Helmholtz Instituut

Utrecht University

Perception Day 2023

Organizers
Ben Harvey
Chris Paffen
Stefan van der Stigchel

Support
Laura van Zantwijk

Abstract reviewers
Teuni ten Brink
Surya Gayet
Marnix Naber
Krista Overvliet
Nathan van der Stoep
Sjoerd Stuit

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 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**	Ruppert Hall
8:55	Welcome to Perception Day!	Ruppert Wit & Ruppert 040
9:00	**Talk session 1A:** patients & special populations	Ruppert Wit
9:00	**Talk session 1B:** attention & visual search	Ruppert 040
10:30	**Coffee break & posters**	Ruppert Hall
11:15	**Talk session 2A:** audition, multisensory perception & timing	Ruppert Wit
11:15	**Talk session 2B**: attention & visual perception	Ruppert Rood
12:45	**Lunch**	Ruppert Hall
14:00	**Talk session 3A:** visual working memory	Ruppert Wit
14:00	**Talk session 3B**: action & pupillometry	Ruppert 040
15:15	**Coffee break & posters**	Ruppert Hall
16:00	**Helmholtz lecture Paul Bays:** "computational principles of visual perception & memory"	Ruppert Wit
17:00	**Drinks**	Ruppert Hall

Talks

Talk session 1A – patients & special populations
9:00 – 10:30, Room Ruppert Wit

9:00	Pupillometry As Index For Biases In Spatial Attention: Pseudoneglect In Healthy Controls, Useful Tool For Diagnosing Cerebral Visual Impairments?	Teuni ten Brink, Utrecht University
9:15	What Exactly Is So 'super' About Super-Recognisers?	Isabel Gillert, Heriot-Watt University
9:30	Quantifying Altered Visual Attention In Cerebral Visual Impairment Using An Eye Tracking Based Visual Search Task	Marinke Hokken, Erasmus MC Rotterdam
9:45	Disruption Of Multisensory Temporal Perception After Sport-Related Traumatic Brain Injury	Nathan van der Stoep, Utrecht University
10:00	Detecting And Reconstructing Visual Field Defects From Free-Viewing Eye Movements	Henning Schulte, University of Groningen
10:15	Long-Term Adaptation To A Visual Field Defect Improves Functional Vision: Evidence From A Continuous Visual Tracking Task	Minke de Boer, UMC Groningen

Talk session 1B – attention & visual search
9:00 – 10:30, Room Ruppert 040

9:00	Searching Near And Far: The Attentional Template Incorporates Viewing Distance	Surya Gayet, Utrecht University
9:15	A Serial Search Paradigm For Measuring Peripheral Crowding Strength	Dilce Tanriverdi, UMC Groningen
9:30	Don't Hide The Instruction Manual: A Dynamic Trade-Off Between Using Internal And External Templates During Visual Search	Alex Hoogerbrugge, Utrecht University
9:45	Pop-In Distractor Suppression During Visual Search In Cortical Area V4 Of The Monkey	Chris Klink, Netherlands Institute for Neuroscience
10:00	Pinging The Brain To Reveal A Hidden Attentional Priority Map	Dock Duncan, VU Amsterdam
10:15	The Costs Of Paying Overt And Covert Attention Assessed With Pupillometry	Damian Koevoet, Utrecht University

Talk session 2A – audition, multisensory perception & timing 11:15 – 12:45, Room Ruppert Wit

11:15	Spaced Vs Massed Learning In Auditory Statistical Learning	Jasper de Waard, VU Amsterdam
11:30	Highest Reaction Time Sensitivity To Sound Modulations At Supra-Threshold Levels	Nina Haukes, Radboud University Nijmegen
11:45	L2 Perception Training And Its Effects On Perception And Word Recognition In The Dutch Classroom	Marlisa Hommel, Utrecht University
12:00	The Effect Of Distance On Audiovisual Synchrony Perception In An Indoor Virtual Reality Environment	Victoria Korshunova-Fucci, Eindhoven University of Technology
12:15	Cortical Quantity Representations Of Visual Numerosity And Timing Overlap Increasingly But Remain Distinct	Evi Hendrikx, Utrecht University
12:30	Time Perception In A Large, Diverse And Naïve Sample Of Museum Visitors	Joost de Jong, University of Groningen

Talk session 2B – attention & visual perception
11:15 – 12:45, Room Ruppert Rood

11:15	Reversal Of Dominance In Neural Competition By Top-Down Signals: Biased Competition Mechanisms Investigated By A Hybrid Neural Circuit	Naoki Kogo, Radboud University Nijmegen
11:30	What Did You Expect? Prediction Error Tuning In Sensory Cortex	David Richter, VU Amsterdam
11:45	Attentional Focus On Internal Representations Impairs Object Recognition Compared To External Focus Of Attention	Charlotte de Blecourt, Radboud University Nijmegen
12:00	Investigating Spatial Predictive Context In Visual Search With Rapid Invisible Frequency Tagging	Floortje Bouwkamp, Radboud University Nijmegen
12:15	Expected Distractor Context Biases The Attentional Template For Target Shapes	Maëlle Lerebourg, Radboud University Nijmegen
12:30	Redesigning Beach Safety Flags To Improve Intelligibility And Effectiveness	Fenne Roefs, VU Amsterdam

Talk session 3A – visual working memory, 14:00 – 15:15, Ruppert Wit

14:00	The Relationship Between Selective Attention And Working Memory Gating	Natalie Nielsen, Radboud University Nijmegen
14:15	Differential Feedforward And Feedback Signals For Central And Peripheral Working Memory Items	Guven Kandemir, VU Amsterdam
14:30	Action Consequences Guide Visual Working Memory Use	Andre Sahakian, Utrecht University
14:45	A Matter Of Availability: Neural Representations Of Task-Relevant Stimulus Features Are Sharper When Stimuli Are Memorized Rather Than Perceived	Samson Chota, Utrecht University
15:00	Hierarchical, Topographic, And Tuned Fronto-Parietal Responses To Visual Short-Term Memory Load	Ben Harvey, Utrecht University

Talk session 3B – action & pupillometry, 14:00 – 15:15, Ruppert 040

14:00	Are Hand Movements Influenced By Illusory Changes In The Identity Of The Goal?	Danai Vorgia, VU Amsterdam
14:15	Seeing Why A Target Is Accelerating Can Help One Intercept It	Eli Brenner, VU Amsterdam
14:30	Cerebrocerebellar Interactions Underlying Active Sensing	Vincenzo Romano, Erasmus MC, Rotterdam
14:45	Does Pupil Dilation Trigger A Shift From Rod-Dominated Vision To Cone-Dominated Vision?	Veera Ruuskanen, University of Groningen
15:00	Causal Effects Of Pupil Size On Visual Processing	Sebastiaan Mathôt, University of Groningen

Posters

P1	Location And Image Prediction In Visual Sequence Learning	Ningkai Wang, VU Amsterdam
P2	Additivity Of Grouping By Proximity And Luminance Similarity: Individual Differences And Stability	Elisabeth van der Hulst, KU Leuven
P3	Changes In Connective Field Properties During Visual Recognition	Mayra Bittencourt, UMC Groningen
P4	Cortical Potentials Evoked By Tone Frequency Change As Objective Measure For Speech Perception	Huib Versnel, UMC Utrecht
P5	Eye State Influences Eigenvector Centrality Of Brain Networks In Resting-State Fmri	Theresa Marschall, UMC Groningen
P6	Withdrawn	Withdrawn
P7	Reduced Contextual Variability Facilitates Learned Attending Towards Task-Relevant Features And Away From Distracting Information	Chris Jungerius, University of Amsterdam
P8	Do We Use Kinesthetic Information To Decide Which Cookie To Take?	Gül Duygun, VU Amsterdam
P9	Action Similarity Modulates Visual Working Memory Similarity	Caterina Trentin, VU Amsterdam
P10	Auditory Pursuit Is Adaptive	Snandan Sharma, Radboud University Nijmegen
P11	An Apparent Motion Color Illusion	Rob van Lier, Radboud University Nijmegen
P12	Reaction Times Capture Temporal Interactions In Electrical Hearing	Ignacio Calderon De Palma, Radboudumc
P13	Does Crowding Predict Conjunction Search? An Individual Differences Approach	Ines Verissimo, VU Amsterdam
P14	Individual Differences In Statistical Learning For Speech Segmentation: Can We Predict Learning With Neural Oscillations And Rhythm Perception?	Iris van der Wulp, Utrecht University
P15	Reconstructing Pupillary Dynamics During Free-Viewing Of Movies: The Roles Of Pupil Light And Orienting Responses	Yuqing Cai, Utrecht University
P16	Adaptation To Numerosity Changes Monotonic Responses Of Early Visual Cortex	Liangyou Zhang, Utrecht University

P17	A Moment To Remember: Immediate Behavioural Interference Reduces Memory Performance In The Virtual Water Maze Task	Marie Pahlenkemper, Maastricht University
P18	Affective Touch Perception And Longing For Touch During The Covid-19 Pandemic	Larissa Meijer, Utrecht University
P19	Visual And Haptic Pleasantness Of Geometric Patterns	Myrthe Plaisier, Eindhoven University of Technology
P20	Eye-Tracking In Innovative Neuropsychological Assessment Of Visual Working Memory	Sanne Böing, Utrecht University
P21	Statistical Learning Facilitates The Selection Of Stimuli Into Awareness	Luzi Xu, Utrecht University
P22	Soft Robotics In Haptic Interaction	Irene Kuling, Eindhoven University of Technology
P23	Active Inference Slows Reversal Learning In Uncertain Environments	Jet Lageman, VU Amsterdam
P24	The Effects Of Eccentricity On Attentional Capture	Elle van Heusden, VU Amsterdam
P25	Involvement Of Superior Colliculus In Complex Figure Detection Of Mice	Alexander Heimel, Netherlands Institute for Neuroscience
P26	Timing Of Tonality And Progression: Anticipation-Related Arousal Speeds Up Subjective Time, Regardless Of Sequential Tonality	Hakan Karsilar, University of Groningen
P27	Teal & Orange	Andrea van Doorn, Utrecht University
P28	Perceptual grouping in haptic enumeration	Kirsta Overvliet, Utrecht University
P29	Objectively positive but subjectively unappealing: visual features of art evaluation	Sjoerd Stuit, Utrecht University
P30	Sound Appraisal Technology In The Real World	Tjeerd Andringa, SoundAppraisal
P31	What Can Visual-Field Deficits Teach Us About Audiovisual Integration?	Peter Bremen, Erasmus MC Rotterdam
P32	Concealed familiar face detection with oculomotor measures and EEG in rapid serial visual presentation	Ivory Chen, University of Groningen

Abstracts - Talks

Talk session 1A – patients & special populations, 9:00 – 10:30, Ruppert Wit

Talk session 1A – patients & special populations, 9:00 – 10:30, Ruppert Wit
9:00 – 09:15

Pupillometry As Index For Biases In Spatial Attention: Pseudoneglect In Healthy Controls, Useful Tool For Diagnosing Cerebral Visual Impairments?

