viewing

Humans actively acquire several visual inputs (i.e., fixations) per second, gathering information to build understanding of the environment. Such fixations vary in the amount by which they convey novel information, or by which their contents could already be predicted from scene context. Predictiveness modulates visual cortical responses in static viewing settings. However, it remains unclear whether and how context-based informativeness is represented in visual cortex during active visual sampling. Here, we analyzed a large-scale naturalistic scene-viewing dataset comprising more than 200,000 fixation epochs with head-cast magnetoencephalography (MEG) recordings. We quantified the visual and semantic informativeness of each fixation patch using several deep neural networks (DNNs) and examined their associations with neural activity. We found that cortex tracks both low- to medium-level visual informativeness, as well as semantic informativeness, of currently fixated image patches with distinct patterns across anatomical regions, frequencies, and latencies. Strikingly, semantic informativeness was positively associated with activity in early visual cortex even before foveation. These results indicate that early visual cortex is highly sensitive to not only visual but also high-level semantic information during active vision and, critically, exhibits anticipatory sensitivity to the semantic information of upcoming fixations.

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14:45 – 15:00

Foveal remapping of task-relevant features for peripheral stimuli

Vision highly dominates human perception, yet many mechanisms remain poorly understood. For example, when an object suddenly appears in the periphery – such as a car while crossing the road – it is still unclear how the brain represents it in order to make fast, accurate decisions. Recent evidence suggests that peripheral objects can be remapped onto foveal early visual cortex, perhaps leveraging its high resolution to aid discrimination. Here we investigate the representational nature of this foveal remapping, using functional magnetic resonance imaging. Participants (N=36) viewed briefly presented objects (for 100 ms) in the periphery while fixating centrally and making object categorization judgments. Stimuli were continuous morphs between object pairs (e.g., horse–bear, car–truck), and categorization tasks requiring within-category (horse vs. bear) decisions. We decoded task-relevant (animacy, category) and irrelevant stimulus features (e.g. direction of animal facing) from foveal early visual cortex. We were able to decode task-relevant, but not irrelevant features. Furthermore, we were able to cross-decode in the foveal early visual cortex between conditions when stimuli were presented in periphery to the same stimuli presented in the fovea suggesting a similar representational format for task-relevant features. Moreover, decoding of category information was only significant when participants made correct decisions, suggesting behavioural relevance of these foveal representations. Together, these results suggest that early visual cortex may act as a high-resolution buffer onto which stimuli presented in the periphery may be remapped to provide higher resolution representations to aid visual perception.

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15:00 – 15:15

Briefer than brief - Uncovering the true temporal resolution of the visual system
The temporal resolution of vision is seriously limited. However, the response to a very brief flash, called the impulse response, is already quite sluggish at the earliest stages of vision, potentially obscuring the true temporal resolution of the rest of the visual system. Faster monitors that produce briefer flashes are subject to diminishing returns because, by definition, they cannot elicit responses that are any briefer than the impulse response. Here, taking inspiration from previous attempts, we develop a novel technique for presenting flashes that elicit 'briefer-than-brief' visual responses. Using a simple deconvolution technique, we reverse-engineer the visual response and estimate the form that the stimulus should take to elicit the response that a faster visual system would produce to a normal flash. Using psychophysics on human observers, we demonstrate that these "briefer-than-brief" (BTB) flashes partially bypass the temporal limits presumably imposed by the early visual system using two paradigms: one that requires temporal segregation and one that requires temporal integration of sequential flashes. With BTB flashes, human observers successfully isolated two successive flashes at shorter intervals than with conventional flashes, improving temporal resolution by around 16%. We found that BTB stimuli not only improved temporal resolution, but also induced poorer performance on tasks requiring temporal integration, suggesting that the visual responses elicited by BTB flashes overlap less in time due to their briefer duration. In sum, our findings suggest that, using reverse-engineered stimuli, we can alleviate a temporal bottleneck that probably originates from the earliest stages of vision. In doing so, we allow higher visual areas to operate at a higher temporal resolution than previously thought possible.

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15:15 – 15:30

Predicting What, Predicting When: A Layer-Resolved Study of Cortical Inference in Human Auditory Cortex
Predictions based on stimulus regularities are fundamental for adaptive perception behavior. However, while predictions of different stimulus features such as contents ("what") and timing ("when") may facilitate sensory processing, they are likely mediated by dissociable neural mechanisms. Here, we analyzed local field potentials recorded from the superior temporal gyrus (STG) using laminar probes (N=5) and from the cortical surface using electrocorticography (N=22) in patients with epilepsy undergoing surgical monitoring. Patients performed a discrimination task on auditory syllables whose "what"

and/or “when” predictability depended on preceding visual cues. “What” and “when” predictability elicited dissociable laminar profiles of STG activity. Specifically, while “what” predictability modulated activity in superficial and deep layers, “when” predictability only affected deep layers. Additionally, both types of predictions interactively modulated activity in deep and middle layers. These results provide direct evidence for functional dissociations and interactions between different types of predictability in cortical microcircuits, showing that “what” and “when” predictions engage different laminar processes.

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Talk session 3B – Confidence & Metacognition
14:00 – 15:30, Ruppert Paars

Chair: Joris Vincent

14:00 – 14:15

Distinct Neural Codes of Past and Present Goals in Prefrontal Cortex

Past experiences affect current sensorimotor decision-making, a phenomenon known as serial dependence. However, the neural mechanisms of such priming-like effects remain controversial. While extant studies have demonstrated concurrent neural representations of previous and current targets, the representational format of previous and current targets remains unclear. We here leveraged large-scale neural population recordings from macaque lateral prefrontal cortex to characterize the neural code of previous and current working memories. In parallel to robust serial dependence in behavior, we found that the

previous target was represented already before the target onset of the next trial. Moreover, after target onset, we found that prefrontal cortex concurrently represented the position of previous and current working memory targets. Importantly, cross-decoding was not possible, demonstrating distinct neural codes of previous and current working memories. To further characterize these codes, we examined spatial coding of individual neurons. Only few neurons were spatially selective to both current and previous targets, and when neurons were selective to both, a vast majority shifted tuning profiles among different trial epochs. Together, we provide converging evidence from population and single-unit analyses to demonstrate that past and present goals are concurrently represented in prefrontal cortex, yet they are represented in distinct neural patterns.

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14:15 – 14:30

Dynamic regulation between internal storing and external sampling reflects costs tradeoffs

When reproducing information from the environment, people can either maintain it in visual working memory (VWM) or resample it directly from the external world. Although both strategies are well documented, the factors that drive strategy selection remain unclear. A straightforward account is that strategy choice reflects VWM load: the more items successfully maintained, the less need to resample. However, this account assumes that behavior directly reflects memory load, which is difficult to verify from behavior alone. More broadly, strategy selection may reflect a tradeoff between internal costs and external costs, but this hypothesis has never been directly tested.
Here, we combined EEG and pupillometry in a modified copy task where participants could freely choose whether to resample the model display. Contralateral delay activity (CDA) indexed VWM load, while pupil size indexed cognitive effort. We found that CDA alone failed to predict strategy choice, whereas pupil size provided significant predictive power above chance. This suggests that strategy selection depends more on internal cognitive state than on objective memory quantity. Finally, strategy updating across trials was predicted by the interaction of previous-trial effort and time cost: participants were more likely to switch strategy when the preceding trial was both effortful and time-consuming. These results reveal that VWM strategy selection is adaptively regulated by the tradeoff between internal effort and external time costs, updated dynamically across trials.

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14:30 – 14:45

Humans learn to distinguish imagination from reality with age

Telling apart what is the product of one's imagination and what is a true sensory experience (i.e., reality monitoring) might feel trivial to most. Yet it remains unclear whether reality monitoring is an innate ability (like breathing, or aversion to pain) or whether it is a learned skill (like speaking, or walking). Here we extend the age range of participants tested by Dijkstra and Fleming (2023) with young children from the age of 5. In a close replication, we tested how likely participants were to report actually seeing a faint left or right tilted grating in dynamic noise, depending on whether they were concurrently imagining the same or an orthogonal grating. We found clear evidence that confusion of imagery and perception steadily declined to none with age - independent of perceptual ability or (subjective) imagery vividness. We empirically show that the ability to tell apart imagination from reality develops over age. These findings provide new insights on how we learn to keep apart imagination from reality, which has important implications for the development of psychopathology.

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14:45 – 15:00

Faces in Focus - Decoding Emotion and Gender in Visual Processing

Human perception is not merely a passive reflection of sensory input but is strongly shaped by current goals, expectations, and task demands. Prior work has shown the anticipatory and task-driven nature of perception (Uithol et al., 2021). Building on this idea, the present fMRI study (n=21) investigates how task instructions modulate the neural processing of faces and expressions. A key innovation of our paradigm is that participants first completed a calibration step, in which they selected faces that, in their view, best represent gender categories (male, female, or androgynous). This procedure yields an individualized stimulus set that accounts for variability in how gender cues are perceived. With this calibrated stimulus set further differed across emotions (happy, neutral, fearful expressions). We then tested whether neural responses differ when participants perceive and categorize either emotion or gender of the same stimuli. Searchlight multivariate

pattern analysis (MVPA) was applied to decode activation patterns across the brain (cluster-level FWE-corrected). The task could be decoded during an anticipatory period before face onset, in bilateral inferior frontal gyri, pre-supplementary motor area, left intraparietal sulcus, and early visual cortex (V1-V2). When task-irrelevant, emotional expressions could be decoded in early visual cortex, whereas face gender was decodable in ventral occipital and right premotor cortex. These findings highlight how top-down, task-driven influences shape perception, providing insights into the nature of goal-directed cognition.

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15:00 – 15:15

Confidence emerges late in the cognitive-process sequence and is not domain-general

In daily life we make many decisions, and we feel varying degrees of confidence about each one. We can report after the decision how confident we feel. However, even while the decision is still being made, neural signals related to confidence have been found. When viewing this decision as a sequence of cognitive processes, it remains unclear where in the sequence confidence emerges, and whether its neural code is shared across tasks.

We address these questions by segmenting single-trial EEG into sequences of cognitive processes using hidden multivariate pattern (HMP) analysis. We used six datasets (150 participants total) spanning motion discrimination, brightness judgment, and orientation detection tasks. A sequence model trained jointly on all datasets represents each detected process as a point in a shared space, so that processes from different datasets could be compared directly.

Within each dataset, subjective confidence could be decoded from these representations in held-out participants independent of variance explained by response time, accuracy, and difficulty. Decodability generally increased over successive cognitive processes and peaked around the response. This suggests that confidence signals are mostly related to processes later in the trial.

Processes from different datasets landed in the same regions of the shared space when they occurred at similar points in the trial, early processes resembled other early processes, regardless of the task. Despite the shared space, confidence did not transfer between datasets. A decoder trained on one dataset barely predicted confidence in another, while a decoder for task difficulty transferred well between those same datasets.

Together, these results suggest that confidence is built up late in a sequence of processes, similarly across tasks, while the content of the confidence signal is shaped by the specific task. Thus, confidence appears to be task-specific rather than domain-general.