Spatial attention is generally slightly biased leftward ("pseudoneglect"). This phenomenon is typically assessed with paper-and-pencil tasks, limited by the requirement of explicit responses and the inability to assess on a sub-second timescale. Furthermore, pseudoneglect is often stable within experiments, but differs vastly between investigations and is sometimes expressed to the left, sometimes to the right. We present a pupillometry-based method to assess spatial attention in an objective manner. The method is based on the principle that changes in pupil size associated with changes in light level are not purely reflexive, but are modulated by spatial attention. More specifically, the pupil changes size as covert attention is moved to parts of the visual scene of differing brightness. Healthy participants (N=41) viewed alternating black/white or white/black stimuli while fixating the center. Pupil sizes were more influenced by bright and peripheral stimuli presented on the left side as compared with the right side of the visual display. In ongoing work, we assessed the feasibility of this method for the diagnosis of visuospatial neglect, a frequent condition after right hemispheric brain damage in which attention to the left side of space is reduced. Indeed, neglect patients (N=3) showed stronger pupil light responses to the right side than the left side of the display, whereas age-matched healthy controls (N=12) did not show this pattern. Furthermore, patients with hemianopia or quadrantanopia (N=7), a visual impairment caused by brain damage in the occipital lobe, showed a similar pattern, where the pupil light responses were stronger for the side of the intact rather than defect visual field. This method could be exploited to improve diagnosis of visuospatial neglect following stroke. Objective assessment of neglect is relevant not only for clinical diagnosis (i.e. to provide psycho-education and to select appropriate treatment), but also for outcome measurement in clinical trials.

Author:
ten Brink, Teuni
Affiliation:
Experimental Psychology, Helmholtz Institute, Utrecht University

Other authors:
van Heijst, Marlies, M, Utrecht University,
Portengen, Brendan, B, Utrecht University,
Naber, Marnix, M, Utrecht University,
Strauch, Christoph, C, Utrecht University

Talk session 1A – patients & special populations, 9:00 – 10:30, Ruppert Wit
09:15 – 09:30

What Exactly Is So 'super' About Super-Recognisers?

Introduction:
Super-recognisers (SR) are people with superior face perception, recognition, and identification abilities that can be classified by a battery of tests (Ramon, 2021; Russell et al., 2009). We test whether their face recognition superiority extends to emotion perception by measuring their sensitivity to different facial expressions and comparing their performance to controls. This will help disentangle their skills in face identity and emotion detection.
Methods:
Participants were grouped into SRs, Middle (just below SR threshold), and Controls depending on test-battery-scores.

An emotion recognition task tested sensitivity to six emotions. Participants judged which of two successively presented faces was more expressive. One face was 0% expressive (neutral), and the other 1-100% expressive. Sensitivity was measured as intensity needed to identify the more expressive face on 82% of trials. All faces were shown upright and inverted.
Results:
SRs and Middle group were more sensitive to emotions than Controls. All participants were most sensitive to happy and least to sad expressions and inversion decreased sensitivity across all emotions. The largest inversion effects were for sadness and anger.
Discussion:
SRs outperformed others across all six emotions. All participants were most sensitive to happy. This was followed by disgust, surprise, fear, anger, and sadness in that order. The visual characteristics that define sad and angry expressions are more ambiguous and often confused for other emotions especially when inverted (Derntl et al., 2009). This could account for the particularly high intensity needed to detect angry and sad expressions for upright and inverted faces.

Author:
Gillert, Isabel
Affiliation:
Heriot-Watt University

Other authors:
Rogers, Claire, Heriot-Watt University,
Davis, Josh P, University of Greenwich,
Rajendran, Gnanathusharan, Heriot-Watt University,
Delicato, Louise S, Heriot-Watt University

Talk session 1A – patients & special populations, 9:00 – 10:30, Ruppert Wit
09:30 – 09:45
Quantifying Altered Visual Attention In Cerebral Visual Impairment Using An Eye Tracking Based Visual Search Task
Objective: Children with Cerebral Visual Impairment (CVI) often struggle finding a target of interest in cluttered and noisy environments, even with (near) normal visual acuity. It remains unknown how environmental or task demands influence their visual search performance, and whether task performance discriminates between CVI and other neurodevelopmental disorders.

Method: We developed a conjunction visual search task with varying task demands (structure, set size, background). We included 19 children with CVI (mean age 9.65 years ± 0.48), 34 children with ADHD (mean age 10.39 ± 0.34), 30 children with Dyslexia (mean age 10.35 ± 0.20) and 39 typically developing (TD) children (mean age 9.22 ± 0.31). The test was executed on an eye tracking device to quantify search behavior in terms of, e.g., reaction times and search patterns.

Results: The duration of first target fixation did not differ across groups. Preliminary data show an overall impairment in the CVI group in reaction times before and after first target fixation (FTF), and larger differences between easy and difficult task demands compared to all other groups. The size of the visual search area before FTF did not differ, but children with CVI had a larger visual search area after FTF compared to all other groups.

Implications: Our preliminary results, showing higher reaction times and worsening performance with increased task demands, are in line with / may explain the reported daily symptoms in children with CVI. Our quantitative approach adds that they tend to not consciously perceive a visual target during first target fixation. This search task is

a promising tool for differential-diagnostic evaluation between CVI, ADHD and Dyslexia.

Author:
Hokken, Marinke
Affiliation:
Erasmus MC, department of Neuroscience
Koninklijke Visio

Other authors:
Kooiker, Marlou M J G, Erasmus MC, department of Neuroscience & Koninklijke Visio
Pel, Johan J J M, Erasmus MC, department of Neuroscience
van der Steen, Hans J, Erasmus MC, department of Neuroscience
Frens, Maarten M, Erasmus MC, department of Neuroscience

Talk session 1A – patients & special populations, 9:00 – 10:30, Ruppert Wit
09:45 – 10:00

Disruption Of Multisensory Temporal Perception After Sport-Related Traumatic Brain Injury

Background: Humans can combine auditory and visual inputs for faster and more accurate detection, identification, and localization of audiovisual events via a process called multisensory integration. Sensory inputs that fall within a temporal binding window tend to be integrated. A large delay between auditory and visual inputs causes them to be perceived as separate events. Traumatic brain injury (TBI) can affect multisensory temporal processing, potentially explaining sensory processing symptoms after TBI. Multisensory temporal processing can be altered by a shift in the point of subjective simultaneity (PSS). This can, among others, lead to out-of-sync audiovisual speech perception and sensory overload. Additionally, the temporal binding window can be altered, affecting at which intersensory delays auditory and visual inputs should be integrated. Objective: The aim of this study was to investigate the prevalence of multisensory temporal processing alterations in patients with TBI and its relation with sensory overload symptoms. Setting and Participants: A total of 125 patients with sports-related brain damage were recruited at the Concussion Clinic of the Dutch Royal Soccer Association of whom 122 were included in the analyses. Design: Patients and healthy controls performed an audiovisual temporal order judgement task to assess their point of subjective simultaneity (PSS) and the size of their temporal binding window (i.e., multisensory temporal precision) to investigate whether abnormalities in MSI are present in this patient population and whether it relates to the TBI and sensory overload. Results: Approximately 14% of the patients had abnormalities in multisensory temporal processing, due to either a shift of the PSS and/or an increase in the size of the TBW. The results showed no direct link between PSS shift and sensory hypersensitivity complaints as measures with the Sport Concussion Assessment Tool. An exploratory analysis revealed that patients' vestibulo-ocular symptoms were predictive of the shift in PSS.

Author:
Van der Stoep, Nathan
Affiliation:
Utrecht University, Department of Experimental Psychology, Helmholtz Institute

Other authors:
Kallenberg, Eveline, E, Utrecht University
Langdon, Shari, S, VU University Amsterdam, Outpatient Clinic KNVB, Zeist
Goedhart, Edwin, E, Outpatient Clinic KNVB, Zeist
Königs, Marsh, M, Amsterdam University Medical Center, Outpatient Clinic KNVB, Zeist

Talk session 1A – patients & special populations, 9:00 – 10:30, Ruppert Wit

10:00 – 10:15

Detecting And Reconstructing Visual Field Defects From Free-Viewing Eye Movements

Perimetry is an important method to assess functional vision. While for healthy, young adults it can raise reliable results, for many patients it might be tiring, difficult to perform and require highly skilled staff. Previous work has shown that in principle, the information to reconstruct visual defects is present in the gaze behavior of participants that are presented with a complex enough stimulus. Based on that idea, we developed methods for visual field defect recognition and localization that rely on free viewing.

Participants were presented a diverse set of short movie clips monocularly with their gaze being tracked. From the comparison between viewing behavior of different participants we predicted location and size of visual field defects. In a second method, we take a distinctive approach towards VFD reconstruction by explicitly taking into account events that were not gazed at.

Glaucoma patients demonstrated direction dependent deviations in saccade amplitudes, next to showing a significantly lower viewing priority than their age-matched controls, moderated by the type of movie clip shown. Using a kernel Principal Component Analysis, it was possible to differentiate the patients with visual field defects from controls.
For the second method, we detected the presence and to varying degrees also reconstructed different simulated visual field defects. In Glaucoma patients, visual field defect detection was reliable, while the localization seemed to be affected by an altered gaze behavior across Glaucoma patients.

We show that it is possible to detect and describe visual field defects from free viewing gaze data in different ways. We believe that the different methods tap into various features of gaze behavior. This makes the search for the best way to extract information on visual field defects from free viewing behavior even more exciting.

Author:
Schulte, Henning
Affiliation:
University of Groningen, UMC Groningen

Other authors:
Gestefeld, Birte B., University of Bielefeld
Cornelissen, Frans F.W., University of Groningen, UMC Groningen

Talk session 1A – patients & special populations, 9:00 – 10:30, Ruppert Wit

10:15 – 10:30

Long-Term Adaptation To A Visual Field Defect Improves Functional Vision: Evidence From A Continuous Visual Tracking Task

Accurate assessment of visual function is essential in ophthalmic care and rehabilitation. Conventional visual field (VF) tests primarily assess the severity of vision loss. However, having a VF defect for a long time could lead to more effective scanning behavior, which could improve the functional VF despite having no effect on the VF test outcome. Easy and intuitive ways to screen the functional VF could improve quality of care. Previously, we have shown that eye movements made during continuous stimulus tracking could potentially be used for such a tool. The aim of this study was to determine 1) if we can detect the presence and severity of VF defects while allowing scanning strategies and 2) if people adapt to their VF defect and how this affects their functional vision.

We evaluated tracking performance of 36 participants with glaucoma, having early, moderate, or severe glaucomatous damage and 36 healthy participants. Each healthy

control was matched to a glaucoma participant and received the VF defect of the glaucoma participant in simulation. All participants monocularly tracked a moving stimulus (Goldmann size-III) at three contrast levels (40%-160%-640%).

We found that the presence of either a real or simulated VF defect decreased tracking performance with the amount of impact depending on severity of the defect. However, participants with glaucoma performed better than their matched control with a matching simulated VF defect. This difference increased for more severe VF defects.

Overall, the data show that a glaucomatous VF defect negatively affects tracking performance, but that those with glaucoma – who are used to the VF defect – learn to adapt to a certain degree for their defect, thereby improving their functional vision. Importantly, even in the presence of such adaptive strategies our continuous tracking approach can still detect the presence of a visual field defect.

Author:
de Boer, Minke
Affiliation: Laboratory of Experimental Ophthalmology, University Medical Center Groningen, University of Groningen

Other authors:
Vrijling, Anne A.C.L., Laboratory of Experimental Ophthalmology, University Medical Center Groningen, University of Groningen; Royal Dutch Visio, Centre of Expertise for Blind and Partially Sighted People
Renken, Remco R.J., Cognitive Neuroscience Center, University Medical Center Groningen, University of Groningen
Marsman, Jan-Bernard J.B.C., Cognitive Neuroscience Center, University Medical Center Groningen, University of Groningen
Grillini, Alessandro A., Reperio BV
Petrillo, Enrico C.E., Reperio BV.
Heutink, Joost J., Royal Dutch Visio, Centre of Expertise for Blind and Partially Sighted People; Department of Clinical and Developmental Neuropsychology, University of Groningen
Jansonius, Nomdo N.M., Laboratory of Experimental Ophthalmology, University Medical Center Groningen, University of Groningen; Department of Ophthalmology, University Medical Center Groningen
Cornelissen, Frans F.W., Laboratory of Experimental Ophthalmology, University Medical Center Groningen, University of Groningen

Talk session 1B – attention & visual search, 9:00 – 10:30, Ruppert 040

Talk session 1B – attention & visual search, 9:00 – 10:30, Ruppert 040
09:00 – 09:15
Searching Near And Far: The Attentional Template Incorporates Viewing Distance
Humans are remarkably proficient at finding objects in cluttered environments. A widespread explanation for this, is that observers generate a representation of the search target (or 'attentional template'), which guides spatial attention towards target-like visual input. Any object, however, can produce vastly different visual input depending on its exact location; your car will produce a retinal image that is ten times smaller when it's parked fifty compared to five meters away. Across four behavioral experiments, we investigated whether observers take viewing distance into account when searching for familiar object categories. On each trial, participants were pre-cued to search for a car or person in the near or far plane of an outdoor scene. In 'search trials', the scene reappeared and participants had to indicate whether the search target was present or absent. In intermixed 'catch-trials', two silhouettes were briefly presented on either side of fixation (matching the shape and/or predicted size of the search target), one of which was followed by a probe-stimulus. We found that participants were more accurate at reporting the location (Exp. 1&2) and orientation (Exp. 4) of probe-stimuli when they were presented at the location of size-matching silhouettes. Thus, attentional templates incorporate contextual predictions about object appearance (e.g., size as inferred from viewing distance). This was only the case, however, when silhouettes also matched the shape of the search target (Exp 1&3). We conclude that canonical attributes of an object (shape) are necessary for contextual attributes (size) to guide the allocation of attention.

Author:
Gayet, Surya
Affiliation:
Utrecht University

Other authors:
Battistoni, Elisa, Radboud University
Thorat, Sushrut, Osnabrück University
Peelen, Marius V, University of Trento

Talk session 1B – attention & visual search, 9:00 – 10:30, Ruppert 040
09:15 – 09:30
A Serial Search Paradigm For Measuring Peripheral Crowding Strength
The inability to distinguish an object in the presence of clutter is referred to as crowding. Crowding is increased in several neurological and ophthalmic disorders, which affects the patients' performance on various tasks. However, due to amongst others the time-consuming nature of current psychophysical approaches, which require manual responses and a great number of repetitions, it is not routinely assessed. Having a faster and more intuitive way of assessing crowding could resolve this.
In this study, we evaluated a new serial search paradigm to measure peripheral crowding using continuous saccadic eye movements and adaptive psychophysics. We compared this new tool to more conventional 2AFC and 6AFC paradigms with manual and eye movement responses.
For all paradigms, a stimulus elements were composed of a Gabor patch that could either be presented alone or surrounded by six Gabor patches (flankers). The orientation of the central Gabor patch was manipulated and was tagged as either being a target (tilted clockwise) or non-target (tilted anticlockwise). The number of stimulus elements, as well as their position on the screen, varied depending on the paradigm.

Participants' target orientation discrimination threshold was measured in crowded and isolated conditions using QUEST. Depending on the paradigm, participants made either saccadic eye movements to the location of the target or responded by pressing a key or moving a mouse.
Crowding strength (crowded - isolated threshold) as measured in the serial Search paradigm (7.3°) was similar to that in the forced-choice paradigms (3.9°, 2.2°, 8.3°, and 10°,$p>0.5$). Importantly, the serial search task took only about half the amount of time (269s) compared to the forced choice tasks (772s, 526s, 799s, and 695s,$p<0.5$). We conclude that our serial search paradigm is a first step towards measuring visual crowding in a faster and more natural way.

Author:
Tanriverdi, Dilce
Affiliation:
Laboratory of Experimental Ophthalmology, University Medical Center Groningen

Other authors:
Cornelissen, Frans, W, Laboratory of Experimental Ophthalmology, University Medical Center Groningen

Talk session 1B – attention & visual search, 9:00 – 10:30, Ruppert 040
09:30 – 09:45
Don't Hide The Instruction Manual: A Dynamic Trade-Off Between Using Internal And External Templates During Visual Search
Visual search is typically studied by requiring participants to memorize a template initially, for which they subsequently search in a crowded display. Search in daily life, however, often involves templates that remain accessible externally, and may therefore be (re)attended for just-in-time encoding or to boost internal template representations. Here, we show that participants indeed use external templates during search when given the chance. This behavior was observed during both simple and complex search, scaled with task difficulty, and was associated with improved performance. We conclude that the external world may not only provide the challenge (e.g., distractors), but may dynamically ease search. These results argue for the extension of state-of-the-art models of search, as external sampling seems to be the default option and is actually beneficial for behavior. Our findings support a model of visual working memory that emphasizes a resource-efficient trade-off between storing and (re)accessing external information.

Author:
Hoogerbrugge, Alex
Affiliation:
Helmholtz Institute, Experimental Psychology, Utrecht University

Other authors:
Strauch, Christoph, Helmholtz Institute, Experimental Psychology, Utrecht University, Nijboer, Tanja, CW, Helmholtz Institute, Experimental Psychology, Utrecht University, Van der Stigchel, Stefan, Helmholtz Institute, Experimental Psychology, Utrecht University

Talk session 1B – attention & visual search, 9:00 – 10:30, Ruppert 040
09:45 – 10:00
Pop-In Distractor Suppression During Visual Search In Cortical Area V4 Of The Monkey
During visual search, it is important to reduce the interference of distracting objects in the scene. The neuronal responses elicited by the search target stimulus are typically enhanced, but it is equally important to suppress the representations of distracting stimuli, especially if they are salient and capture attention. We trained monkeys to

make an eye movement to a unique shape stimulus that 'popped-out' among an array of distractors. One of these distractors had a salient color that varied across trials and differed from the other stimuli, causing it to also pop-out. The monkeys were able to select the pop-out shape target with high accuracy and actively avoided the pop-out color distractor. This behavioral pattern was reflected in the activity of neurons in area V4. Responses to the shape targets were enhanced, while the activity evoked by the pop-out color distractor was only briefly enhanced, directly followed by a sustained period of pronounced suppression. These behavioral and neuronal results demonstrate a cortical selection mechanism that rapidly inverts a pop-out signal to 'pop-in' for an entire feature dimension thereby facilitating goal-directed visual search in the presence of salient distractors.

Author:
Klink, Chris
Affiliation:
Vision & Cognition, Netherlands Institute for Neuroscience
Experimental Psychology, Helmholtz Institute, Utrecht University
Institut de la Vision, INSERM-CNRS

Other authors:
Teeuwen, Rob R.M., Netherlands Institute for Neuroscience
Lorteije, Jeannette A.M., Netherlands Institute for Neuroscience
Roelfsema, Pieter R., Netherlands Institute for Neuroscience & Institut de la Vision

Talk session 1B – attention & visual search, 9:00 – 10:30, Ruppert 040
10:00 – 10:15
Pinging The Brain To Reveal A Hidden Attentional Priority Map

Exciting work in the working memory literature has demonstrated that hidden, or so-called 'latent', memory representations can be inferred through external perturbation. Here we explored whether the same technique can be used to visualise the landscape of spatial priority maps. It is generally assumed that statistical learning, for example about high probability target locations, affects weights within spatial priority maps. We hypothesised that while these maps may be hidden from techniques analysing elevated neural activity, they may be revealed after perturbing the visual system with visual noise. We sought to test this using the additional singleton paradigm to implicitly train participants to expect search targets to appear in certain locations in space. Then, in the intertrial period we occasionally presented high-contrast visual 'pings' similar to those used to reveal latent working memory content. Using multivariate pattern analysis on EEG data, we show robust anticipatory decoding of the high probability target location before stimulus onsets, but critically only on trials containing a 'ping' prior to search display onset. Our findings thus highlight that synaptic mechanisms offer a plausible explanation for how statistical learning arises, as well as offering a new, striking method of revealing learned attentional priority.

Author:
Dock H Duncan
Affiliation:
Vrije Universiteit Amsterdam

Other authors:
Dirk van Moorselaar
Jan Theeuwes

Talk session 1B – attention & visual search, 9:00 – 10:30, Ruppert 040
10:15 – 10:30
The Costs Of Paying Overt And Covert Attention Assessed With Pupillometry

Attention can be shifted with (overtly) or without an accompanying saccade (covertly). Thus far, it is unknown how effortful these shifts are, yet quantification of such cognitive costs is necessary to understand how and when attention is deployed overtly or covertly in a given situation. Here, we use pupillometry to show that overt shifts are more costly than shifting attention covertly, likely because executing saccades is more complex. We pose that these differential costs will, in part, determine whether attention is shifted overtly or covertly in a given context. A subsequent experiment showed that relatively complex oblique saccades are more costly than relatively simple saccades in horizontal or vertical directions. This provides a possible explanation for the cardinal direction bias of saccades. The utility of a cost-perspective as presented here is vital to further our understanding of the multitude of decisions involved in processing and interacting with the external world efficiently.

Author:
Koevoet, Damian
Affiliation:
Utrecht University

Other authors:
Strauch, C, Utrecht University
Naber, M, Utrecht University
Van der Stigchel, S, Utrecht University

Talk session 2A – audition, multisensory perception & timing, 11:15 – 12:45, Ruppert Wit

Talk session 2A – audition, multisensory perception & timing, 11:15 – 12:45, Ruppert Wit
11:15 – 11:30
Spaced Vs Massed Learning In Auditory Statistical Learning
In auditory statistical learning (ASL), listeners implicitly learn to partition a continuous stream of syllables by discovering the fixed pairs or triplets of syllables that make up the auditory stream. In the current study, we ask whether auditory statistical learning benefits from spaced learning (i.e. learning blocks that are spread out over multiple days) as compared to massed learning (i.e. learning blocks that are lumped together on a single day). Given the advantage of spaced learning in explicit learning paradigms, we predicted that auditory statistical learning would benefit from a spaced training phase, and this is indeed what we found. In a longitudinal online study on Prolific, we trained 100 participants in a spaced way (spread out over three days), and another 100 in a massed way (in one day). The training phase consisted of listening to streams of syllables made up of pairs, while responding to a target syllable. After a two-week retention period, we tested participant's knowledge of the pairs in a 2AFC task. While both groups performed above chance level, the spaced group had higher accuracy. This implies that current investigations of ASL underestimate human's statistical learning abilities. Furthermore, it suggests that ASL may not be so different from more explicit forms of memory, at least in the way that it is encoded and stored.

Author:
de Waard, Jasper
Affiliation:
Vrije Universiteit

Other authors:
Theeuwes, Jan, J, Vrije Universiteit
Bogaerts, Louise, L, Ghent University

Talk session 2A – audition, multisensory perception & timing, 11:15 – 12:45, Ruppert Wit
11:30 – 11:45
Highest Reaction Time Sensitivity To Sound Modulations At Supra-Threshold Levels
Natural sounds such as speech and music are dynamic signals of which the spectrotemporal envelope modulates continuously. We are sensitive to these modulations, especially to low spectral modulations containing information on, for example, pitch and melody, and to temporal modulations contained in speech. Determining the spectrotemporal modulation sensitivity of any individual listener has proven to be problematic and inefficient. Most previous tests focused on random sound instances (words), varying little and non-systematically over the entire possible modulation space (one ripple density), with the outcome being a discrete answer (detection or not). Recently, it was shown that these problems could be overcome, by using a continuous reaction-time task in which listeners had to detect the onset of parametrically varied dynamic ripples as fast as possible. However, it remains unclear whether the modulations need to be presented at near-threshold levels as for a discrete detection task. Here we show that manual reaction times to the onset of a modulation are longer and more variable when its depth is smaller. This holds even when the modulations are clearly above threshold. This indicates, unsurprisingly, that listeners become less sensitive as modulation depth decreases. However, the spectral

and temporal modulations which listeners are most (in)sensitive to, remains the same for any depth. So, in contrast to discrete-detection tasks, the largest modulation depths will yield the most-informative (i.e. least-variable, but still specific) data. We therefore advocate estimating spectrotemporal modulation sensitivity at a large, suprathreshold modulation depth. This will create a fast and easy paradigm, making the task especially suited for children, elderly, and hearing-impaired people.