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15:15 – 15:30

Metacognition in Ensemble and Single-Object Perception

Humans can efficiently extract summary statistics from visual ensembles, yet it remains unclear whether they can accurately monitor their own perceptual decisions in such contexts. We compared metacognitive ability between ensemble and single-object perception. On each trial, participants viewed either twelve Gabor patches arranged on a circle (ensemble condition, with 4:8 or 8:4 ratios of vertical versus horizontal orientations) or a single Gabor presented at a random location while the remaining positions contained noise patches. Participants identified whether the predominant (or single) orientation was vertical or horizontal and rated their confidence. Behavioral responses, pupil size, and EEG were recorded. Metacognitive efficiency (M_ratio) was significantly lower for ensemble than for single-object perception ($p < .05$). Further analysis revealed that on incorrect trials, participants were paradoxically more confident in the ensemble condition ($p < .001$). Pupil size also showed attenuated confidence-related modulation in the ensemble relative to the single-object condition, suggesting reduced differentiation of decision uncertainty. Time-frequency EEG analyses further revealed that confidence-related posterior oscillatory activity differed between conditions. During single-object perception, low confidence was associated with greater posterior power than high confidence from approximately 0.4 to 1.3 s after stimulus onset (6–24 Hz, $p = .001$), whereas no significant confidence-related difference emerged during ensemble perception. The difference in confidence-related activity between conditions emerged at approximately 0.5 s and extended to 1.35 s (5–24 Hz, interaction $p = .014$), remaining significant when analyses were restricted to correct trials ($p = .013$). Thus, increased posterior 5–24 Hz activity was particularly associated with lower confidence during single-object perception, while this confidence-related neural differentiation was attenuated during ensemble perception. Together, behavioral, pupillary, and EEG findings indicate reduced metacognitive access during ensemble perception, potentially because ensemble representations provide less detailed cues for self-evaluation and instead support confidence based on less-precise, gist-based representations.

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Abstracts – Posters

P1

The costs of resizing the attentional field

Visual spatial attention determines the degree to which information from our surroundings is processed. The size and shape (attentional field) of the area we attend to can be flexibly changed, but it is unclear whether there are costs associated with those changes. Previous work has shown that pupil size reliably reflects cognitive effort, including the effort of eye movements. The current study therefore tested whether resizing the attentional field is costly, using pupil size as an index of cost. To this end, participants were auditorily cued to attend one of two differently sized overlapping circles. Within these circles dots shifted from random to coherent motion to the left or right, and participants reported the motion direction. To equate task difficulty, the performance for each of the two sizes was staircased separately. Each trial consisted of two intervals, in which the cued field could either stay the same or switch to the other size. Pupil size did not differ between attending the broad versus the narrow circle, indicating no cost difference between field sizes. In contrast, pupil size was significantly larger when the cued size switched compared to when it stayed the same, indicating that it is the reconfiguration of attentional breadth, rather than the size of the field itself, that is costly. Specifically, the cost of switching was asymmetric; switching from a narrow to a broad field was associated with larger pupil sizes than switching from a broad to narrow field. Together, these findings show that reconfiguring the attentional field, rather than holding a given size, is effortful, and lay the groundwork for future work on attentional resizing.

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P2

Usage of auditory and haptic landmarks as directional cues by blind individuals in a route memory task

Blind individuals can receive Orientation and Mobility (O&M) training to learn how to navigate using auditory and haptic cues. Previous research suggests that O&M instructors often prioritise haptic information in their instruction, though some instructors adopt a more multisensory approach that also centers the use of auditory information. In turn, recent studies suggest that blind individuals themselves have clear preferences for one modality above the other, however, it remains unclear whether cue modality impacts how well a route is remembered by the client. The current study investigated route memory performance in blind individuals while using auditory versus haptic cues, and examined whether performance was related to subjective cue preferences.

We expected better route memory performance when participants can use their preferred versus non-preferred cues. An indoor route learning experiment was carried out. Fifteen blind participants learned and subsequently retraced indoor routes in which auditory or haptic directional cues were presented at left/right decision points. Cues were either placed in the environment or presented via a handheld device. Route-memory performance was assessed based on correspondence between the learned and remembered routes, including route overlap, shape similarity, correct left/right decisions, endpoint deviation, and the number of stops. Subjective cue preferences were measured using the Personal Sensory Navigation Profile Questionnaire. Preliminary analyses suggest that the participants in our sample did not have a clear subjective preference for either auditory or haptic cues, but rather for neither or for both. Furthermore, route memory performance did not differ between auditory and haptic cue conditions. We will further discuss how blind individuals use auditory and haptic cues for navigation in relation to their subjective cue preferences.

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P3

Does uncertainty reduction drive naturalistic, unconstrained visual sampling? A CityLab study

We are driven to gain knowledge about ourselves and our environment even when there is no obvious 'reward'; that is, we are curious to learn for the sake of information itself. Uncertainty, in the sense of a lack of information, is a necessary precondition for curiosity. However, people differ in how curious they are and how driven they are to learn, possibly due to individual differences in the need to reduce uncertainty. Moving beyond deliberate learning and the constrained setting of a task, we devised a 'micro-experiment' for CityLab. We aim to investigate whether uncertainty reduction drives naturalistic, unconstrained visual sampling in a large and diverse sample (N > 1,000), what kind of uncertainty is reduced, and to what degree this is modulated by personality traits such as intolerance of uncertainty. Participants will explore three images from a subset of the Natural Scenes Dataset (NSD), each initially covered by a black mask. Using a touchscreen, they can reveal as many circular patches as they like, for as long as they like. At the end they will rate how much they like the images, and they will also complete four items from the Intolerance of Uncertainty Scale. By comparing the cumulatively revealed image regions to the full image, we can estimate how much uncertainty is reduced. Using neural networks, we can additionally quantify the type of uncertainty that is reduced, ranging from low-level visual information to higher-level semantic scene understanding. Moreover, because sampling is costly, we can investigate when people decide to stop sampling and whether, for

example, people who are less tolerant of uncertainty oversample. This approach allows us to study the principles of visual sampling under conditions that closely resemble everyday life.

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P4

Intercepting accelerating targets with the help of sound

We know that people are very poor at visually judging acceleration, and consequently do not consider visual estimates of acceleration when intercepting moving targets. As a result, their interceptive movements end up slightly behind accelerating targets and ahead of decelerating ones. If the target repeatedly accelerates in the same manner, people quickly learn to compensate for such errors. But if the acceleration varies from trial to trial, they keep making systematic errors. We have previously shown that providing information about the acceleration in the form of different background images (ice for a constant velocity; sand for strong deceleration) does not help cope with acceleration. Here we examined whether an accompanying sound rather than a background image does help. We interleaved accelerating targets that were accompanied by a sound that increased in both volume and frequency with decelerating targets that were accompanied by a sound that decreased in volume and frequency. Adding such sounds reduced the systematic errors associated with ignoring acceleration considerably. The sounds did not provide actual information about the acceleration. Neither did the sounds influence the time taken to perform the interceptive movements. Presumably participants learnt to aim further ahead of the moving target when they heard the sound with increasing volume and frequency than when they heard the other sound.

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P5

Sensory Sensitivity and ERP Markers of Auditory Selective Attention in Neurotypical Adults

Heightened sensory sensitivity affects approximately 20% of the neurotypical population and is associated with daily challenges and a reduced quality of life. Despite its prevalence, the underlying neurophysiological mechanisms remain poorly understood. This project focuses on auditory sensory processing, examining whether the degree of self-reported sensory sensitivity is associated with neurophysiological markers of auditory sensory processing. One candidate mechanism is selective attention: the ability to focus and prioritize specific sensory input while ignoring or suppressing irrelevant or distracting sensory input. Auditory selective attention can be assessed using a selective attention task (SAT), in which subjects are required to focus on auditory stimuli presented to one ear while ignoring stimuli presented to the opposite ear. Event-related potential (ERP) were computed to investigate the hypothesis that alterations in neural markers of selective auditory attention are related to degree of sensory sensitivity. Specifically we investigated the Nd effect, an index of top-down attentional modulation of stimulus processing; the MMN, an index of deviance detection; and the N100, an index of early sensory processing. All three ERP components have been previously implicated in populations characterized by sensory processing impairments and heightened levels of sensory sensitivity. Neurotypical adults (n = 78) completed the Multi-Modal Evaluation of Sensory Sensitivity (MESSY) questionnaire alongside EEG recording during a SAT. At the group level, grand average ERP waveforms and topographical distributions showed that in the SAT, the Nd, MMN, and N100 components manifested as expected. However, correlation analyses revealed no evidence that either ERP component was significant associated with MESSY scores. Therefore, our findings suggest that neural correlates of selective attention do not meaningfully explain individual differences in subjective sensory sensitivity in neurotypical individuals.

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P6

Simulating Synesthesia: A Computational Approach to Investigating the Effects of Grapheme-Color Representations on Visual Working Memory

Synesthesia is a striking form of divergent perception in which an inducing stimulus (e.g., the letter "M") evokes an additional sensory experience (e.g., the color orange). Color often aids memory, and synesthesia has been linked to better-than-average memory, particularly for color. We investigated whether the structured nature of synesthetic mappings provides a memory benefit beyond the general benefit of color using two integrated computational models. First, we

approximated synesthesia-like cross-talk in visual-temporal cortex using a recurrent neural network, treating its output as emergent grapheme-color mappings. We observed that similarly-shaped graphemes (Hamming distance) were mapped to similar colors (Euclidean distance), mirroring developmental synesthesia. Second, we used a neurobiologically-informed working memory model to compare performance for graphemes across achromatic, random, and emergent grapheme-color conditions in a delayed match-to-sample task. Contrary to our hypothesis, emergent grapheme-color mappings reduced grapheme discriminability more than random or achromatic mappings, driven by a disproportionate increase in target correlation strength for new (untrained/foil) relative to old (previously trained target) graphemes, an effect strongest for the dissimilar grapheme set. These findings suggest that emergent grapheme-color mappings do not benefit memory in an architecture that pools color and shape into an undifferentiated similarity signal and instead compound shape-based confusability. We propose instead that color benefits visual working memory only when treated as a differentiating feature bound to item identity, rather than a continuous contributor to item-level similarity.

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P7

From auditory perception to motor output: a novel approach to probing subcortical motor pathways

Perception and action are closely interconnected: sensory information can rapidly influence motor output through subcortical pathways. Exploiting this interaction may provide new approaches for understanding, and ultimately modulating, motor function. In particular, combining sensory stimulation with motor stimulation could offer novel strategies for targeting pathways involved in walking and motor recovery after stroke. The present study, JumpStart, investigates a novel approach to probing the contribution of the reticulospinal tract (RST) to lower-limb motor control by combining an auditory startle stimulus with transcranial magnetic stimulation (TMS).

The reticular formation can be activated by a startling acoustic stimulus (SAS), providing a means of transiently increasing reticulospinal excitability. Mooney et al. (2023) demonstrated that pairing SAS with TMS increased the size and occurrence of ipsilateral motor evoked potentials (iMEPs) in upper-limb muscles, particularly when TMS was delivered 10 ms after the acoustic stimulus. JumpStart extends this approach to the lower limb, investigating whether sensory stimulation can similarly modulate motor responses in muscles relevant for walking.

Healthy young adults perform isometric contractions of the tibialis anterior (TA) and rectus femoris (RF) while single-pulse TMS is delivered to the motor cortex. Trials consist of TMS alone or TMS preceded by an SAS at different stimulus-onset asynchronies (5, 10, and 15 ms). Additionally, SAS-only trials are included to account for any effects caused solely by the acoustic startle stimulus. Surface electromyography (EMG) is recorded bilaterally from the TA and RF to identify motor evoked potentials, while sternocleidomastoid EMG is used to verify the startle

response.
We test whether preceding TMS with an acoustic startle increases the amplitude and/or occurrence of ipsilateral MEPs compared with TMS-only trials, and whether this effect depends on the interval between SAS and TMS. Based on Mooney et al., we expect the strongest facilitation at approximately 10 ms. Establishing this paradigm in lower-limb muscles would provide a new experimental approach for studying sensory–motor interactions and subcortical contributions to lower-limb control, with potential future applications in developing rehabilitation strategies to improve walking capacity after stroke.

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P8

Fixed across traits and states? The stability of the exogenous attentional spotlight across autism, ageing, and cue size.

Visual attention enables us to navigate our surroundings by continuously selecting relevant spatial information for further processing. Here, spatial attentional selection is often conceptualized as an attentional spotlight. Importantly, this spatial shape may be related to individual trait-differences. The present study investigated trait-differences in exogenous attention by comparing individuals with- and without an official autism diagnosis and by including a sample of older adults. Surprisingly, the exogenous attentional spotlight was remarkably similar across our groups. To determine whether this reflected a genuine stability of attentional distribution or limited sensitivity of our outcome measure, we subsequently evaluated the paradigm's ability to detect spotlight modulations. Manipulating cue size did not affect the size of the attention window. In contrast, introducing an endogenous component by manipulating target-distance recurrence yielded reliable differences in attention allocation, demonstrating that the paradigm was sensitive to detect spotlight modulations when present. Together, these findings suggest that the spatial extent of the attentional spotlight is surprisingly stable at the exogeneous level, but appears sensitive to endogenous influences.

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P9

Temporal expectations facilitate perceptual performance by driving early visual processing

Expecting a red light right after a yellow light is possible because stoplights follow predictable timing. Temporal expectations about relevant sensory events reliably improve response time and response accuracy. Improved accuracy is in part attributed to preparatory changes in visual areas. However, physiological evidence for this preparation relies primarily on endogenous neural markers (e.g., alpha oscillations), whose precise relationship to visual processing is debated. Here, we employed Rapid-Invisible-Frequency Tagging (RIFT), an invisible experimenter-induced neural marker of early visual processing intensity, while participants completed a temporal orienting task (manipulation of expected target timing). In line with previous research, behavioral performance (precision) improved when targets were presented at the expected time. Crucially, the RIFT response revealed that anticipating relevant events increased visual processing shortly before their onset. Moreover, this increase was functionally meaningful, as an increased pre-target RIFT response predicted improved behavior for unexpected targets on a single trial level. Using induced (rather than endogenous) neural oscillations, these results show that temporal expectations facilitate perceptual performance by driving the earliest stages of visual processing.

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P10

A Co-Design Approach to Visual Analytics for VR-Based Visual Rehabilitation

Homonymous hemianopia is the most frequently reported visual impairment after stroke in which visual stimuli go undetected in one visual field. It severely limits patients' daily functioning and quality of life. While patients can learn to compensate for vision loss through rehabilitation, structured training opportunities during the chronic phase after stroke remain limited and waiting lists are long. Our project, VR4eVR (Virtual Reality for enhanced Visual Rehabilitation), a collaboration among Dutch universities and Royal Dutch Visio, aims to overcome these challenges by developing accessible and effective vision training using Virtual Reality (VR): patients can train independently at home, while clinicians can optimize training by gaining time- and context-dependent insights into patients' conditions. Visual Analytics (VA) systems are key to making such insights – e.g., eye-tracking metrics and task performance – accessible, explainable, and clinically useful, helping clinicians monitor progress, identify trends, and respond to patterns requiring follow-up.

To ensure our VA system reflects clinical needs, we follow an iterative co-design process. Patients and therapists recruited through Visio participate in field lab sessions, surveys, and semi-structured interviews. Because home-based VR training removes the direct observation of eye

and head movements on which therapists rely in conventional compensatory saccadic training, these activities investigate which gaze-based information is needed to assess training sessions remotely. Preliminary findings indicate a need for both longitudinal overviews of training activity and performance and detailed inspection of individual sessions, including gaze extent into the affected field, the pace and consistency of gaze shifts, and eye-head coordination strategies. We support these assessments by aligning detected fixations and saccades with head movements and task events. A remaining challenge is to summarize the large volume of VR data at complementary levels of detail, making training interpretable and actionable for clinicians and ultimately facilitating the clinical integration of home-based VR rehabilitation.

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P11

The added value of a Virtual Reality restaurant simulation in the cognitive assessment of acquired brain injury

Acquired Brain Injury (ABI) frequently causes significant impairments in daily life. Effective diagnosis and treatment are critical in realizing the best possible outcome for ABI patients. This study examines the added value of a Virtual Reality (VR) simulation in cognitive assessment for ABI patients during outpatient rehabilitation, by investigating (1) feasibility of a VR simulation in this patient group, (2) the user-experience of the patients, and (3) the (dis)similarities in behavioral observations during gameplay by researchers and therapists.
Participants with ABI (n = 15) played a VR restaurant simulation in which they had to get the orders of virtual customers ready. Feasibility was assessed by looking at completion rate, completion time, and participant understanding. All the ABI patients were able to complete the full assignment. The average completion time was 416.33 secs, which makes it feasible to implement the simulation in current clinical practice (e.g. addition to a traditional neuropsychological assessment). One ABI patient needed a break during gameplay, and three needed an extra bit of feedback to be able to complete the assignment (e.g. “Look closely to your right”). User-experience was investigated with a questionnaire, indicating relatively high levels of presence, flow, engagement, and transportation and relatively low negative side effects (e.g. nausea, headache). Preliminary analysis shows that behavioral observations of ABI patients during gameplay differed between researchers and therapists, emphasizing e.g. hardware and software issues and more strategical analysis, respectively. Taken together, these results suggest that VR simulations could be used with ABI patients and that multidisciplinary observations will give the richest insight in patient performances. Next steps will be to evaluate the performances of ABI patients by analyzing eye tracking and (hand) movement data in relation to experienced restrictions in daily life situations, objectively estimated cognitive functions, as well as normalization of performance scores.

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P12

Saccade Selection Predictably Changes With Load

Recent works posit that saccade selection follows an economic cost-benefit arbitration, wherein the intrinsic attentional cost of an eye movement is weighed against its expected perceptual benefit. If saccade selection truly depends on the balance between costs and benefits, the availability of cognitive resources should likewise be relevant to this process. We therefore propose that the extent of one's available resources may shift the relative cost of an eye movement, which should, in turn, alter saccadic behavior. In the present study, we tested this hypothesis by manipulating cognitive load through a non-spatial memory task performed concurrently with saccade selection. The design of the present study followed existing work that quantified direction-specific effort costs using pupil responses. Participants freely selected between targets presented into different directions from a central fixation point, while target eccentricity was held constant. In Experiment 1, monetary rewards were staircased against participants' preferences such that higher rewards would eventually compensate initially less preferred directions. Replicating previous findings, we found pupil-inferred effort costs to be compensable on a monetary scale and established a range of rewards sufficient to offset these intrinsic cost differences. In Experiment 2, this same reward range was used to test how memory load affects the valuation of costs and rewards during selection. Indeed, we found stronger preferences for cost-efficient saccades under higher memory load. Furthermore, limited cognitive resources led to participants selectively cutting the longer tail of the saccade latency distribution, consistent with load-adaptive scaling of decision depth during selection. Together, these findings demonstrate that saccade selection depends on the cognitive resources available to the observer, providing further support for an economic account of visual selection.

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P13

Extending Physiologically Informed Dynamic Causal Modelling with Interlaminar Connectivity for Laminar fMRI

Background: Laminar fMRI offers a non-invasive approach to probe how perceptual information flows through cortical microcircuits, but interpreting laminar BOLD signals is challenging as they reflect haemodynamic and not neuronal activity directly. Computational models can help disentangle these processes to infer neuronal dynamics. Physiologically informed Dynamic Causal Modelling (P-DCM) achieves this by pairing a neuronal model with a haemodynamic model that accounts for the ascending vein effect in laminar BOLD signals. However, current P-DCM models the neuronal layers without interlaminar connections. We extend this model with these connections to capture the directional flow of information across cortical layers.
Methods: We validated a single-region P-DCM framework comprising a neuronal model with coupled excitatory (E) and inhibitory (I) populations per layer (N=3; superficial (S), middle (M), deep (D)), neurovascular coupling, and a haemodynamic model (K=7 depths). We added neuronal interlaminar connections based on the canonical microcircuit: M→S, S→D and D→M, with driving input (C) at the M layer. Forward simulations established face validity, and noise-free parameter recovery assessed identifiability of interlaminar structural (A) and modulatory (B) connectivity, C, neuronal parameters: E self-connection (σ), I→E connection (μ; per layer) and I gain (λ; I self-connection and E→I connection; per layer); and ascending vein haemodynamic parameters: Grubb's exponent (α), in-/deflation viscoelastic time-constants (τ (in), τ (de)) and CBV slope (s).
Results: Simulations showed plausible layer-specific dynamics and distinct laminar BOLD profiles. Following C, the M layer responded first, propagating activity to S and D via A. I mirrored E responses with a delay. Modulation increased responses globally. Parameter recovery showed partial identifiability. A, B (M→S), B (S→D), C, σ and s recovered well. μ, λ, α, and τ (in) had range-dependent recovery. Both B (D→M) and τ (de) exhibited shrinkage towards the prior.
Conclusion: Results show the model captures core dynamics and clarifies identifiability boundaries. Future work will explore the effect of experimental design (repetition time, stimulus duration) and assess parameter interactions via multi-parameter recovery, followed by validation using empirical 7T fMRI and intracranial EEG (Bayesian fusion). The model will provide the foundation for a multi-region framework to study how sensory information is processed across cortical microcircuits.

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P14

Resolving Corticothalamic Circuits in Human Auditory Selective Attention with 7T fMRI and Laminar iEEG

Selective auditory attention allows humans to focus on a relevant sound stream while ignoring competing noise. However, the neural mechanisms underlying this capacity remain poorly understood. Animal studies have provided evidence for distinct corticothalamic loops relevant for spectral (frequency-based) versus temporal (time-based) attention, but whether such loops are also present in humans remains unknown due to methodological constraints, including limited access to thalamic nuclei and insufficient spatial resolution to resolve cortical layers. To address this, we employ a multimodal approach combining ultra-high field fMRI with intracranial EEG (iEEG) recordings. Participants performed an auditory attention task that manipulated the attended tone frequency (low vs. high) and temporal modulation rate (slow vs. fast). Using this paradigm, we map laminar-specific responses in auditory cortex (Heschl's gyrus) and in subcortical nuclei, including the medial geniculate body (MGB) and inferior colliculus. With population receptive field (pRF) modelling, we characterise tonotopic and temporal tuning profiles across cortical depths and subcortical structures. Ongoing iEEG data collection is expected to provide temporally precise insights into feedforward and feedback dynamics across cortical layers. Pilot 7T fMRI results show reliable tonotopic maps and amplitude modulation rate preference across deep, middle, and superficial cortical layers. Subcortically, frequency-specific responses were observed in both MGB and inferior colliculus, with MGB responses allowing segregation into ventral and dorsal divisions. Preliminary evidence additionally suggests attention-related shifts in frequency preference. These findings demonstrate the feasibility of characterising corticothalamic loops at the level of circuits and laminar processing, aiming to improve our understanding of auditory attention.

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P15

Interruptions and the Time Course of Goal Perseveration in Visual Search

Interruptions disrupt goal memory and increase task errors, yet little is known about how they affect goal-driven attention when people resume the primary task. To address this, we combined interruptions with a visual search task. While we recorded eye movements, participants searched for three targets in a fixed order and were occasionally interrupted by brief arithmetic problems. Interruptions reliably reduced performance accuracy. Crucially, errors were not random but showed perseveration toward the target that had been searched for before the interruption. This raises the question of how this outdated goal comes to guide search. The previous goal may already be fully active as search resumes, or weakly established, emerging from a competition between multiple candidates, so that the previous target comes to dominate only later in the search. A time-course analysis of eye movements revealed that, on error trials, the previous target

color already dominated fixations soon after display onset. Although guidance towards the old target color was slightly weaker than when participants searched for the correct target, the pattern indicates that post-interruption errors are the result of an old goal that has been wrongly retrieved and rapidly shapes search from the outset.