Author:
Haukes, Nina
Affiliation:
Radboud University, Donders Centre for Neuroscience, Neurobiology

Other authors:
van Wanrooij, Marc M, Radboud University, Donders Centre for Neuroscience, Neurobiology
van Opstal, John A, Radboud university, Donders Centre for Neuroscience, Neurophysics

Talk session 2A – audition, multisensory perception & timing, 11:15 – 12:45, Ruppert Wit
11:45 – 12:00
L2 Perception Training And Its Effects On Perception And Word Recognition In The Dutch Classroom
This study reports on the effects of perceptual training sessions on participants' perception and word recognition. Previous perception training studies have shown that perception training improves perception and production . However, the effect of perception training on word recognition has not been investigated. Two theoretical models that support the claim that improved L2 segmental perception improves L2 word recognition are Shortlist B, a Bayesian model and the revised L2LP model . Accurate L2 word recognition can fail at the segmental level, where misheard phonemes can cause the merge of minimal word pairs or spurious lexical activation . Improved segmental perception mitigates segmental confusion. Speech perception training could improve L2 segmental perception, in turn facilitating L2 word recognition.
Sixty students were tested (N = 30 in the test group and N = 30 in the control group). The test group received five training sessions. Each session was the same and consisted of 38 English phonemes that are difficult for Dutch learners. Results indicate that participants improved in their perception but not in their word recognition. Implications are discussed. Improvement in participants' speech perception in the classroom indicates that perception training is ecologically valid and that it could therefore be a useful tool in the classroom to improve Dutch learners' English speech perception. The lack of improved word recognition could be due to the nature of the task or due to the distance in conceptual space i.e., word recognition is too distant from segmental perception.

Author:
Hommel, Marlisa
Affiliation:
Utrecht University

Talk session 2A – audition, multisensory perception & timing, 11:15 – 12:45, Ruppert Wit
12:00 – 12:15
The Effect Of Distance On Audiovisual Synchrony Perception In An Indoor Virtual Reality Environment
For several decades it has been debated whether a distance compensation mechanism exists during audiovisual (AV) synchrony judgments, regardless of the vast difference

between the speed of sound and light. Here we aimed to investigate the effect of stimulus distance on the human tolerance for (physical) asynchronies and broaden earlier findings with a state-of-the-art head-mounted display (HMD) Oculus Rift. In this study, we measured the point of subjective simultaneity (PSS) of visual and auditory stimuli in an indoor virtual environment (VE). The synchrony judgment method was used for 11 stimulus onset asynchronies (SOA) and six egocentric distances up to 30 m. In addition, to obtain higher validity of the dataset, we implemented in our analysis the results from the previous studies of the egocentric distance perception and the AV hardware latency delay. Our findings displayed positive PSS values that increased with distance showing that in our VE a distance compensation mechanism is taking its place. However, the gain was smaller than was expected for complete compensation for the slower speed of sound.

Author:
Korshunova-Fucci, Victoria
Affiliation:
Eindhoven University of Technology

Other authors:
Raymond H. Cuijpers

Talk session 2A – audition, multisensory perception & timing, 11:15 – 12:45, Ruppert Wit
12:15 – 12:30

Cortical Quantity Representations Of Visual Numerosity And Timing Overlap Increasingly But Remain Distinct

Numerical and temporal quantity estimations show perceptual commonalities and interactions. This is striking, as numerosity and timing are unrelated in natural scenes, for example, more numerous events do not consistently last longer. A predominant theory ascribes such behavioral interactions to a generalized magnitude system with shared neural responses across quantities, allowing action planning to consider multiple quantities. Recently, 7T fMRI and neural model-based analyses have revealed largely overlapping networks of cortical maps with tuned responses to both visual numerosity and visual event timing (duration and period). These maps are topographically organized, with quantity preferences gradually changing across the cortical surface. They also show hierarchical relationships between maps, with anterior and superior maps showing more specific responses that are more closely linked to behavior. Here we asked whether numerosity and event timing are also hierarchically transformed into a common representation that might underlie their behavioral interactions. We found that there is no significant overlap between the earliest, most posterior numerosity and timing maps. Thereafter, overlap increases from inferior to superior maps. In some maps around the intraparietal sulcus we find consistent correlations between numerosity and timing preferences, and relationships between their topographic progressions. Therefore, responses to different quantities are initially derived separately then progressively brought together in the same brain areas, without generally being transformed into a common representation. However, one small posterior parietal area shows relationships between numerosity and timing preferences comparable to relationships between repeated measures of quantity preferences. Perceptual and behavioral interactions may result from a common quantity representation in this specific area, but may alternatively reflect interactions between distinct neural populations responding to different quantities within many partially shared brain areas. Other superior parietal and frontal brain areas may bring distinct responses to different quantities together to access shared comparison and action planning systems nearby.

Author:
Hendrikx, Evi

Affiliation:
Utrecht University

Other authors:
Paul, Jacob M, University of Melbourne
van Ackooij, Martijn, Utrecht University
van der Stoep, Nathan, Utrecht University
Harvey, Ben M, Utrecht University

Talk session 2A – audition, multisensory perception & timing, 11:15 – 12:45, Ruppert Wit
12:30 – 12:45
Time Perception In A Large, Diverse And Naïve Sample Of Museum Visitors
From checking the second hand of a watch to figuring out how long you've been browsing an interesting museum, we are equipped with an intuitive sense of time. At the same time, experience teaches that our sense of time is fragile and malleable. For instance, life seems to speed up as we age and time flies when we're having fun.

Effects like these have typically been studied in the lab, where participants can learn to maximize task performance. However, this begs the question whether such studies tell us much about how we intuitively experience time in incidental scenarios that may not occur often. An ideal experiment would have each participant estimate a single interval only once, but that would require thousands of participants.

To this end, we collected data from over 16.000 participants that visited our interactive museum exhibit about time perception. Visitors completed several experiments testing their sense of time. We present data from three experiments, where visitors needed to estimate a 1-second interval a few times, close their eyes for 60 seconds, and retrospectively estimate for how long they had been browsing the museum (which typically took 20 minutes). We were able to replicate some classical psychophysical time perception effects, such as Vierordt's law. Further, we found that time estimates were affected by age: older participants estimated longer intervals in both prospective and retrospective conditions. Interestingly, we found that a visitor's rating of the museum exhibit influences their prospective time estimates, but had no discernible effect on retrospective time estimates. In sum, the museum data allows us to study temporal experience in a highly diverse, but naïve sample of participants.

Author:
de Jong, Joost
Affiliation:
University of Groningen

Other authors:
van Rijn, Hedderik, University of Groningen

Talk session 2B – attention & visual perception, 11:15 – 12:45, Ruppert Rood

Talk session 2B – attention & visual perception, 11:15 – 12:45, Ruppert Rood
11:15 – 11:30
Reversal Of Dominance In Neural Competition By Top-Down Signals: Biased Competition Mechanisms Investigated By A Hybrid Neural Circuit
The visual cortex coherently integrates different features of visual sensory inputs acquired at different areas in the hierarchy. Through dynamic interactions between the areas mediated by bi-directional neural connections, it is possible to establish the final interpretations of often ambiguous and noisy sensory inputs.

We recently developed a hybrid system where biological neurons in the visual cortex interact with each other through an artificial computer-modeled neural circuit and investigated the dynamics of neural competition of two pyramidal neurons of V1 in an ex vivo mouse visual cortex. We now combined the system with electric stimulation at an area equivalent to V2 and investigated the influence of top-down signals from V2 on the neural competition in V1.

Double patch clamp recording of two pyramidal neurons was performed while a "dynamic clamp" system constructed di-synaptic inhibitory connections to establish a mutual inhibition circuit between the two neurons. A stimulation electrode array was placed at V2 to evoke top-down signals. Simulations of two biologically defined noises, background synaptic noise by spontaneous neural activities, and probabilistic synaptic transmission, were implemented into the dynamic clamp system.

During "sustained competition", where two neurons show bi-stable activity with alternating dominance, the top-down signals were able to reverse the dominance of the competition. The reversal was especially effective when the stimulation was made during the later period of the dominance durations, likely due to adaptation of the dominant neuron. At "onset competition", where the two neurons compete to win dominance at onset, again it was possible to reverse the outcome of the competition with the top-down signals. Hence, we conclude that, in the given experimental model, the top-down signals can bias, and even reverse, the outcome of competition at the lower-level. The roles of excitatory and inhibitory inputs and the biological noises to the dynamics will be discussed.

Author:
Kogo, Naoki
Affiliation:
Donders Institute for Brain, Cognition and Behaviour, Radboud University, The Netherlands

Other authors:
Kern, Felix B., University of Tokyo
van Wezel, Richard, Radboud University

Talk session 2B – attention & visual perception, 11:15 – 12:45, Ruppert Rood
11:30 – 11:45
What Did You Expect? Prediction Error Tuning In Sensory Cortex
Perception is fundamentally modulated by our prior knowledge. Expectations derived from such prior knowledge facilitate behavior and perception. In line with hierarchical predictive processing theories, neuroimaging studies have shown that sensory responses to surprising stimuli are enhanced compared to expected inputs, likely reflecting larger sensory prediction errors. However, at present it is unknown what kind of surprise drives these putative prediction errors. In most previous studies expectations about specific stimuli were induced, thus allowing for the prediction of

specific low- and high-level stimulus features. Hence, the observed prediction errors in sensory cortex may reflect tuning specific expectation violations, unique to each level of the visual cortical hierarchy; e.g., in terms of surprising oriented edges at the level of V1. Alternatively, sensory prediction errors may represent more abstract, conceptual knowledge, such as the category of the expected object. In two recent studies we investigated what kind of surprise predictions errors in sensory cortex represent.

In the first study we showed that recently acquired conceptual associations, acquired linguistically (e.g., the word 'dog' predicting the word 'car'), generalized to form perceptual predictions. Specifically, sensory responses, in terms of fMRI BOLD, throughout the ventral visual stream showed reduced sensory responses to conceptually expected images (e.g., the image of a car following the word 'dog'). These results suggest that conceptual associations may modulate prediction errors throughout the visual hierarchy. In the second study, we showed that high level visual features, usually represented in higher visual areas, explained prediction error magnitudes throughout the entire visual system, including early visual cortex. Combined these results suggest that, in line with hierarchical predictive coding theories, visual cortical areas may inherit predictions top-down and come to reflect prediction errors in terms of higher visual or conceptual features.

Author:
Richter, David
Affiliation:
Vrije Universiteit Amsterdam
Donders Institute, Radboud University Nijmegen

Other authors:
Yan, Chuyao C, Nanjing Normal University
Kietzmann, Tim T, University of Osnabrück
de Lange, Floris F, Donders Institute - Radboud University Nijmegen

Talk session 2B – attention & visual perception, 11:15 – 12:45, Ruppert Rood
11:45 – 12:00

Attentional Focus On Internal Representations Impairs Object Recognition Compared To External Focus Of Attention

The phenomenon of "seeing less" while attending internal representations is well-known among the general public. For example someone might miss a traffic sign because they were thinking of their shopping list. However, direct comparisons of the effect of internally versus externally directed attention on visual processing are rare. In the present study, we measured the effect of internal versus external attention on the recognition of objects in natural scenes. Perceptual performance was probed while participants directed attention either internally or externally using a dual-task design. An internal attention state was induced by having participants perform a visual working memory task, while an external attention state was induced by having participants monitor whether briefly presented images exhibited mirror symmetry. Half of the trials within each task ended with the object recognition probe while the other half ended with a probe relevant to the respective task types. Also, half of the blocks displayed intervening distractor scenes between trial start and task probe, while the other half only had a waiting period between trial start and probe. Participants reported fewer objects while focussing their attention on internal representations compared to focussing attention on the external environment. False positive object reporting was not affected. The results also indicated a main effect of intervening distractor scenes, but the effect of intervening scenes did not interact with attention state. These results shed a light on how explicitly directed internal attention affects object recognition compared to an external attentional focus.

Author:

de Blecourt, Charlotte
Affiliation:
Donders Centre for Cognition, Radboud University

Other authors:
Maris, Eric , Radboud University
Peelen, Marius V, Radboud University

Talk session 2B – attention & visual perception, 11:15 – 12:45, Ruppert Rood
12:00 – 12:15

Investigating Spatial Predictive Context In Visual Search With Rapid Invisible Frequency Tagging

The brain exploits statistical regularities, or predictive context, to guide our perception. Within visual search, spatial predictive context, learned outside of awareness, can improve behavioral performance, also known as contextual cueing. Here, we set out to investigate how predictive context modulates neural processing of target and distractors during visual search, leveraging Rapid Invisible Frequency Tagging (RIFT) and Magnetoencephalography (MEG). We tagged target and distractor stimuli at different frequencies within visual search scenes that were either New (without predictive context) or Old (with predictive context).

We show successful entrainment of multiple frequencies simultaneously, showing the potential of RIFT as a method for tracking covert attentional processing of competing stimuli.

Moreover, we show that when spatial context has predictive value, target stimuli are enhanced compared to when there is no predictive context. This target enhancement is accompanied by a suppression of nearby distractors.

We conclude that spatial predictive context sharpens the attentional field, allowing for faster localization of targets in visual search.

Author:
Bouwkamp, Floortje, FG
Affiliation:
Donders Institute for Brain, Cognition and Behaviour

Other authors:
De Lange, Floris, FP, Donders Institute for Brain, Cognition and Behaviour
Spaak, E, Donders Institute for Brain, Cognition and Behaviour

Talk session 2B – attention & visual perception, 11:15 – 12:45, Ruppert Rood
12:15 – 12:30

Expected Distractor Context Biases The Attentional Template For Target Shapes

Visual search is supported by an internal representation of the target, the attentional template. However, which features are diagnostic of target presence critically depends on the distractors. Accordingly, previous research showed that consistent distractor context shapes the attentional template for simple targets, with the template emphasizing diagnostic dimensions (e.g., colour or orientation) in blocks of trials. Here, we investigated how distractor expectations bias attentional templates for complex shapes, and tested whether such biases reflect inter-trial priming or can be instantiated flexibly. Participants searched for novel shapes (cued by name) in two probabilistic distractor contexts: either the target's orientation or rectilinearity was unique (80% validity). Across four experiments, performance was better when the distractor context was expected, indicating that target features in the expected diagnostic dimension were emphasized. Attentional templates were biased by

distractor expectations when distractor context was blocked, also for participants reporting no awareness of the manipulation. Interestingly, attentional templates were also biased when distractor context was cued on a trial-by-trial basis, but only when the two contexts were consistently presented at distinct spatial locations. These results show that attentional templates can be highly flexible, incorporating expectations about target-distractor relations when looking for the same object in different contexts.

Author:
Lerebourg, Maëlle
Affiliation:
Radboud University, Donders Institute for Brain, Cognition and Behaviour

Other authors:
de Lange, Floris P
Peelen, Marius V

Talk session 2B – attention & visual perception, 11:15 – 12:45, Ruppert Rood
12:30 – 12:45

Redesigning Beach Safety Flags To Improve Intelligibility And Effectiveness

Over the past 20 years, on average 106 people per year died of accidental drownings in the Netherlands. Most drownings occur at open water locations, like the sea. Different measures are in use to ensure people's safety, including beach safety flags. These flags form an international warning system intended to prevent accidents, including drownings. However, little is known about people's familiarity with these flags and their effectiveness.

In Study 1, we tested the recognition and understanding of beach warning flags using a survey among a convenience sample of the Dutch population (N = 174). The results show an overall poor understanding of the meaning of all but the red flags (which indicate high hazard). The level of confidence respondents had in their answer largely followed the same pattern, with little confidence for most flags except the red ones. We conclude that familiarity with the flag system in the Netherlands is wanting and we propose a number of recommendations to improve public understanding.

In Study 2, we conducted an online survey among a representative sample of the Dutch population (N= 465) with the aim of testing two new flag sets, based on established design guidelines. The adapted design of the new flags included pictograms to clarify the flags' meaning. Compared to the existing set, the addition of pictograms depicting concrete representations greatly improved intelligibility and level of confidence. Moreover, the respondents' intentions with regard to entering the water were more in line with the safety recommendations as meant to be conveyed by the flags.

Author:
Roefs, Fenne
Affiliation:
Vrije Universiteit Amsterdam
MijksWise (part of Mijksenaar)

Other authors:
Olivers, Christian N. L. (Vrije Universiteit Amsterdam)
Hoogslag, Martin (Dutch Institute for Safety at Bathing Areas NIVZ)

Talk session 3A – visual working memory, 14:00 – 15:15, Ruppert Wit

Talk session 3A – visual working memory, 14:00 – 15:15, Ruppert Wit
14:00 – 14:15

The Relationship Between Selective Attention And Working Memory Gating

Information that is temporarily stored in working memory guides our behaviour. Capacity limits of this temporal storage require selectivity. Goal directed attention can ensure that only goal-relevant information is actively maintained in working memory and can therefore influence our actions and thoughts. Accordingly, selective attention and working memory are closely intertwined cognitive functions [1].

The current study investigates neural mechanisms underlying selective working memory gating processes and thereby, gives insights into attentional modulatory mechanisms. Current theories of working memory gating, such as the prefrontal cortex basal-ganglia working memory (PBWM) model, predict a critical role for the striatum in this selective gating process [2]. Two types of working memory gating processes are differentiated: input-gating, i.e., the filtering of information that enters WM, and output-gating, i.e., the selection among stimuli within WM for guidance of action and attention. To this end, we employed a cued delayed response task with pre-cues (presented prior to encoding) or retro-cues (presented post encoding), which instructed participants to attend selectively to either faces or scenes or to attend globally to both faces and scenes.

Analyses of behavioural data demonstrate that selectivity increases performance, probably because selective cues enabled a load reduction. The success of the gating manipulation was substantiated by functional magnetic resonance imaging analyses, which revealed increased stimulus-selectivity of BOLD signals in visual association cortex during both input- and output gating. Critically, BOLD signal in the striatum was enhanced during output-gating but not during input-gating. These data strengthen the hypothesis that the striatum contributes to the output-gating of working memory representations but raise the question whether the paradigm was optimised for capturing the selective nature of the putative striatal input-gating process. Arguably, the pre-cue trials of the paradigm rather account for early attentional modulation during visual encoding.

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[2] O'Reilly, R. C., & Frank, M. J. (2006). Making working memory work: A computational model of learning in the prefrontal cortex and basal ganglia. Neural Computation, 18(2), 283–328. https://doi.org/10.1162/089976606775093909

Author:
Nielsen, Natalie
Affiliation:
Donders Institute, Nijmegen

Other authors:
*Calcott, Rebecca R, Donders Institute, Nijmegen & Radboudumc, Nijmegen,
Spronkers, Floortje F, Donders Institute, Nijmegen & Radboud University, Nijmegen,
Olraun, Helena H, Donders Institute, Nijmegen & Radboud University, Nijmegen,
Verkes, Robbert-Jan R-J, Donders Institute, Nijmegen & Radboudumc, Nijmegen,
den Ouden, Hanneke H, Donders Institute, Nijmegen & Radboud University, Nijmegen,
Cools, Roshan R, Donders Institute, Nijmegen & Radboudumc, Nijmegen

Talk session 3A – visual working memory, 14:00 – 15:15, Ruppert Wit

14:15 – 14:30

Differential Feedforward And Feedback Signals For Central And Peripheral Working Memory Items

Visual working memory is assumed to rely on the recruitment of sensory mechanisms, including V1. However, vision is not unitary across the visual field (Strasbuger et al., 2011), as both resolution and the susceptibility to perceptual interference worsens with increasing eccentricity (Rosenthal, 2016). Yet little is known about how eccentricity influences visual working memory. In the current study we investigated the role of eccentricity on working memory for a single oriented Gabor patch, which was either placed at central vision or at 15° eccentricity left or right on the horizontal axis. Eye gaze was monitored using an eye-tracker to ensure central fixation. Simultaneous EEG recordings were analysed with multivariate methods in order to trace and contrast trial-specific orientation representations. At the behavioral level, mixture modelling revealed increased guess rates and reduced precision for the peripherally presented relative to the centrally presented orientations. Furthermore, we observed a stronger impact of previous trial memoranda on peripherally encoded memories, suggesting a stronger top-down contextual component when the input signal is less reliable. Supporting this, the EEG signals related to peripherally presented stimuli appeared to totally lack the usual early sensory component found for central stimuli, and only reached reliable classification levels quite late in the trial (after ~300 ms). These results are indicative of peripheral vision receiving support from hierarchically higher brain areas for the formation of a globalized representation that then drives the behavioural response (Williams et al., 2008).

Author:
Kandemir,Guven
Affiliation:
Vrije Universiteit Amsterdam

Other authors:
Olivers, C.N.L., Vrije Universiteit Amsterdam

Talk session 3A – visual working memory, 14:00 – 15:15, Ruppert Wit

14:30 – 14:45

Action Consequences Guide Visual Working Memory Use

Visual working memory (VWM) is a store for temporary maintenance of visual information. It is often disregarded, though, that this information is typically stored to enable actions, and therefore, the context of such actions is of great importance for how VWM is used. The severity of the consequence of an action might, for example, affect the precision with which action-relevant information is stored. Here we set out to examine whether strategy changes in VWM-use occur when incorrect actions are penalized. We employed an (online) copying task, where participants recreated a model comprised of several items in a grid, using a (larger) pool of items. Crucially, we manipulated the severity of the penalty: in the high error cost condition participants had to wait 5 seconds after an erroneous item-placement (versus 0.5 seconds in the low error cost condition). Additionally, we manipulated the accessibility of task-relevant information, a well-studied manipulation in this paradigm (implemented here as a 0.5 versus 5 second wait to inspect the model). Manipulating the cost of sampling information provided a direct comparison for the effects of error cost. Our results showed that (1) the number of model inspections halved with higher sampling cost, but were unaffected by error cost; (2) inspection durations increased with higher sampling cost, but were again unaffected by error cost; and (3) the number of errors increased with higher sampling cost, but decreased with higher error costs. Thus, more severe action consequences (error costs) increase the reluctance to act on uncertain information in VWM; but (against our expectations) do not lead to longer, nor to more frequent attempts to store information in VWM. We conclude that, in contrast to the accessibility of information, action consequences do not affect how

information is stored, but do affect the willingness to act based on the available information.