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P16

Presaccadic information changes the dynamics of salience, relevance, and eccentricity

Previous research has shown that visual salience and retinal eccentricity influence short-latency eye movements, whereas the effects of relevance emerge only at longer latencies. However, these studies have generally examined selection control in tasks requiring participants to make just a single eye movement after display onset. By contrast, in natural viewing selection unfolds across sequences of eye movements while visual information remains continuously available. Little is known about how successive fixations alter the dynamics of the contributions of salience, retinal eccentricity, and relevance to the selection of subsequent saccade targets. The present study aimed to examine how the availability of visual information at a previous fixation reshapes the relative contributions of salience, relevance, and retinal eccentricity to selection of the current fixation goal. Participants first executed an instructed saccade from an initial to a second fixation point, after which they were instructed to make a speeded second saccade toward a target singleton. The search display either appeared only upon fixation at the second fixation point (no-preview condition) or was already visible before the start of the first saccade (preview condition), thus allowing information to accumulate across fixations. In the no-preview condition, short-latency second saccades were guided by both stimulus salience and retinal eccentricity, whereas relevance exerted an influence only at longer latencies, replicating the typical temporal dynamics of salience and relevance effects on initial selection. Strikingly, preview reshaped these dynamics. In the preview condition, relevance influenced selection from the earliest latencies, while the contributions of salience and retinal eccentricity were substantially reduced. These findings demonstrate that the temporal dynamics of visual selection are not fixed but depend critically on information acquired across consecutive fixations. While relevance accumulates, saliency and eccentricity attenuate over multiple eye movements.

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P17

Exploring eye-hand coordination in central field loss with virtual reality

Eye-hand coordination relies on accurate depth perception and gaze control, both of which are impaired in central field loss (CFL). Using an immersive VR paradigm, we examined how CFL affects gaze and hand control during a dynamic 3D butterfly-catching task. Seven patients with CFL and 13 controls performed three conditions: eye-tracking only (following the butterfly with gaze), hand-tracking (keeping the butterfly centered in a virtual net), and catching (capturing it). Patients performed all conditions binocularly and monocularly, while controls additionally performed them with a simulated scotoma. Binocular viewing led to faster catching times, and to more accurate gaze in both patients and controls compared to monocular viewing, with a greater binocular advantage in patients. Vergence analyses revealed that gaze followed the depth of the target more accurately during active catching in both groups, but only under binocular viewing, indicating that motor engagement refines depth estimates when binocular disparity is available. For hand-tracking, the ability to track the target in depth was particularly affected in patients under monocular viewing, again suggesting a dependence on disparity information. Taken together, our VR studies reveal compensatory eye-hand strategies in CFL that support depth tracking under binocular viewing conditions that mimic real life.

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P18

Representational Tuning Models: Parametric Encoding Within Arbitrary Stimulus Domains

Encoding models characterize parametric response functions for individual recordings but require predefined stimulus dimensions. Conversely, Representational Similarity Analysis (RSA) accommodates arbitrary stimuli but relies on population-level patterns, obscuring individual-site tuning. To bridge this gap, we introduce Representational Tuning Models (RTMs). RTMs utilize RSA and multidimensional scaling to project arbitrary stimuli into continuous, latent representational spaces, within which parametric tuning functions are fit to predict individual recording responses. Validating this framework with 7T fMRI responses to natural scenes, we show that RTMs capture voxel-specific tuning in high-level (but not early) visual maps with performance approaching the noise ceiling. Our results reveal systematic increases in selectivity across the visual hierarchy and show that latent representational space dimensions largely reflect cortical topography. Finally, we quantify representational sampling and functional connectivity by modeling voxels as functions of distant representational spaces. RTMs provide a unified, modality-agnostic tool for mapping neural tuning and information transformations.

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P19

To fill or not to fill? That's the question for pixelated tactile images of different sizes

Tactile displays are used to make digital information accessible. These displays rely on pin-based mechanisms (i.e. pixels). Most of these devices are used for Braille, but new tactile displays can display images as well. There exists only limited research that has investigated how image rendering can be optimized for perceptual performance on such displays. For static raised line drawings (i.e. on swell paper), research suggests that filled images are recognized better than images with only an outline, and that bigger images are easier to recognize than small ones. However, for pixelated images, guidelines suggest using only an outline. This guideline is based on limited research. We expand this research by investigating rendering methods for pixelated tactile images using more complex images, and different sizes than used previously.
We did two experiments, both with 20 participants. We had 14 different pixelated images, varying in complexity and three conditions (images with an outline only, filled with pixels equally high as the outline, and filled with pixels half the height of the outline). The first experiment was done with big images, and the second with small images.
We found no significant effect of condition on recognition performance in either of the two experiments. This is not in line with previous research that showed better performance if the pixelated images were presented with an outline only. It is also not in line with previous research about continuous line drawings, where performance was better when a filling was used. Since previous studies are limited and differed in the complexity of images used, it is difficult to compare directly. The role of complexity of the image will be explored in a future study.

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P20

"I / Eye" Like That! Explaining Individual Aesthetic Judgments Using Eye Movement Data

Aesthetic preferences can be subjective, as the same image may elicit different aesthetic judgments for different individuals. The degree of appreciation may be reflected in how the

viewer perceptually organizes the image. This perceptual organization can be captured through their eye movements. In this study, we explore the relationship between individual gaze behaviors and subjective liking ratings.
We conducted an eye-tracking experiment in which 41 participants viewed a dataset of 80 images (40 paintings and 40 photographs) for 15 seconds each, followed by an aesthetic rating task. Eye movement data were analyzed spatially and temporally to extract metrics including fixation density, saccadic amplitude, gaze transition entropy, area coverage, and the focal/ambient k-coefficient.
Results show that for most participants, ratings for photographs were higher than those for paintings. The similarities and differences in eye movement metrics across these two image categories are summarized. Moreover, our results highlight the need to account for individual differences. Analyzing the data at an individual level reveals that the same gaze pattern can produce opposite effects across participants, increasing liking ratings for some while decreasing them for others.
These findings demonstrate that personalized models are needed to capture visual aesthetic evaluation. Aesthetic preference is not only driven by image properties alone, but also by the subjective representation of the visual input. By linking eye movement data to subjective preferences, this work helps bridge the gap between human visual processing and aesthetic judgment.

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P21
Tracking binocular rivalry without report: Toward neural decoding of the full perceptual stream
Binocular rivalry, during which different images presented to the two eyes cause alternating or mixed percepts despite unchanged sensory input. This provides a powerful window into how the brain resolves perceptual ambiguity. Most studies, however, rely on continuous perceptual reports, which introduce additional neural processes that can confound measurements of conscious perception. Moreover, mixed percepts remain relatively understudied and are often treated merely as brief transitional states between exclusive percepts. Here, we evaluated a novel approach for tracking the full perceptual stream without continuous report by combining EEG steady-state visually evoked potentials with linear discriminant analysis. A binary classifier trained on independent non-rivalry data was applied to exclusive rivalry percepts, while a three-class classifier trained on self-report rivalry data was used to classify exclusive and mixed percepts. Under non-rivalry conditions, the binary classifier distinguished the stimuli with high accuracy. During self-report rivalry, it decoded exclusive percepts well above chance, and decoder-derived switch rates correlated moderately with reported switch rates. However, on average, during self-reported mixed percepts, classifier performance was at chance. Therefore, decoding performance remained insufficient for reliable moment-to-moment tracking of

perceptual states. Classifier-derived switch rates during no-report also correlated with self-reported switch rates. Furthermore, a classifier trained directly on the self-report data revealed no neural features uniquely predictive of mixed percepts, possibly reflecting their heterogeneous nature. Together, these findings provide a proof of principle that EEG-based decoding can capture key aspects of binocular rivalry without continuous report, while also highlighting the challenges of decoding mixed percepts. More broadly, they offer important methodological guidance for developing reliable no-report measures of the complete perceptual stream.

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P22

Cost, then reward: saccade selection is a temporally integrated economic decision

We make around 100,000 saccades each day. Where those saccades go is believed to be an economic decision which is attuned to maximizing the expected utility of each saccade. That is to say: saccades are generally made toward locations associated with the least oculomotor effort and the highest reward gain. However, little is known about the temporal dynamics with which these factors contribute to saccade selection. Because oculomotor costs are intrinsically linked to target location, whereas rewards depend on externally provided information, their relative influence may change as a saccadic decision unfolds. Here, we tested whether oculomotor costs and rewards differentially affect saccade choices as a function of saccade latency. In the current study, twenty participants freely made saccades to one of two targets in a saccade choice task. Each of the targets had an intrinsic oculomotor cost (determined by its location) and an external monetary reward (determined by its shape). We binned saccade onset latencies from 100 ms to 450 ms. When participants made relatively early saccades, they most often chose the low-cost option without considering reward. Vice versa, later saccades were more often made toward high reward targets, with a decreased role for oculomotor costs. As such, the weighted decision behind saccade selection is indeed affected by temporal dynamics: cost, then reward. Our presented model and paradigm can be easily extended to include selection history and salience as additional factors, with the aim of building a complete picture of how the priority map underlying saccade selection unfolds over time.

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P23

Object-Centered Spatial Learning in Dynamic Contexts: History-Driven Distractor Suppression and Target Enhancement

The world around us is inherently structured and often repetitive. Research has shown that we can implicitly learn to prioritize relevant objects and locations while filtering out distracting information, creating an integrated priority map for attention allocation. The current study examines whether providing an object-like reference frame would induce an object-centered attentional bias or whether the bias would remain in egocentric (viewpoint-centered) coordinates. The search display consisted of six stimuli that were surrounded by a wheel and square frame. In two experiments, either a distractor or a target appeared more frequently in one location, leading to the suppression or enhancement of that location, respectively. Learning blocks were followed by test blocks, where the frame rotated, creating egocentric-matching and object-centered locations. These experiments showed that both target and distractor learning relied on an egocentric reference frame only. In follow-up experiments, the likely target and distractor location rotated dynamically with the frame during learning. This revealed that participants can learn to enhance a likely target location in an object-centered manner. We hypothesized that while space-based learning feeds into a priority map reliant on an egocentric reference frame, object-based learning allows for implicit prioritization of subparts of objects independent of their spatial orientation.

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P24

Binocular Saccadic Benefit Declines with Interocular Reliability Imbalance

Binocular viewing can shorten saccadic reaction times relative to viewing with either eye alone, yet how this benefit depends on the reliability of the two monocular signals remains unresolved. Tests of reliability-weighted integration commonly vary the reliability of sensory estimates by manipulating stimulus properties. Such manipulations alter the physical information presented to the observer rather than retinal sensitivity itself. Here, we used transient retinal desensitization to vary monocular sensory reliability while leaving the stimulus unchanged.
In a stereoscopic gap paradigm, two intensively sampled participants made saccades to peripheral targets presented to the left eye, right eye, or both eyes. Before target presentation, retinal sensitivity was transiently reduced in the left eye, right eye, both eyes, or neither eye. Nine

recovery delays varied the magnitude and interocular asymmetry of desensitization. Monocular reliability was quantified as inverse saccadic reaction-time variance. Binocular benefit was defined as the difference between the faster monocular and binocular reaction times. Desensitization-related changes in monocular reliability and binocular benefit varied over the recovery period, whereas the no-desensitization condition remained stable. Binocular benefit decreased systematically as the faster-eye reliability weight increased relative to slower-eye weight. Benefit was largest when the two eyes had comparable reliability and progressively diminished with increasing interocular reliability asymmetry, approaching zero when one eye dominated. Observed binocular responses were faster than predictions from an independent-channels Race model, particularly when monocular reliabilities were balanced, whereas a LATER-style coactivation model closely captured the observed binocular reaction times, with little systematic dependence of model error on reliability weight.
The reliability dependence of binocular benefit and close correspondence between observed and LATER-predicted reaction times support reliability-sensitive coactivation beyond independent-channel statistical facilitation, rather than an effect of binocular stimulation alone. Transient retinal desensitization thus offers a controlled means of revealing how changes within individual sensory channels influence their binocular combination.