Author:
Sahakian, Andre
Affiliation:
Experimental Psychology, Helmholtz Institute, Utrecht University, The Netherlands

Other authors:
Gayet, Surya, Experimental Psychology, Helmholtz Institute, Utrecht University, The Netherlands
Paffen, Chris LE, Experimental Psychology, Helmholtz Institute, Utrecht University, The Netherlands
Van der Stigchel, Stefan, Experimental Psychology, Helmholtz Institute, Utrecht University, The Netherlands

Talk session 3A – visual working memory, 14:00 – 15:15, Ruppert Wit
14:45 – 15:00

A Matter Of Availability: Neural Representations Of Task-Relevant Stimulus Features Are Sharper When Stimuli Are Memorized Rather Than Perceived

Our visual environment is relatively stable over time and an optimized visual system ought to capitalize on this by not devoting any representational resources to objects that are still present. Subjective experience, however, suggests that externally available (i.e., perceived) information is more strongly represented in neural signals than memorized information. To distinguish between these possibilities, we use EEG multivariate pattern analysis to quantify the strength of representation of task-relevant features (color or spatial frequency) in anticipation of a change-detection task. Perceptual availability was manipulated between experimental blocks by either keeping the stimulus on the screen during a two second delay period (perception) or removing it shortly after its initial presentation for the same time period (memory). We find that task-relevant (i.e., attended) memorized features are more strongly represented than irrelevant features. More importantly, we find significantly weaker representations for available (perceived and attended) features than for unavailable (memorized and attended) features. Contrary to what subjective experience suggests, our findings demonstrate that vividly perceived and attended stimuli elicit weaker neural representations (in terms of detectable multivariate information) than stimuli maintained in visual working memory. We hypothesize that an efficient visual system spends little of its limited resources on the internal representation of information that is externally available anyway.

Author:
Chota, Samson
Affiliation:
Helmholtz Institute, Department of Experimental Psychology, Utrecht University

Other authors:
Gayet, Surya, S., Kenemans, Leon, J.L., Olivers, Chris, C.N.L., Van der Stigchel, Stefan, S.

Talk session 3A – visual working memory, 14:00 – 15:15, Ruppert Wit
15:00 – 15:15

Hierarchical, Topographic, And Tuned Fronto-Parietal Responses To Visual Short-Term Memory Load

Visual short-term memory (VSTM), intentionally remembering image features, relies on interacting sensory and executive processes. Sensory processing relies on tuned responses, organized in hierarchical networks of topographic maps. How does the brain distribute responses to task demands across neural populations? During ultra-

high field fMRI (7T), we examined responses to the number of remembered visual items (VSTM load). We describe neural populations showing tuned responses to VSTM load in an extensive series of topographic maps, hierarchically increasing in VSTM load preferences from posterior sensory to anterior executive areas. These responses are absent when viewing the same stimuli without varying task demands. These results generalize principles of neural tuning, topographic organization, and hierarchical transformations from sensory encoding to distribution of task demands across neural populations.

Author:
Harvey, Ben
Affiliation:
Utrecht University

Other authors:
van Ackooij, Martijn, Utrecht University
Paul, Jacob M, University of Melbourne
van Helden, Joeri, University of Birmingham
Hendrikx, Evi, Utrecht University
Gayet, Surya, Utrecht University
van der Stoep, Nathan, Utrecht University

Talk session 3B – action & pupillometry, 14:00 – 15:15, Ruppert 040

Talk session 3B – action & pupillometry, 14:00 – 15:15, Ruppert 040
14:00 – 14:15
Are Hand Movements Influenced By Illusory Changes In The Identity Of The Goal?
If the target of a goal-directed hand movement is suddenly displaced, the hand moves accordingly. Does the hand's response only depend on what the target itself does, or is it also influenced by factors such as grouping, as our percepts are? We examined this using a Ternus display: a row of identical items of which one is moved from one end of the row to the other. If the display is briefly removed whilst this happens, the display elicits the percept of group motion, whereby the items at all positions in the row appear to shift and thus change their identity. The aim of the present study was to find out whether this apparent change in identity influences the hand's response. We asked participants to quickly move their finger from a starting point to hit an indicated item (the target) within a Ternus display. The target was purple rather than black and it never actually changed position. While the finger was moving, the percept of group motion of the display was elicited. Trials in which the leftmost item jumped to the right or the rightmost item jumped to the left, were randomly interleaved. The number of items and thereby the distance between the target and the ends of the row was also varied. The hand responded to group motion and this response was larger when there were fewer items. Thus, hand movements are influenced by the apparent identity of the item at the position towards which the hand is moving. We conclude that ongoing movements can be influenced by complex spatio-temporal relationships.

Author:
Danai, Vorgia
Affiliation:
Vrije Universiteit Amsterdam

Other authors:
Liz R. van Hout, Vrije Universiteit Amsterdam, Eli Brenner, Vrije Universiteit Amsterdam, Emily M. Crowe, University of Nottingham.

Talk session 3B – action & pupillometry, 14:00 – 15:15, Ruppert 040
14:15 – 14:30
Seeing Why A Target Is Accelerating Can Help One Intercept It
People are extremely poor at visually judging acceleration. Consequently, they make systematic errors when trying to intercept accelerating objects. They anticipate some gravitational acceleration for unsupported objects, but do not learn to associate images of surfaces with different friction coefficients with corresponding differences in deceleration for objects sliding across surfaces. Can people use fixed spatial relationships between objects to deal with acceleration when intercepting moving objects? The valve on the wheel of a bicycle that is moving at a constant velocity follows a complicated trajectory in space. Does the relationship between the valve and the wheel help decompose the valve's complicated pattern of accelerations and decelerations into a constant velocity of the axis of the wheel and a constant acceleration of the valve towards the axis, and thereby make it easier to intercept the valve? We found that it does. Participants were asked to hit targets that moved as a valve on a wheel does. They hit more targets when the wheel was visible than when it was not, despite the target following exactly the same trajectory. Thus, visual information pertaining to spatial relationships can be considered when guiding movements. Some participants consistently tried to hit the target when it was at the same phase of its rotational movement, rather than hitting it after about the same time from when it appeared. Those participants hit more targets, presumably because the target's acceleration depends on the phase so that adjustments in the opposite direction than the error on the previous trial reduce systematic errors related to

ignoring the acceleration. The benefit was particularly clear when the wheel was not visible. We conclude that spatial relationships can be used to guide movements.

Author:
Brenner, Eli
Affiliation:
Vrije Universiteit Amsterdam

Other authors:
Smeets, Jeroen BJ, Vrije Universiteit Amsterdam
Crowe, Emily M, University of Nottingham

Talk session 3B – action & pupillometry, 14:00 – 15:15, Ruppert 040
14:30 – 14:45

Cerebrocerebellar Interactions Underlying Active Sensing

Understanding how we coordinate complex sensorimotor behaviour is critical for restoring physical disabilities. Previous studies, while enhancing our understanding of simple networks, have often been limited to examining how one area of the brain encodes one specific sensory or motor function. Therefore, we lack a comprehensive understanding of how we coordinate complex movements. Here, we investigate how cerebrocerebellar interactions affect active sensing in awake, freely whisking mice. Our results show that the direction of signals between the cerebral cortex and the cerebellum vary depending on the phase (i.e., planning, execution and assessment) of active touch. The vector from cerebrum to cerebellum dominated during the planning stage but reverted during the execution stage. These results shed a light on how the cortico-cerebellar loops sustain active sensing during complex sensorimotor behaviour.

Author:
Romano, Vincenzo
Affiliation:
Erasmus MC, Rotterdam

Other authors:
Van der Horst, Annabel, A; Bauer, Staf, S; Thomas, Jacobs, J; Van Wingerden, Nathalie, N.

Talk session 3B – action & pupillometry, 14:00 – 15:15, Ruppert 040
14:45 – 15:00

Does Pupil Dilation Trigger A Shift From Rod-Dominated Vision To Cone-Dominated Vision?

Pupil size determines the amount of light that enters the eye, as well as how that light is focused. Consequently, pupil size shapes visual processing. However, the exact mechanisms are poorly understood. In humans, pupil size has been shown to influence detection performance, whereby large pupils improve the detection of faint stimuli. In mice, it has recently been demonstrated that changes in pupil size trigger a shift from rod-dominated to cone-dominated vision by allowing either less light into the eye, thus emphasizing rod vision (because rods are sensitive and do not require much light), or more light into the eye, thus emphasizing cone vision.
Here, we test whether fluctuations in pupil size differentially influence the detection of either red or blue targets that are presented in either parafoveal or peripheral vision. The recent results from mice lead to the (counterintuitive) prediction that detection of blue targets and peripheral targets should be impaired less by smaller pupils, because detection of these targets relies more on rod vision than on cone vision, and because rods are more sensitive than cones.
Participants completed a detection task with faint red and blue stimuli shown either in parafoveal or peripheral vision while their pupil size was recorded. We focused on how spontaneous fluctuations in pupil size correlated with detection performance.

Preliminary results (N = 18) suggest that detection performance is positively correlated with larger pupils in all conditions, as we have found before. Crucially, this correlation was similar for blue and red targets as well as for parafoveal and peripheral targets; that is, we do not find clear evidence for a shift from rod-dominated vision to cone-dominated vision with increased pupil size.

Author:
Ruuskanen, Veera
Affiliation:
University of Groningen

Other authors:
Mathot, Sebastiaan, S, University of Groningen

Talk session 3B – action & pupillometry, 14:00 – 15:15, Ruppert 040
15:00 – 15:15

Causal Effects Of Pupil Size On Visual Processing

The size of the eyes' pupils determines how much light enters the eye and also how well this light is focused. Through this route, pupil size shapes the earliest stages of visual processing. Yet causal effects of pupil size on vision are poorly understood and rarely studied. Here we report the effects of both experimentally induced and spontaneous changes in pupil size on stimulus-evoked EEG responses. We compare these to the effects of stimulus intensity and covert visual attention. These factors all have comparable effects on some common measures of early visual processing, such as detection performance and steady-state visual evoked potentials; but it is still unclear whether these are superficial similarities, or rather whether they reflect similar underlying processes. Using a mix of neural-network decoding, ERP analyses, and time-frequency analyses, we find that induced pupil size, spontaneous pupil size, stimulus intensity, and covert visual attention all affect stimulus-evoked responses, mainly over occipital and parietal electrodes, but—crucially—that they do so in qualitatively different ways. Induced and spontaneous pupil-size changes mainly affect the high-frequency beta band; this may reflect a causal effect of pupil size on oculomotor activity and/ or visual processing. In addition, spontaneous (but not induced) pupil size seems to correlate negatively with alpha-band power; this may reflect a non-causal relationship that is mediated by arousal. Taken together, our findings suggest that pupil size has a qualitatively different effect on visual processing from stimulus intensity and covert visual attention. Taken together, our results clearly show that pupil size causally affects visual processing, and provides concrete starting points for further study of this important yet understudied phenomenon.

Author:
Mathôt, Sebastiaan
Affiliation:
University of Gronigen

Other authors:
Berberyan, Hermine, H, PwC, Büchel, Philipp , P, University of Groningen, Ruuskanen, Veera, V, University of Groningen, Vilotijević;, Ana, A, University of Groningen, Kruijne, Wouter, W, University of Groningen

Abstracts – Posters

P1

Location And Image Prediction In Visual Sequence Learning

The human brain can build models from historical events and anticipate the future. Here we designed an experiment to explore further how location and image are organized in our brains. In this experiment, participants were exposed to spatiotemporal sequences where each consisting of five items (O-A-B-C-D). Detaily, each sequence starts with a particular object, followed by two faces and two scene pictures. Participants were asked to respond to greyscale pictures during the experiment. Among all three kinds of sequences, we have the so-called "structured sequence", which has exemplar pictures and regularities on location and the order of pictures; The second sequence is called "exemplar sequence", which has exemplar pictures but random order and location. The third sequence is "random sequence", which has random pictures picked from the file pool, random order, and location. We found the participants can respond significantly faster to signal trials from the structured sequence than the other two kinds of sequences without awareness, which means a human can learn sequences unconsciously. We also use a violation design to test if the human brain can learn location and image separately, this part will be revealed soon. This study is a pilot study before it is employed with fMRI.