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P25

From perception to mental rotation: tracing spatial codes with MEG

Spatial working memory requires retaining a stimulus location and, when instructed, transforming it into a new response location. Whether the neural geometry of these representations is preserved across conscious access and mental rotation remains an open question. This project reanalyses magnetoencephalography recordings from a masked spatial working-memory task combining subjective visibility reports with delayed mental-rotation instructions.
Time-resolved ridge regression predicts circular position through its sine and cosine coordinates. Cross-validation distinguishes actual target position, response-inferred pre-rotation position, and reported response position. Decoding is evaluated separately for seen and unseen trials. Complementary representational similarity analysis compares crossvalidated sensor-pattern distances with circular position geometry during encoding and the pre-cue delay. Sensitivity analyses assess multivariate noise normalization and temporal aggregation.
Initial decoding showed positive seen-target estimates during encoding and early delay. Current RSA results also suggest seen-position geometry in these periods, although the strength of the association varies across analysis choices and individuals.
This pilot examines whether spatial prediction and representational geometry provide convergent evidence about the evolution of working-memory codes. Further analyses will trace the transition

from perceived target location to the response representation while accounting for visibility and preprocessing sensitivity.

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P26

Representation of Movement Direction and Eye-Movement Type Across the Visual Cortex and Cerebellum

The role of the cerebellum has traditionally been associated with motor and sensorimotor processes. Recently, evidence for cerebellar involvement in visual and visuomotor processing has started to broaden this view. Previous studies have identified visually driven responses in several cerebellar regions, including the oculomotor vermis, involved in eye-movement control. However, much of this work included a fixation task. In everyday vision, we make saccades and track objects across different directions in visual space. Here, we used ultra-high field (7T) fMRI to investigate how cerebral and cerebellar BOLD responses vary with eye-movement type (saccade vs. smooth pursuit) and movement direction. Seven healthy participants were enrolled. During functional runs, participants followed a visual target moving along a star-shaped trajectory in eight directions, using both saccadic and smooth pursuit eye movements. In cerebral cortex, we observe clear direction-dependent differences in V1, with leftward eye movements engaging the right hemisphere V1 and rightward eye movements engaging left V1. Although we find MT/V5 to be responsive to eye movements, the responses did not show a preference across directions of eye movements. Within the cerebellum, directional responses are observed mainly in Lobule VI and Crus regions. Some directional contrasts show a more lateralized response pattern, with a preference in right Lobule VI for rightward compared with leftward eye movements. Smooth pursuit elicited more extensive cerebellar responses than saccades, particularly across Crus I/II and Lobule VIII. Our results suggest that cerebellar activity during active vision is organized not only by eye movement type, but also by eye movement direction. The direction-related pattern in the oculomotor vermis is particularly interesting as it may reflect a fine-scale motor control in the human cerebellum. These observations provide further insight into how visual and oculomotor information may be processed across the cerebellum during active vision

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P27

From 3D Ability to 2D Neural Profiles: Individual and Task-Driven Oscillatory Dynamics in Mental Rotation

Individual differences in three-dimensional (3D) mental rotation ability are widely observed, yet the cognitive and neural mechanisms underlying these differences remain poorly characterized. In particular, whether and how oscillatory neural dynamics during two-dimensional (2D) rotation reflect individual differences in 3D mental rotation ability. The present study examined whether frontal theta and parietal alpha oscillations track rotation demands and individual differences in 3D mental rotation ability during a 2D letter rotation task. Forty participants completed the Vandenberg and Kruse Mental Rotation Test (3D-MRT) and a computerized 2D letter rotation task at four orientations (0°, 60°, 120°, 180°) while EEG was recorded. Higher 3D-MRT scores were associated with more gradual accuracy declines across rotation angles, confirming that 3D mental rotation ability generalizes to 2D rotation at the behavioral level. At the oscillatory level, a clear dissociation emerged: alpha desynchronization (8–13 Hz) at POz scaled parametrically and linearly with rotation angle, reflecting progressive engagement of visuospatial processing as rotational demand increased, but did not significantly predict individual 3D-MRT scores ($r = .290$, $p = .069$; $BF_{10} = 1.18$, inconclusive). Frontal theta synchronization (4–7 Hz) at FCz, by contrast, did not scale with rotation angle but strongly predicted individual 3D-MRT performance ($r = .591$, $p < .001$; $BF_{10} = 419.5$), with higher ability individuals showing greater overall theta power. These findings reveal a dissociation between task-driven alpha dynamics and ability-driven theta dynamics, suggesting that alpha indexes the demands of rotation itself while theta reflects stable individual differences in the cognitive resources underlying visuospatial rotational ability.

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P28

Revealing Mid-Level Factors in Rich Images: A Framework and Dataset for Perceptual Grouping and Composition

Perceptual organization is widely agreed to be a critical step connecting low- and high-level processing stages in the perceptual processing hierarchy. However, the majority of research on the different processes of perceptual organization has been conducted using simplistic stimuli with high parametric control. In this study, we extend this work by creating a large dataset of visual annotations on a body of photographs and digital images of paintings, more closely resembling our visual reality.

During a large online study (N ~ 300) participants annotate images in five perceptual grouping tasks (clustering, segregating, linking, layering and configuring) and three higher-order image characteristics (emphasis, repetition, balance), relating to overall image composition. The study includes 40 photographs and 40 paintings, which are randomly assigned to the participants and task combinations. Each participant will annotate around 15 images for one grouping and one higher order task, using a novel online image annotation tool with a limited set of simple colors, lines, basic shapes, and free-form shapes. We provide clear instructions for each of the tasks, with a useful example. In addition, we will also ask for their aesthetic appreciation and visual expertise.

With these annotations, it will be possible to explore the hierarchy and interplay of different principles of perceptual grouping in rich images with more ecological validity, as well as to investigate their role for the overall composition principles of the images. Through hierarchical analysis of the different regions and annotations, we can explore how the different perceptual organization factors related to one another as well as to low-level image properties and aesthetic qualities.

The result is an unprecedented dataset, and a comprehensive investigation of perceptual grouping, image composition, and aesthetics.

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P29

Eyes on the Input: Combining Pupillometry and the Head-turn Preference Paradigm in Infant Pattern Detection

Understanding what drives infants' ability to detect patterns (regularities) in their linguistic input, which can constitute the basis for inducing the rules of their native language, is a central goal in linguistics. A widely used measure of infant language learning is the Head-Turn Preference Procedure (HTPP), a behavioral paradigm including an exposure and a test phase [1]. However, behavioral measures assess the learning outcome, but do not provide insights into the learning process itself; specifically what stimuli infants attend to and to what extent, which can affect

learning outcomes [2]. Neurophysiological methods, such as EEG, that provide such insights, require long setup and testing times, making their use with infants challenging. Cognitive pupillometry, in contrast, which measures changes in pupil diameter associated with cognitive processes, including attention and mental effort, requires minimal setup and testing time [3]. Recent studies demonstrated its value for language research and its compatibility with standard behavioral paradigms [3].

This project had three objectives: (a) to evaluate the feasibility of using pupillometry as a measure of infants' pattern detection during exposure to novel linguistic input; (b) to assess the feasibility of combining pupillometry with the HTPP; and (c) to test whether changes in pupil size during exposure to novel linguistic input predict learning outcomes.

We used an artificial language-learning task with 12-month-old infants, previously shown to result in successful auditory pattern detection [4]. During exposure, infants listened to trisyllabic strings of the form a_iXb_i (a_i predicts the corresponding b_i, X varies), while pupil responses were recorded. Exposure phase included pattern-consistent (a_iXb_i) and oddball trials (a_ib_iX). During test, pattern detection was assessed via HTPP by comparing looking times toward pattern-consistent versus pattern-inconsistent trials (a_iXb_j, $i \neq j$).

We predicted: (1) differences in mean pupil size between pattern-consistent and oddball trials, indicating pattern detection; (2) decreasing pupil size over time, indicating increasing familiarity with the pattern; (3) longer looking times during the HTPP for pattern-inconsistent than pattern-consistent test stimuli, indicating pattern learning; and (4) a correlation between mean pupil size during exposure and looking times during test, reflecting an effect of attention/mental effort on learning. Data analysis is ongoing.

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P30

Do the Math: A Behavioral Study of Human Arithmetic

Math underpins everyday life and scientific reasoning, yet how humans perform arithmetic is not fully characterized. It remains unclear which features of an equation affect its perceived difficulty, accuracy and reaction time. It also remains unclear how these metrics differ between tasks in different formats: symbolic numbers, numbers of physical objects (numerosity) and spatial quantities like size or line length. Here we collected a densely sampled behavioral dataset measuring arithmetic performance and subjective experience across operations and numerical representations. Current analyses include 74,760 trials from 57 participants. The task comprises 400 shared addition and subtraction problems presented as symbolic numbers, dot arrays, or line lengths, plus symbolic multiplication and division problems. We recorded participants' answers, reaction times, and trial-level ratings of difficulty, strategy, and calculation steps, alongside demographic questionnaires before and after participation. In comparing different formats, dots and lines showed similar patterns of variation in absolute error and perceived difficulty with the magnitude of the lengths and numerosities: correlations between these two formats were far stronger than showed with symbolic number. Unlike in symbolic numbers, accuracy for numerosity and line length tasks was correlated with the magnitude of both the operands and the correct answer. As a result, the error and perceived difficulty of subtraction tasks were higher than addition tasks with the same result: subtractions had larger operands for the same result. These initial results highlight the combined contributions of perceptual and calculation processes on operations with sensory quantities. By linking responses to individual problems with subjective reports, this dataset provides an empirical basis for developing and evaluating models of how people calculate.

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P31

Individual Differences in Perceptual Experiences: Exploring Associations between Imagery Vividness, Sensory (Processing) Sensitivity, Synaesthesia, and (Subclinical) Psychiatric Traits

According to the predictive processing theory of perception, typical perception depends on a balance between top-down and bottom-up processes. It has been proposed that in divergent perception (e.g., in psychosis, autism, synaesthesia) the balance between top-down and bottom-up influences during perceptual inference is altered. In this study, we aim to leverage individual

differences in mental imagery vividness (a top-down process) and sensory (processing) sensitivity (theorized to be indicative of bottom-up influences on perception) to understand more about top-down and bottom-up influences in divergent perception in the general, non-clinical, population.
We examined how these individual differences relate to each other and to (clusters of) sub-clinical psychiatric traits. We hypothesized that perceptual extremes (aphantasia, hyperphantasia, high sensory (processing) sensitivity) should be associated with divergent perceptual experiences, especially in the case of an imbalance between extremes (e.g., high imagery vividness combined with low sensory (processing) sensitivity). Furthermore, we hypothesized that imagery vividness predicts the sensory richness of psychosis (e.g., hallucinations versus delusions).
To test this, we collected data from N = 720 participants, overrepresenting participants at the extremes of the mental imagery vividness-continuum (aphantasia N = 91; hyperphantasia N = 139), synaesthesia (N = 374), as well as control participants. We found associations between imagery vividness, sensory (processing) sensitivity and subclinical psychiatric traits, and, as expected, imagery vividness predicted the sensory richness of psychotic-like experiences. These findings suggest an increased vulnerability to specific psychiatric experiences in people with higher imagery vividness. We are currently further exploring the added predictive value of imbalances between extremes in mental imagery vividness and sensory processing sensitivity for (subclinical) psychiatric experiences.

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P32

The fusion illusion: explaining apparent standstills of overlapping transparent objects

We (re-)discovered a visual illusion consisting of an apparent standstill of two colliding, identical, semi-transparent, and continuously moving noise patterns during overlap. Furthermore, when two patterns collide with shallow angles, they appear to stick together despite a clear spatial offset between them. To investigate the illusion's underlying mechanism, we tested four candidate accounts. First, the visual system's spatial resolution limit makes it impossible to distinguish the patterns (and their movement) when almost overlapping. Second, the patterns' motion-vectors are averaged by the visual system, causing cancellation of vectors towards a zero-speed net result. Third, when patterns overlap, contrast increases transiently, which may cause visual suppression of motion. Fourth, the visual system fuses displaced patterns to achieve visual stability. Each account predicts a unique profile of illusion strengths (i.e., how long or how likely

motion stops) across a set of manipulations to the patterns properties. Across seven psychophysical experiments, observers viewed overlapping moving stimuli while spatial frequency, edge sharpness, pattern similarity, luminance dynamics, collision angle, and the number of overlapping stimuli were systematically manipulated. Illusion strength increased when stimuli were less distinguishable due to lower spatial frequency and blurred edges. However, the illusion persisted under conditions of sharp edges and luminance equalisation, arguing against spatial resolution limitations and transient suppression accounts. Manipulations of collision geometry and stimulus similarity further contradicted predictions of motion-vector averaging. In contrast, fusion strength increased with the number of overlapping stimuli and was associated with aspects of binocular fusion. Together, these findings support a sensory integration mechanism in which overlapping visual signals are combined into a unified percept based on their spatial intensity profiles. We propose that a sensory fusion process, analogous to binocular fusion, biases perceived position toward a shared centre of mass, thereby enhancing perceptual coherence during dynamic overlap.

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P33

Quantifying Auditory Engagement to Naturalistic Stimuli During Auditory Attention

Background

To navigate complex auditory environments, listeners can attend to one sound while suppressing others. However, sounds also differ in how engaging they are, with some capturing and maintaining engagement more strongly than others. To understand how engagement interacts with auditory attention, we ultimately aim to examine the accompanying neural and physiological responses during naturalistic listening. As a first step, two behavioral pilots served to develop the experimental paradigm: identifying musical stimuli that vary in elicited engagement, and testing whether engagement can be measured during a selective attention task.

Methods

In the first study, 13 participants listened to 60 musical tracks from 5 genres, generated from MIDI files to allow manipulation of acoustic features such as tempo and instrument. After each track, participants rated their engagement on a 7-item questionnaire (1–7 scale), to identify stimuli eliciting different engagement levels within and across listeners. In the second study, 6 participants heard two competing tracks containing gaps and counted the gaps in one track, directing attention to that stream. After each trial, they rated their engagement with the attended track using the same questionnaire.

Results

Engagement ratings varied across tracks and genres. Some genres elicited consistently low or high engagement across participants, while others varied more between individuals, potentially reflecting listener-specific preferences. In every participant, tracks spanned the full range of

engagement ratings. In the selective attention task, participants achieved ~70% accuracy while still showing variation in engagement with the attended stream.
Conclusion
These pilots establish a stimulus set and task combining naturalistic music varying in engagement with dual-stream selective attention. The paradigm will next be combined with EEG and physiological measures (pupil dilation, breathing, heart rate, EMG) to investigate the neural and bodily mechanisms underlying auditory attention and engagement.

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P34

Planning horizon of sequential reaching movements depends on target configuration

In visuomotor control, humans often choose movements that are suboptimal for the present action in order to secure better options for future actions. The benefit of such forward planning depends on the nature of the task, but whether humans dynamically adjust their planning horizon to task demands is unknown. In this study, participants performed a fast sequential hand reaching task where they were asked to collect as many targets as possible within a limited time period. This time constraint incentivises minimising the movement distance between sequential targets. Targets were presented in a configuration of 14 targets, which were either distributed homogeneously or cluttered across either a small or large workspace. Participants collected on average 6-8 targets during each trial. We fit optimal planning models with various planning horizons based on the participants' target choices. This revealed that participants shifted to a longer planning horizon with cluttered target configurations, particularly in the large workspace. We conclude that planning ahead is more beneficial for minimising distance in a cluttered environment. Thus, humans are capable of adjusting their planning horizon for fast sequential reaching movements according to workspace configuration.

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P35

Neural traces of past stimulus reliability emerge during ongoing perception

Bayesian theories of perception propose that current sensory input is integrated with prior information according to their relative reliability. In previous behavioral work, we used serial dependence in duration perception to test whether prior information is updated according to this reliability-weighted principle. Consistent with this view, we found that serial dependence was enhanced with increased previous reliability and attenuated with increased current reliability. Here, we used EEG to investigate the neural signatures of this reliability-weighted integration across successive percepts. Participants reproduced the duration of Gabor stimuli embedded in dynamic visual noise, while stimulus reliability was manipulated via Gabor contrast. Regression-based ERP analyses revealed that the reliability of the previous stimulus modulated neural activity during encoding of the current stimulus. Critically, across participants, the magnitude of this neural modulation correlated with the effect of previous reliability on serial dependence. Moreover, neural activity during encoding of the current stimulus was associated with trial-by-trial variation in subsequent duration reproductions, further supporting the link between encoding-stage activity and subsequent behavior. Together, our results show that neural signatures of past reliability relevant for perceptual integration arise while perception of the current stimulus is still ongoing.

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P36

From categorization to quantification: Stage-dependent neural and behavioral mechanisms of facial emotion recognition

Facial emotion recognition (FER) is a core process in social communication, involving the identification of emotion categories and the estimation of intensity. Although both are essential for adaptive social functioning, whether they rely on shared or partially differentiated neural processes remains unresolved. To address this issue, the present study combined event-related potential (ERP) measures with trial-by-trial brain-behavior modeling using (generalized) linear mixed-effects models, i.e., (G)LMMs, in 44 healthy adults performing sequential emotion categorization and intensity rating on morphed faces varying in category (happiness, anger, fear, and sadness) and intensity (25%, 50%, 75%, and 100%). Behaviorally, categorization reflected categorical distinctions, whereas intensity estimation revealed emotion-specific patterns that did not align with categorization. At the neural level, ERP results revealed a temporally ordered pattern. Early (P1, N170) and mid-latency (EPN) components were modulated by category, while sensitivity to intensity emerged only at the late stage (LPP), indicating a temporal difference between structural encoding and evaluative integration. Brain-behavior modeling further revealed

stage-specific predictive associations. In categorization, early and mid-latency components were negatively associated with performance, while the late components (LPP) indicated positive predictive associations; in intensity estimation, these associations varied with emotional category and intensity. Together, these findings suggested that within a fixed sequential judgment paradigm, intensity-related evaluation showed behavioral and brain-behavior association profiles that differed from those observed for categorization, without implying fully independent processes. By leveraging trial-by-trial brain-behavior modeling, this study uncovers stage-dependent predictive associations that traditional condition-average analyses cannot capture.

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P37

Conveying visual shape and color with a single vibrotactile pattern

Cross-modal correspondences are instances where an attribute in one modality is associated with an attribute in another modality, such as between visual and haptic perception. Such correspondences could be exploited for use in assistive technology. To convey visual information via the haptic channel, it is beneficial to convey multiple visual attributes via a single haptic stimulus. However, most studies to date have examined isolated sensory cross-modal correspondences, such as associations between color and vibrotactile stimulation or shapes varying in angularity and complexity. In this study we investigated whether a single vibrotactile pattern can be used to convey both color and visual shape.
Participants (N=25) wore a vibrotactile vest and had to select colors and shapes that best matched the presented vibrotactile pattern. We performed three tasks, one in which participants matched vibration intensity to a color, one in which they matched six spatiotemporal vibration patterns to a visual shape varying in angularity and finally an experiment in which a vibration pattern varying in both intensity and spatiotemporal pattern had to be matched to both color and shape angularity. Consistent with literature, results showed associations between color and vibration intensity, with higher vibrotactile intensity associated with darker colors and warm hues and lower intensity associated with brighter colors and cool hues. Similarly, discrete vibrotactile patterns were associated with angular shapes, whereas continuous patterns were associated with rounded shapes. When both intensity and spatiotemporal vibration pattern varied simultaneously, no significant interactions were found and each manipulation had largely independent effects: intensity was the strongest predictor of color, and vibration pattern was the strongest predictor of visual shape. These findings provide, to our knowledge for the first time, a proof-of-principle that it is possible to convey multiple visual attributes in a single vibrotactile signal, with important implications for assistive technologies.

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P38

Expected visual locations bias observers' perceived sound locations

To make sense of our complex environment, we reduce uncertainty via several mechanisms such as integrating information from multiple sensory modalities or forming predictions of future events. In certain cases, however, such strategies lead to perceptual biases. While perceptual cross-modal biases and within-modality predictions have been widely studied, it remains unclear whether such cross-modal biases can occur through predictions. We investigated this using an auditory localization task, measuring both behavior and neural activity using electro-encephalography(EEG). Specifically, we tested whether participants' auditory perception would be biased by a visual spatial expectation, which we elicited by presenting partially occluded visual motion upstream of the sounds. Indeed we found that participants' spatial perception of sounds was biased in the direction of the visual motion. We did not find an effect of visual motion on the overall amplitude of neural activity, as visible in the event-related potentials. However, using decoding analyses, we found that sensory representations of sounds presented at an unexpected location, with regards to the visual spatial prior, were biased towards the direction of the visual motion. Together, our findings suggest that visual predictions can bias auditory perception, demonstrating cross-modal bias by prediction.

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P39

Neural Representations of Body Awareness and Imagery in Depersonalization

In everyday life, awareness of our body is crucial to how we perceive the world and interact with it. Signals from within the body, together with somatosensory and proprioceptive inputs, contribute to homeostatic maintenance, selecting actions, and the ongoing representation of the body. These are usually outside conscious awareness, but bodily sensations can become salient when attention is directed toward them or when pain or injury occurs. The ability to attend to, mentally represent, and experience one's body as one's own is therefore a fundamental aspect of embodied self-experience.

Depersonalization is characterized by disruptions in the integration of self-related experiences, including an altered sense of connection to one's own body and feelings of bodily detachment. Converging evidence suggests atypical interoceptive processing, multisensory integration, and body ownership in depersonalization. These processes are thought to depend on distributed somatosensory, (pre)motor, insular, and parietal systems that integrate bodily signals into a coherent representation of the embodied self. However, it remains unclear how the underlying

neural mechanisms and representations are altered in depersonalization. In this study, we used fMRI with a body awareness and imagery task to examine differences in neural patterns between patients and healthy controls when consciously paying attention to body parts (e.g., legs, hands). We applied the general linear model and representational similarity analysis to investigate these differences at multiple levels of analysis. To acquire robust within-subject estimates, we employed inter-subject and model-based RSA using cross-run comparisons, and within each participant, results from multiple runs were combined using fixed-effects analysis. Some patients showed altered patterns in (pre)motor, somatosensory, insula, occipitoparietal, and temporal areas. Some group-level differences, however, did not pass the correction for multiple comparisons. Our study paves the way for future work investigating underlying neural mechanisms and pathophysiology of depersonalization and other related psychiatric conditions.

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P40

Implicit spatiotemporal prediction in cortex and behaviour defaults to linear paths over physics intuition

To make sense of the world we need more than just our senses. We need our brain to integrate noisy sensory signals into coherent percepts, allowing us to navigate and function in our complex surroundings. It does so, using model representations of the outside world that pick up regularities in sensory samples. As such, they capture structure in the world and effectively learn its regularities. We can then extrapolate from such internalized structure to generate predictions about the state of the world and what perceptual input that brings about, allowing for efficient and robust perception. Theories on predictive processing find substantial empirical support, mostly from studies that operationalize prediction as the anticipation of specific input based on simple, lab-learned stimulus associations. Beyond these simple associations, we (implicitly) learn how objects (inter)act in the world through lifelong exposure, leading to an internal intuitive physics model (e.g., objects that are not supported fall to the ground due to gravity). Here, we focus on predictions derived from such an intuitive physics model. In a separate behavioural and fMRI study of an occluded ball collision experiment, we test whether our perception is sensitive to violations of physics and linear motion when simply viewing dynamic objects.