Author:
Wang, Ningkai
Affiliation:
Institute Brain and Behavior Amsterdam (iBBA), Vrije Universiteit Amsterdam, Noord-Holland, The Netherlands

Other authors:
Knapen, Tomas T, iBBA, Spinoza, Department of Experimental and Applied Psychology
Theeuwes, Jan J, iBBA, Department of Experimental and Applied Psychology

P2

Additivity Of Grouping By Proximity And Luminance Similarity: Individual Differences And Stability

One of the fundaments of Gestalt Psychology states that "the whole is more/different than the sum of its parts". This statement advocates that as an outcome of the construction of a Gestalt, properties emerge that cannot be explained by the features of the separate elements without any organization. However, this idea was contradicted when Kubovy and van den Berg (2008) revealed that the strength of grouping within a dot lattice results from an additive integration of the separate grouping principles at play (i.e., proximity and luminance similarity). In a recent replication study by Van der Hulst et al. (under review), this additive effect was explored further with the addition of an individual differences approach. This setup had to rule out the possibility of mistakenly averaging of different types of observers in the original study. The additive integration was replicated on an individual level. However, sensitivity to proximity and luminance similarity did differ between individuals. Moreover, based on an observed correlation between both grouping principles, a general sensitivity to grouping cues was suggested. To assess the reliability of these discovered individual differences and to get a quantification of the weight of each principle, in a new study, we tested a few participants longitudinally in multiple sessions of the original task over the time span of a month. A first analysis revealed medium to high stability over time within participants. In further analyses, to be completed before the conference, the trajectories of the individual participants over sessions will be assessed and a we will model the results for each participant individually.

Author:
Van der Hulst, Elisabeth
Affiliation:
KU Leuven

Other authors:
Wagemans, Johan

P3

Changes In Connective Field Properties During Visual Recognition

The detailed neural mechanisms behind the interactions between primary and later visual areas during visual recognition remain to be determined. One way to do so is by examining the intracortical connections between visual areas. A suitable approach for this is Connective field (CF) modelling which predicts the activity of one brain region (target) based on the activity of a different region (source). Here, we investigate changes in CF properties during a visual recognition task while observers' brain activity was recorded using functional magnetic resonance imaging (fMRI). In the task, participants viewed static images of animals and objects gradually appearing out of dynamic visual noise. Participants indicated the moment they recognized the image with a button-press. CFs for target visual areas (i.e. V2-V4, LO1-LO2) were estimated based on the activity of V1 (source). A CF was modelled as a two-dimensional circular symmetric Gaussian, folded to follow the cortical surface. Estimated CF parameters were location (center eccentricity and polar angle) and size (i.e. Gaussian width). Variance explained was calculated to assess CF-model performance.
For all visual areas, we found overall increased CF-model performance that was driven by a relatively small proportion of voxels whose connectivity to V1 increased. For the remaining voxels, CF-model performance (either high or low) remained the same. After visual recognition, a larger number of voxels had CFs closer to the fovea and fewer voxels sampled information from the periphery of the visual field (i.e. CF eccentricity >10 deg). Moreover, after recognition the size of CFs located closer to the fovea increased, while those in the visual periphery decreased. These results suggest selective changes in cortical information processing, which might reflect increased feedback as well as selective attention. Our work helps understand how the primary and later visual cortical areas interact during recognition.

Author:
Bittencourt, Mayra
Affiliation:
University of Groningen, University Medical Center Groningen (UMCG)

Other authors:
Daghlian, Marcus, Spinoza Center for Neuroimaging
van Ommen, Marouska, University Medical Center Groningen
Renken, Remco, University Medical Center Groningen
Dumoulin, Serge, Spinoza Center for Neuroimaging
Cornelissen, Frans, University of Groningen, University Medical Center Groningen (UMCG)

P4

Cortical Potentials Evoked By Tone Frequency Change As Objective Measure For Speech Perception

The acoustic change complex (ACC), a cortical potential evoked by a change in an ongoing sound, has appeared as a promising tool for objective measures of suprathreshold hearing performance without, however, breaking through in the clinical practice. Using electrode configurations and equipment as used for auditory brainstem

response recordings in the clinic, we recorded ACCs with the objective to examine correlations between ACC measures and speech perception in noise.

ACCs were recorded in 13 adult subjects with sensorineural hearing loss (SNHL) and 24 age-matched normal-hearing (NH) subjects. The stimuli consisted of a 3-s base tone, followed by a 3-ms frequency sweep towards a target tone 12% above the base (~2 semitones). Base frequencies were 0.5, 1, 2 and 4 kHz. Speech reception thresholds (SRTs) were measured using Dutch standardized sentences in a background of stationary noise. Hearing loss (HL) was quantified by tone thresholds across 0.5, 1, 2 and 4 kHz.

In almost each subject we could record clear ACC waveforms with larger amplitudes for NH subjects than for SNHL subjects (Vonck et al., Hear Res 420: 108508, 2022). Using multiple regression analysis we found that SRT could be explained for 87% by ACC latency (35%) and HL (52%). Considering only the ACC measures, SRT could be explained for 74% by latency (60%) and amplitude (14%).

The ACC to fast frequency changes of two few semi-tones can be used to predict speech perception in noise. The predictive value using the latency is better than using the ACC threshold, which moreover requires more time (Vonck et al., Hear Res 401:108154, 2021). When confirmed in validation studies with larger numbers of subjects, it can aid clinicians in their evaluation of auditory performance, in particular when behavioral testing is unreliable, e.g., with patients whose first language is not Dutch.

Author:
Versnel, Huib
Affiliation:
Department of Otorhinolaryngology and Head & Neck Surgery, University Medical Center Utrecht, UMC Utrecht Brain Center, University Medical Center Utrecht

Other authors:
Vonck, Bernard MD, Department of Otorhinolaryngology and Head & Neck Surgery, University Medical Center Utrecht
UMC Utrecht Brain Center, University Medical Center Utrecht
van Heteren, Jan AA, Department of Otorhinolaryngology and Head & Neck Surgery, University Medical Center Utrecht
UMC Utrecht Brain Center, University Medical Center Utrecht
Stokroos, Robert J, Department of Otorhinolaryngology and Head & Neck Surgery, University Medical Center Utrecht
UMC Utrecht Brain Center, University Medical Center Utrecht
Lammers, Marc JW, Department of Otorhinolaryngology and Head & Neck Surgery, University Medical Center Utrecht, the Netherlands
UMC Utrecht Brain Center, University Medical Center Utrecht, Utrecht University, the Netherlands
Department of Otorhinolaryngology and Head and Neck Surgery, Antwerp University Hospital
Department of Translational Neuroscience, Faculty of Medicine and Health Science, University of Antwerp

P5

Eye State Influences Eigenvector Centrality Of Brain Networks In Resting-State Fmri

Whether participants' eyes are open or closed can affect their level of attention or awareness – even in dark surroundings. In turn, these differences may influence the information flow in the brain and thus impact the composition of its networks. These effects could have implications for the design and interpretation of resting state

functional magnetic resonance imaging (RS-fMRI) studies. A way to quantify the network structure of the brain is by examining eigenvector centrality (EC). EC identifies the most central and influential nodes within the brain and can be used to assess whether eye state influences the role of nodes in the network.

RS-fMRI data of the Beijing Eyes Open Eyes Closed Study (Liu et al., 2013) was preprocessed using fMRIprep. We obtained EC measures for the 232 ROIs of the Power atlas using the fECM toolbox. Next, differences in EC between eye states and the ranking of the ROIs based on the EC values were assessed. For this, a Wilcoxon rank test was used to determine if the median of the differences between the states deviated significantly from 0.

Differences in EC and ranks between the two eye states did not significantly differ from 0 when comparing the whole distribution. However, when focusing on the ROIs with the 10% highest or lowest values an effect of the two states could be seen. The visual network exhibited more extreme values in the open condition for 24% of changes, whereas the DMN showed the opposite effect for 21% of changes.

This study suggests a shift in the centrality of the VN and DMN in the brain's network reflecting an internal vs external focus depending on the eye state. The findings highlight that eye state can influence the analysis of brain networks and should be taken into consideration when interpreting RS-fMRI studies.

Author:
Marschall, Theresa
Affiliation:
Laboratory of Experimental Ophthalmology, University Medical Center Groningen

Other authors:
Renken, Remco J, Department of Biomedical Sciences of Cells & Systems, University Medical Center Groningen;
van Laar, Teus, Department of Neurology, University Medical Center Groningen;
Cornelissen, Frans W, Laboratory of Experimental Ophthalmology, University Medical Center Groningen

P6

C: An Introduction To A New National Research Project

In our "Virtual Reality for enriched Visual Rehabilitation" (VR4eVR) project, we aim at transforming vision rehabilitation following stroke by means of remotely monitored, individualized, adaptive, home-based vision training. Stroke-related damage to the central neural pathways from the eye to the brain results in partial blindness. Affected individuals often become blind in one half of their visual field. Although not fully blind, this impairment severely impacts their physical, social, and emotional wellbeing, and limits their ability to maintain a healthy lifestyle and participate in society.
Vision training aimed at either visual field restoration or compensatory visual scanning can alleviate some of the associated issues in stroke-related visual impairment but presently training is time and resource consuming and fatiguing, potentially limiting its effectiveness. Moreover, not all individuals profit equally from training.
Our aim is to understand how to make vision training more accessible and effective, and how this ultimately translates into healthier living.
Therefore, in VR4eVR, we aim to create an enriched, adaptive, at-home vision training system that deploys virtual reality (VR) technology, serious gaming elements, and on-line monitoring. We will optimize training effectiveness for individuals based on neuroscientifically-motivated personal biomarkers that can be assessed using functional MRI. Additionally, the VR can be used to demonstrate to family, employers, and caregivers, in simulation, the consequences of the visual impairment.

To do this, VR4eVR brings together individuals with stroke-induced vision impairment and professionals from private, public and academic partners to transform vision rehabilitation following stroke. Our solutions will be evaluated in field labs at regional rehabilitation centers, which allows optimizing them. Ultimately, our solution will remove barriers and alleviate pressure on health care by optimizing both accessibility and effectiveness via at-home rehabilitation.

Author:
Cornelissen, Frans
Affiliation:
University Medical Center Groningen

Other authors:
de Boer, Minke; Jansonius, Nomdo M, University Medical Center Groningen
de Haan, Gera, University of Groningen
Heutink Joost; Grootendorp, Renske; Vissers, Michel, Royal Visio
Haak, Koen V; van den Berg, Bert; Bergsma, Douwe, Donders Institute for Neuroscience
Nijboer, Tanja; Telea, Alex; Vangorp, Peter; UU
Hobbelen, Hans; Waninge, Aly, Hanzehogeschool Groningen

P7

Reduced Contextual Variability Facilitates Learned Attending Towards Task-Relevant Features And Away From Distracting Information

The capture of attention by salient singletons during visual search appears to be tied to the variability of the context in which such singletons occur. In previous work, we showed that when participants perform two sessions of search, the singleton loses its ability to capture attention in the second session only when it occurs in a small set of possible search display configurations. However, the mechanism by which reduced contextual uncertainty may reduce capture remains unclear. Here, we asked whether this loss of capture is unique to the displays participants can become familiar with, indicative of contextual cueing effects, or generalises to new displays, suggesting that lowered contextual uncertainty instead facilitates general learning about predictive structure present across search configurations. To test this, we performed a large online study (n=200), in which participants performed a visual search task similar to our previous study. After two sessions in which participants were trained with a small set of search display configurations, we tested them in a third session on a mix of familiar and novel configurations, comparing the degree to which singletons captured early attention. We used letter recall in a probe-capture paradigm to index the locations which participants attended to within the search display. We replicated our previous finding that capture by the singleton disappeared after an initial training session. Notably, comparison of capture in the novel and familiar contexts in session 3 revealed that capture was eliminated in both conditions. As such, our results suggest that familiar configurations did not improve visual search performance by providing contextual clues about the location of the singleton, but that the development of generic predictions about task-relevant locations and features of the display may have reduced capture, which does not occur in settings with higher variability.