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P41

Tracing Sensory Processing Across Cognitive Stages

Mental chronometry aims to decompose reaction times into distinct cognitive processing stages. Rapid invisible frequency tagging (RIFT), which provides a time-resolved measure of visuo-sensory processing, may be particularly useful for this purpose. However, relating fluctuations in the RIFT response to specific cognitive stages is complicated by cross-trial variability in stage timing.

The present study explored an approach for mapping sensory-processing dynamics onto cognitive processing stages in a random-dot motion decision task. RIFT time courses were realigned based on single-trial stage latencies estimated with hidden multivariate pattern analysis (HMP). This mapping suggested that sensory processing increased during early sensory stages, declined around the putative onset of decision making, and showed a decision-related feature-based attentional effect emerging at this transition and subsequently plateauing.

Two auxiliary analyses assessed the validity and interpretability of this mapping. First, using a speed-accuracy trade-off manipulation to accelerate early sensory stages, we found that a commonly observed RIFT-response peak occurred earlier under speed emphasis, indicating that temporal variation in the RIFT response can reflect changes in processing-stage timing. Second, target- and distractor-evoked RIFT responses were compared to assess feature-based attentional modulation. Although conventional stimulus-locked analyses revealed no reliable attentional effect, a significant effect emerged after HMP-based realignment.

Together, these findings support the use of RIFT, particularly in combination with HMP, as a tool for mental chronometry and provide preliminary insight into how sensory processing and attention unfold across cognitive stages underlying perceptual decision making.

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P42

Improving SONDA visual field reconstruction using Threshold-Free Cluster Enhancement

SONDA (Standardized Oculomotor and Neuro-Ophthalmic Disorder Assessment) is a vision test paradigm from which visual field information can be derived. It consists of a follow-the-dot task including smooth random walk and sudden jump sections. The time it takes to relocate the target after a jump is assumed to relate to local visual field integrity. However, when a new target location is not immediately perceived, the search path contains useful visual field information. In this project, we explore using every time point by employing Threshold-Free Cluster

Enhancement (TFCE). We adapt TFCE to 2D time series data to integrate continuous latency and offset to the SONDA target.
SONDA viewing data from 100 visually healthy participants (three measurements each) were processed with the novel TFCE analysis. We fitted the TFCE data of controls using a six-parameter model to construct their "TFCE Valley of Vision". From this we derived normative distributions for each visual field location in a resolution 1x1 degrees of visual angle. Deviations from this normative distribution are considered to indicate relative functional visual field loss. Next, we test 100 glaucoma patients against this distribution and create a fine-grained and a compressed 24-2 visual field plot that allows us to draw comparisons to clinical Humphrey Field Analyser data.
First results show that SONDA-TFCE can reliably generate visual field maps from eye-movement perimetry data by incorporating gaze information from every recording time point. We find plausible visual field defects for most glaucoma patients and only a limited number of false positive defects in controls.
SONDA-TFCE provides a novel framework for deriving visual field maps from eye-movement data. Incorporating the full gaze trajectory increases the spatial information available from SONDA. Its utility potentially increases with inability to follow the target jumps, making it especially interesting for participants with severe visual field defects.

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P43

Spatial Learning During Walking with Vibrotactile Feedback

This study investigated spatial learning while walking through an invisible environment using a wearable vibrotactile display. We compared spatial knowledge acquired through free exploration against a guided exploration of the environment.
Participants (N = 17) navigated two virtual reality (VR) maze environments containing four auditory landmarks. The VR headset tracked the position of users, but gave no visual information of the environment. A vibrotactile vest (bHaptics) signaled the direction of nearby obstacles through vibrations on the upper torso. Participants explored an environment for 8 minutes in one of two conditions: In 'Guided Exploration', additional vibrations around the waist guided the participant along a route past all landmarks; In 'Free Exploration' participants independently explored the environment.
Spatial knowledge after exploration was assessed through 12 navigation trials in which participants navigated between landmarks under a time limit. In half the navigation trials the

shortest route between the two landmarks was blocked and participants had to choose an alternative path. After the navigation trials, participants sketched a map of the environment. Preliminary results showed no significant difference in navigation performance following the two exploration conditions. However, participants drew more accurate maps after Free Exploration. Higher exploration quality during the 8-minute exploration phase significantly improved navigation performance in trials where no additional obstacle was added. Increased complexity of a path (i.e., higher number of turns) also significantly reduced navigation performance.
Overall, these results suggest that free exploration does not necessarily improve navigation performance, even though it may support the development of more accurate spatial representations.

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P44

From training to practice: Effects of an eye movement modelling intervention on nautical operators' CCTV viewing behaviour

Closed-circuit television (CCTV) scanning requires nautical operators to distribute visual attention across multiple camera streams. Systematic viewing, defined as scanning CCTV streams and areas in a consistent, structured sequence, is a measurable aspect of this behaviour. Previous research in remote nautical object (bridge/lock) control showed that systematic viewing is associated with more extensive visual inspection, reflected in greater CCTV dwell time and coverage. An important next question is whether systematic viewing can be trained and transferred to operational practice.
This study investigated whether a brief training intervention could establish systematic viewing behaviour in experienced operators and whether behavioural changes would persist during subsequent operational work. The intervention combined explicit instruction, an Eye Movement Modelling Example (EMME) displaying the gaze behaviour of an expert operator, guided practice, and behavioural assessment. The aim was to make an otherwise implicit visual strategy observable and applicable in daily practice.
Professional nautical operators (N = 19) participated in a within-subject design consisting of two baseline measurements, an immediate post-training assessment, and a follow-up assessment approximately four weeks later. Data was collected during regular operational work on four occasions. Dwell time, coverage, and systematic viewing – quantified using gaze transition entropy – were measured throughout the study.
By evaluating a brief intervention under operationally realistic conditions, this study examines whether systematic viewing can be trained and sustained in experienced operators. More broadly, it explores whether eye movement modelling can make expert visual strategies observable, learnable, and transferable to real-world performance. Given the limited recurrent training of

nautical operators and the lack of explicit instruction in visual scanning behaviour, this intervention may offer a practical means of maintaining inspection quality and situation awareness in daily operations.

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P45

Effector similarity warps visual feature space in working memory

Working memory not only maintains information but also prepares and guides future actions. Previous research has shown that action planning on objects in working memory can influence how they are represented and interact. Specifically, similar visual features exhibit stronger repulsion when associated with different types of action (e.g., grasping versus sliding). Here we addressed the question whether this action-relation modulation extends to distinctions between effectors (while the action type remains identical).

We conducted two experiments in which participants sequentially memorized the orientations of two bars presented on a touchscreen, both of which were to be reproduced at the end of the trial, using a sliding movement with the index finger. Crucially, during the delay period after encoding, each bar was followed by a cue specifying whether its orientation should later be reproduced with the left or the right hand. In the different-hand condition, the two bars were each associated with different hands (one left, one right), whereas in the same-hand condition, they were linked to the same hand (both left or both right). The results showed a robust repulsion effect, with similarly oriented bars being reported as more distinct than they actually were. Critically, this repulsion effect was significantly stronger in the different-hand condition than in the same-hand condition. A second experiment replicated this effect and ruled out that it was driven by biases arising during motor execution.

Together, these findings demonstrate that effector distinctions can influence the organization of visual representations in working memory. Even when the type of action planned is identical, associating similar items with different hands increases the repulsion between them. More broadly, the results extend previous work by showing that effector-similarity, like action similarity, shapes representational interactions in working memory, further highlighting how prospective actions and their associated effectors structure information maintained for future behavior.

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P46

An eye for action: Do object affordances shape how we represent others' attention?

Tracking others' gaze helps us infer where their attention is directed and anticipate their behaviour. Previous research suggests that the brain represents another person's attention as an implicit beam of motion travelling from their eyes toward the object they are looking at. Evidence for this account comes from visual motion adaptation: after viewing a static image of an avatar gazing at an object, participants are faster at discriminating moving dots when the dots move opposite to the gaze direction than when they move in the same direction. This pattern is consistent with a motion aftereffect, as though viewing the gaze had adapted the visual system to motion travelling from the avatar's eyes toward the object. If this implied-motion signal reflects attributed attention, its strength should depend on cues that influence how much attention observers believe the agent directs toward the object. One such cue may be action compatibility. Objects that can be easily acted on are known to receive enhanced attentional processing. Observers might therefore infer that an agent pays more attention to an object when the agent can readily act upon it (e.g., grasp it). We tested whether agent–object action compatibility modulates gaze-related implied motion. Participants viewed an avatar gazing at an object whose orientation either facilitated or hindered a potential interaction from the avatar's perspective. Each image was followed by a random dot kinematogram, and participants indicated whether the dots moved leftward or rightward. Reaction times revealed a significant interaction between action compatibility and motion–gaze congruency: the advantage for gaze-incongruent over gaze-congruent motion was present only for action-compatible objects. These findings demonstrate that action compatibility modulates gaze-related implied motion, and supports the notion that observers perceive others as paying greater attention to objects they can readily interact with.

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P47

Colours of Consciousness: Using synesthetic training to identify the neural computations behind subjective experience

Understanding how the brain generates subjective experience remains a fundamental challenge. The Predictive Processing Framework (PPF) proposes a bold
answer: conscious perception reflects the brain's predictions rather than incoming sensory

input directly. If true, systematically altering predictions should directly alter what we experience; this claim has rarely been tested empirically.
We address this question using grapheme–colour synesthesia (GCS) as a model of prediction-driven perception. In GCS, achromatic letters reliably evoke colour experiences, illustrating how internal models shape perceptual content. We manipulate prediction strength in non-synesthetes using a longitudinal "reading-in-colour" paradigm, in which participants are trained on systematically coloured texts with parametrically varied letter–colour probabilities and letter frequencies. Their performance is compared to that of developmental synesthetes.
Participants complete behavioural and pupillometry sessions before and after training. Subjective colour experience is assessed using detailed questionnaires, while pupil dilation indexes prediction error and information gain. Using information-theoretic measures, we test whether physiological responses scale with model-derived estimates of information gain, and whether the intensity of reported colour experience scales with the strength of learned predictions, indexed by pupil dynamics.
This approach enables a direct, quantitative link between computational theory, physiological signals, and phenomenology. By showing that experimentally induced predictions shape both physiology and conscious experience, this work provides a stringent test of the PPF's central claim. More broadly, this work contributes to the development of pupil dynamics as a tractable, non-invasive marker of subjective experience and offers a framework for studying how the brain constructs perceptual reality.

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P48

Is Spatial Language Grounded in Perception? Language Usage In Persons With A Visual Impairment through Verbal Fluency Tasks

Most people experience the world with a strong reliance on their vision. Persons with a visual impairment (PVI) experience the world differently. They rely more on other modalities such as touch, hearing and smell to navigate the physical world. Distinct perceptual experiences may influence how spatial and visual concepts are organised. One way to investigate this is through language. If persons with a visual impairment differ in use and representation of spatial and visual words, this could suggest that spatial language is grounded in perception. However, if there is little difference, it is more likely that these concepts are fully linguistically determined, that is by lexical associations formed throughout life.
The current study therefore explores the language usage of PVI for different lexical categories. We compared verbal fluency performance in blind, low vision and sighted persons on letter fluency (A) and categories involving spatial concepts (prepositions) and visual concepts (animals and colours).

Results were analysed on total number of correct words, number of incorrect words and duplicate words per task for each experimental group. Mean scores per task show little difference per group. In all groups score variance per task was high, except for the prepositions task. The preposition task further differed with a high number of duplicate and incorrect words. Most incorrect words were other spatial terms (e.g. “left”, “east”), suggesting that participants generalised to the broader semantic category of spatial words.
The results did not show a significant difference between the three experimental groups on any of the verbal fluency tasks, suggesting that limited or absent visual input does not strongly influence one’s language network.

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P49

Low-level influences on numerosity adaptation

Numerosity perception (the approximation of the number of objects in a scene) has been described as functioning analogue to our primary senses, such as audition and vision. Two characteristics of numerosity processing support this notion: its map-like cortical representation, and that adaptation to a specific numerosity alters the perception of a subsequently presented numerosity. However, where in the perceptual (here visual) hierarchy numerosity processing (and thus adaptation) occurs is still a matter of debate.
We investigate this by adapting to either a low (20 dots) or a high (80 dots) numerosity and matching the numerosity of a (40 dots) test stimulus, subsequently presented in the same location, to a variable number of dots presented in the opposite hemifield. In one experiment the adapting stimulus was presented to one eye, and the test stimulus to the same or the other eye (monocular vs dichoptic presentation), in the other experiment the contrast polarity of the dots in the test stimulus was the same or opposite to that of the adaptation stimulus. As such, the adaptation effects can be used to differentiate between lower, monocular and with separate ON- and OFF-channels (i.e. subcortical up to V1 input layers) and higher, binocular cortical areas.
In all conditions, adapting to a low numerosity led to a higher perceived test-numerosity than adapting to a high numerosity (the typical effect). In the dichoptic and opposite-contrast conditions the test stimulus was overestimated after low numerosity adaptation and underestimated after high numerosity adaptation. However, although the monocular and same-polarity conditions showed the same overall pattern, here both high and low numerosity adaptation resulted in underestimation.
This demonstrates an additional adaptation component on a monocular level or within separate ON- or OFF-channels with an effect comparable to that of adapting to a high numerosity. Possible candidates will be discussed.

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P50

Benchmarking pupil perimetry in young children: finding visual field anisotropies

Reliable visual-field assessment in young children remains challenging. Standard perimetry tests, where a participant presses a button when a small light was detected in the visual field, require sustained fixation, task comprehension, and motor response, limiting feasibility particularly in children. We recently developed two objective perimetry tests that circumvent these problems: gaze-contingent flicker pupil perimetry (gcFPP) and its VR implementation (VRgcFPP).
Both paradigms present flickering stimuli at 20 visual-field locations and use stimulus-evoked pupillary oscillations as an objective marker of local visual sensitivity. No subjective response is needed and eye tracking maintains the stimulus at the intended visual-field location despite gaze changes; VRgcFPP additionally permits free head movements. We assessed vertical and horizontal visual-field anisotropies (VFAs) in healthy children. VFAs are systematic sensitivity differences, found consistently in adults, between visual-field regions and provide an internal benchmark for evaluating the new methodologies.
Among 30 children tested with gcFPP and 38 with VRgcFPP, pupillary responses were stronger for temporal than nasal stimulation, revealing a nasal–temporal VFA. The upper–lower VFA was less pronounced, although responses were generally stronger for upper than lower visual-field stimulation. No clear associations between VFAs and age or height were observed.
These findings indicate that gcFPP and VRgcFPP can detect systematic spatial differences in visual sensitivity in children, supporting their feasibility for paediatric visual-field assessment. The presence of VFAs suggests that regional sensitivity differences should be controlled for when interpreting results in clinical populations.
Importantly, these results demonstrate feasibility in children with intact visual fields; the sensitivity and specificity of gcFPP and VRgcFPP for detecting neurological visual-field defects remain to be established. Future studies will investigate the overlap between (VR)gcFPP and standard visual-field tests at UMC Utrecht in these children, using the current datasets as normative reference.
Attendees are invited to try VRgcFPP at the poster.

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P51

Physiologically and subjectively inferred costs are minimized during saccade selection

Recent work suggests visual selection to follow an economic opitimization process between information maximization and cost minimization. Pupil size is a proposed measure of these costs, however so far this has only been established for saccades in different directions. In the current study we measured the effort of eye movements in different directions as well as for varying amplitude. We used pupil size as an index of effort expenditure while planning cued and delayed saccades. We found downwards saccades to be more effortful than upwards saccades and long saccades to be more effortful than short saccades. This effort (or cost) of planning saccades was correlated to behavioral saccade preferences: in a subsequent behavioral preference task, the 'expensive' eye movements were avoided. In a final task we measured participants' subjective cost awareness across saccade targets. We tested participants' subjective effort expenditure across amplitudes and cardinalities. To do so, participants saccaded forward and backward from a central starting point to a target and then repeated the same procedure to another target. Participants then indicated which of the two sequences was more effortful. Providing convergent validity to the pupillometric saccade cost measure, longer amplitude and more diagonal saccades were rated as more effortful, while upward/downward differences could not be tested. These results challenge the prevailing assumption that the effort behind eye movements is subliminal and not considered during the selection of visual attention

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P52

Linguistic and non-linguistic hearing performance with a cochlear implant and the role of residual cochlear function

A cochlear implant (CI) can restore hearing of severely hearing-impaired or deaf people by electrically stimulating the auditory nerve bypassing lost and damaged sensory hair cells. Residual hearing may contribute to hearing performance of CI users. Residual hearing is typically measured by tone detection thresholds and it can be assessed by electrocochleography (ECochG) using the CI electrodes to record hair cell responses. We investigated to which extent speech perception in noise, a task depending on linguistic skills, and discrimination of spectrally modulated broadband noises, a non-linguistic task, is related to pure-tone thresholds and

ECochG.
Forty-eight adults with severe hearing loss participated to the study. Intraoperatively and at four moments postoperatively (1.5, 3, 6, 12 months), residual cochlear function was assessed using pure-tone average (PTA) and ECochG for frequencies ranging from 125 to 4000 Hz. Speech perception in quiet and in noise, and spectral resolution (spectral-temporally modulated ripple test; Aronoff & Landsberger, J. Acoust. Soc. Am. 134: EL217–EL222, 2013) were assessed at 12 months. Relations between the four different measurements - CM, PTA, SMRT, and speech perception - were examined using regression analyses.
For low frequencies (125 – 500 Hz) tone detection thresholds significantly correlated with CM amplitudes ($R2 = 0.22$, $p = 0.003$). Spectral resolution scores correlated with CM for both low and high frequencies ($R2 = 0.2$, $p < 0.05$). While speech perception correlated with spectral resolution ($R2 = 0.21$, $p = 0.02$), it did not correlate with CM or tone detection ($R2 < 0.1$, $p > 0.1$).
Residual cochlear function, as reflected by CM and tone detection, contributes to non-linguistic auditory processing after cochlear implantation. The contribution of cochlear health to speech perception is arguably relatively small due to linguistic factors.

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P53

Distinguishing Rembrandt from his students: evidence for tacit perceptual learning in a connoisseur-level task

Visual experts can see things that are invisible to the non-expert, but how is expertise acquired? Can this expertise be transferred through verbal descriptions, or is the knowledge tacit and only acquired through feedback? A domain where visual expertise plays an important role, both in education and in professional authentication practice, is the arts. Various studies have shown that non-experts can learn to distinguish art styles, but the task difficulty was generally far below that of the art connoisseur. Here, we investigate whether a truly difficult task, even for connoisseurs, can be learned: distinguishing drawings of Rembrandt from those of his pupils (e.g. Govert Flinck, Ferdinand Bol). We collected 288 drawing pairs (Rembrandt-pupil) that were matched on subject matter using CLIP embeddings. In the first experiment we let 30 participants perform a 2AFC task with feedback. To facilitate learning, a 200 word instruction by an expert was offered and could be consulted throughout. A minimum of 6 seconds viewing time per trial was imposed the actual experiment took over one hour. Of the 22 participants who passed the catch-trial

criterion (≥75%), 17 showed a positive logistic learning curve. The overall increase of 4% in accuracy was significant ($t(21)=3.38$, $p=0.0028$). To investigate the effect of expert instruction we ran a second experiment, in smaller blocks (around 100 pairs) with 86 participants. In these shorter sessions, no learning effects were observed for both without ($t(44)=1.42$, $p>0.05$) and with ($t(40)=1.43$, $p>0.05$) instruction. More importantly, the effect of instruction on accuracy was absent ($t(84)=1.16$, $p>0.05$). This study shows that visual expertise on a truly difficult task can be acquired but apparently does not require explicit instructions. Implication for art education is to develop more interactive visual learning tools aside from using textbooks.

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P54

Pseudo-haptic perception across three movement conditions

Pseudo-haptics uses a controlled mismatch between a person's movement and its displayed consequence to create haptic-like impressions without mechanically transmitted force. Existing research has shown that such mappings alter perceived resistance, stiffness, and agency, but these effects are usually characterized within one movement condition, leaving unclear how the same gain is perceived when the movement goal and visual reference change. A strength validated in one task may not feel the same, or remain detectable at all, in another. Sixty-three participants used a computer mouse to control a cursor-like object in one-dimensional tasks displayed on a monitor. Five levels of pseudo-haptic gain controlled how strongly a hidden reference position altered the object's displayed position. The three tasks were 1) dragging the object between fixed checkpoints, 2) holding it against a moving reference while a target stayed still, and 3) tracking a moving target while the reference pulled against it. After every trial, participants rated perceived resistance and sense of agency, and reported whether the object felt connected to something else. Deviation distance and time outside the target region measured control cost in the two continuous-control conditions. Higher gain increased perceived resistance and connection reports, reduced sense of agency, and increased control costs. Even at the lowest nonzero gain, participants frequently reported a connection in both continuous-control conditions, whereas connection reports remained uncommon during checkpoint dragging. Connection detection in the checkpoint-dragging condition generally required higher gain values. The perceptual consequences of pseudo-haptic gain therefore depended on the movement condition in which it was experienced. This context dependence makes movement-specific calibration necessary when pseudo-haptic gain is used as an experimental variable or an interaction design parameter.

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P55

Age-related Preservation of Statistical Learning in Distractor Suppression

Statistical learning, the ability to extract regularities from the environment, is a fundamental cognitive process that influences many aspects of human cognition. However, it is not yet entirely clear whether—and to what extent—this ability declines with age. While older adults are known to effectively learn environmental regularities to guide their search, it remains unclear whether they can also learn to suppress locations likely to contain a distractor. In the present study, 96 young and 96 older adults (mean ages 24 vs. 65 years old, respectively) performed an additional singleton task, searching for a shape singleton while a color singleton distractor was present. Crucially, the color distractor appeared more frequently in one specific location than in others. In line with previous research, participants exhibited (i) more effective suppression of distractors appearing at high-probability locations, (ii) a clear spatial gradient of suppression, with search efficiency decreasing as the distance from the distractor increased, and (iii) hampered target selection when the target appeared at the location that usually contained a distractor. Although both young and older adults showed learned suppression largely within the first block, and this effect then persisted throughout the experiment, the magnitude of suppression was smaller in older adults than in young adults. We conclude that the ability to learn distractor locations is largely preserved, but that the consequential impact on behavior diminishes with age.

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P56

Attention alters numerosity tuned responses in the human brain

Neural populations tuned to numerosity, the number of items in a visual display, are precursors of advanced numerical cognition. While numerosity tuning is typically studied during passive viewing, real-world numerical cognition is goal-directed. Here, we tested whether endogenous attention to target numerosities dynamically transforms numerosity tuning, mirroring mechanisms of visuospatial attention. Using 7T fMRI, we mapped voxel-wise numerosity tuning while participants attended to target numerosities (2 or 6) or a non-numerical feature (color). Attention attracted numerosity preferences toward the target and sharpened tuning, effects that amplified along the cortical processing hierarchy and persisted when targets were absent. Computational attention field models predicted these transformations, revealing a progressive narrowing of top-down attention fields along the hierarchy. These findings reveal that cortical representations of abstract quantity are flexibly reconfigured by behavioral goals, demonstrating

that attentional gain mechanisms operate universally across basic sensory and abstract cognitive domains.

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