Author:
Jungerius, Chris
Affiliation:
Amsterdam University
Vrije Universiteit

Other authors:
Perizonius, Sophie, S, Vrije Universiteit
Slagter, Heleen, H.A., Vrije Universiteit

P8

Do We Use Kinesthetic Information To Decide Which Cookie To Take?

How do you decide which cookie you take from the tin? Several studies have shown that such decisions are not finalized before you start moving. Decision making is an ongoing process which continues during the execution of the movement. The decision is continuously updated based on information about the position and velocity of the hand: we tend to choose the cookie that is easiest to pick. Although vision provides the necessary information, the kinesthetic sense also provides this information. To determine whether kinesthetic information is used in this decision-making, we asked participants to tap on a target while the vision of the hand is available and not. Once participants have started to move forward, the target split into two and they had to choose one of the two targets. Both with and without vision, participants tended to make their online decision based on where their hand was relative to the two targets. We conclude that we can make our on-line movement decisions based on kinesthetic information.

Author:
Duygun, Gül
Affiliation:
Department of Human Movement Sciences, Vrije Universiteit Amsterdam, the Netherlands

Other authors:
van Mastrigt, Nina M., Vrije Universiteit Amsterdam
Smeets, Jeroen B. J., Vrije Universiteit Amsterdam

P9

Action Similarity Modulates Visual Working Memory Similarity

Recent studies suggest a close link between action and sensory representations in working memory. Here, we asked for the first time how action plans influence the way in which visual working memory (VWM) representations interact. We pursued our question by capitalizing on the phenomenon of intra-trial dependence, for which stimuli that are similar on a visual dimension (here orientation) tend to repel each other in memory, while stimuli that are dissimilar are attracted to each other. In particular, we hypothesized that associating two visual stimuli with different action plans would make them appear more dissimilar in memory than two stimuli linked to the same action plan. Participants (n=32) memorized the orientation of two bars, which were serially presented on a touch screen. After a delay, they sequentially reproduced each of the orientations. Crucially, after the presentation of each bar, participants saw an action cue, indicating the action to perform to reproduce the memorized orientations, which could be either a swipe or a grasp action. In the different action condition, the bars were always associated with different action plans, while in the same action condition, they were linked to the same action plan. Our results show that when the bars are similar in orientation (i.e., they differ less than 90 degrees), they are repelled significantly more from each other in the different action than in the same action condition. These findings suggest that action similarity importantly contributes to how similar VWM representations look to our mind's eyes. They also beg for a reconsideration of the presumed sensory nature of VWM representations, as they reveal that not only visual features but also action attributes may become an integrant part of VWM representations.

Author:
Trentin, Caterina
Affiliation:
Vrije Universiteit Amsterdam

Other authors:

Falanga, Luigi, L.
Olivers, Christian , C. N. L.
Slagter, Heleen, H. A.

P10

Auditory Pursuit Is Adaptive

Human can localize sounds highly accurately. The underlying physiological and behavioral mechanisms for this localization are well established. However, it is unclear how the brain processes moving sounds. Early eye-tracking research indicates that auditory motion tracking is imprecise. However, we have shown that we can faithfully follow an unpredictably moving sound in the horizontal plane through head movements. Results indicated that the system behaves as a second-order low-pass filter with a characteristic resonance frequency and damping coefficient. The resonance frequency was found to be constant around 0.6 Hz, the damping coefficient increased with increase in number of trials exhibiting an adaptive behavior. Here, we study this in more detail by expanding the range over which sounds can move (up to 60 deg) and including higher motion frequencies (up to 1.05 Hz). We found that the auditory craniomotor pursuit system continued to operate as an adaptive second-order low-pass system with increase in damping coefficient over trials. However, the resonance frequency increased due to the higher frequency of sound motion, pushing the pursuit system to the limit with which it can faithfully follow the implicit movement spectrum. These results suggest that head-based auditory smooth pursuit is highly adaptive, enabling us to keep a putative computational auditory fovea on the moving sound.

Author:
Snandan, Sharma
Affiliation:
Radboud University

Other authors:
Marc van Wanrooij
John van Opstal

P11

An Apparent Motion Color Illusion

We introduce and demonstrate a new illusory color phenomenon. The demonstration comprises a rapid alternation of two images. One image comprises rows of non-overlapping purple disks. The other image concerns rows of partly overlapping pinkish and blueish disks. The size of the disks is the same as the disks in the first image, whereas the color of the overlapping disk regions is the same purple as the color of the disks in the first image. The overall color appearance highly depends on the relative positions of the disks on the first and second image. We argue that the colour appearance is the result of a color filling-in effect that is mediated by perceived apparent motion.

Author:
Van Lier, Rob
Affiliation:
Radboud University, Donders Institute for Brain, Cognition and Behaviour

Other authors:
Vebjørn Ekroll, University of Bergen, Norway

P12

Reaction Times Capture Temporal Interactions In Electrical Hearing

Cochlear implants are neuroprostheses that enable people experiencing severe to profound sensorineural hearing loss, recover hearing sensations by directly stimulating the auditory nerve. To do so, trains of electric pulses are consecutively delivered to intra-cochlear electrodes. Each pulse is typically presented at a unique timepoint (also called interleaved sampling). However, the auditory nerve integrates electric stimuli over time, facilitating interactions between consecutive pulses. Prolonged integration, for example, due to degradation of the auditory nerve, could therefore impair the ability of cochlear implant users to adequately detect and recognize sounds.
We tested temporal interactions in electric hearing by measuring cochlear implant recipients' reaction times to pairs of biphasic pulses (i.e. quadruphasic). We varied the interval between the constituent biphasic pulses and manipulated them to have an anodic or cathodic centre phase. Results show that reaction times are shorter when the intervals between the pulse pair decreases. These results are in line with peripheral temporal integration. Furthermore, stimuli with anodic centre phases led to faster responses than stimuli with cathodic centred phases. This represents greater integration for anodic centred pulses.
Our results suggest that reaction times are a valid and straightforward technique for evaluating peripheral temporal interactions and polarity sensitivity in electrical hearing. Future work will explore the impact of temporal integration on speech outcomes, for cochlear implant recipients with different performance levels.

Author:
Calderon De Palma, Ignacio
Affiliation:
Radboudumc

Other authors:
Beynon, Andy J, Radboudumc
Pesch, Joerg, Cochlear Benelux
van Opstal, A John, Radboud University
Mylanus, Emmanuel A M, Radboudumc
van Wanrooij, Marc M., Radboud University

P13

Does Crowding Predict Conjunction Search? An Individual Differences Approach

Searching for objects in our visual environment is an integral part of human behaviour. Most of the information used during visual search comes from the periphery of our vision, thus understanding the basic mechanisms of search requires taking into account the inherent limitations of peripheral vision.
Our previous work using an individual differences approach has shown that one of the major factors limiting peripheral vision (crowding) is predictive of slower search, more eye movements, and longer fixation durations in a feature-search task. Here we extended this work, by testing the relationship between crowding and visual search in a conjunction-search paradigm, where task difficulty requires serial search behaviour. We tested sixty participants with regard to their sensitivity to both orientation and color-based crowding (as measured by critical spacing) and their efficiency in searching for a color/orientation conjunction (as indicated by manual response times and eye movements). While the correlations between the different crowding tasks were high, the correlations between the crowding and search tasks were only of low to moderate effect. The results suggest that, in contrast to feature search, conjunction search relies more on top-down guidance by color and is therefore relatively less determined by these feature contrasts.

Author:
Verissimo, Ines
Affiliation:

Vrije Universiteit Amsterdam

Other authors:
Olivers, Christian, CNL, Vrije Universiteit Amsterdam

P14

Individual Differences In Statistical Learning For Speech Segmentation: Can We Predict Learning With Neural Oscillations And Rhythm Perception?

Language learners are challenged with speech segmentation: dividing continuous speech into words. This is an important first step in language development [1]. Statistical learning (SL) – becoming sensitive to the statistical structure of a stimulus stream – is thought to underlie speech segmentation [1-4]. The statistical structure of language can be quantified as transitional probabilities (TPs) between neighbouring syllables; the probability that a syllable X is immediately followed by a syllable Y, given the frequency of X [3]. Adults and children track TPs between syllables and treat low TPs as word boundaries [1-4].

Previous research found considerable inter-individual differences in SL performance; not everyone is equally successful at segmenting out words from continuous speech [1,4]. The aim of our project is to use neural oscillations to identify what underlies individual differences in SL. EEG measures of brain-stimulus phase-locking can assess individual learning trajectories during exposure [4]. Our hypothesis is that rhythm perception abilities benefit SL, possibly by facilitating brain-stimulus phase-locking during learning [5-6].

We created a new artificial language, following the phonotactics of Dutch and with carefully controlled TPs. We conducted a behavioural pilot experiment with the following goals:

1) to validate whether participants could segment our new stimuli into words;
2) to look for first indications that rhythm perception, measured as musical sophistication, is associated with better SL for word segmentation.

We found robust behavioural evidence of SL yielding perception of words in our continuous speech stimuli. This was attested both through above-chance performance on a two-alternative forced-choice task measuring explicit word memory, and an implicit-memory reaction time (RT) task. Musical sophistication positively modulated performance on the RT task. These results suggest that our stimuli can be used in future SL experiments, and that follow-up research on the role of rhythm perception for SL through implicit (neural) measurements is warranted.

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Author:
van der Wulp, Iris

Affiliation:
Utrecht University Institute for Language Sciences

Other authors:
Struiksma, Marijn, M.E., Utrecht University Institute for Language Sciences
Wijnen, Frank, F.N.K., Utrecht University Institute for Language Sciences

P15

Reconstructing Pupillary Dynamics During Free-Viewing Of Movies: The Roles Of Pupil Light And Orienting Responses

Pupil size dynamically adapts to changes in low-level visual features, as well as cognitive factors. When cognitive factors are manipulated in pupillometric research, low-level visual features are usually strictly controlled and the fixation position is required to be constant. This severely limits the range of options for experimental designs. Instead of controlling for low-level features, the current study attempts to model and predict pupillary dynamics based on complex changes in low-level features. Any unexplained variance can then be attributed only to higher-level factors.
Forty healthy participants free-viewed a collection of 60-second movie clips while gaze position and pupil size were recorded. Visual features, namely luminance changes and color changes, were extracted across the movie frames. Following the idea of linear time-invariant systems, visual feature changes were convolved with pupil response functions (PuRFs) for light and orienting processes separately. To find the model that best fitted the actual pupil size recordings, we systematically varied the peak latency, width, and amplitude of the PuRFs.
The fitted models demonstrated that pupil responses predicted by light matched the real pupil size changes. The median proportion of explained variance across data from all movie clips (n = 453) was approximately 30%. In addition, this proportion significantly improved to 34% after including transient pupil orienting responses to changes in color space.
In conclusion, these results illustrate that our model of the pupil light and orienting response can explain a substantial proportion of variance of pupil size changes during unconstrained viewing of complex visual stimuli. Extensions of the current model could be used to produce baseline pupil traces that allow researchers to (1) control for confounds of low-level features in experimental designs, (2) discover which low-level visual aspects drive pupillary dynamics, and (3) investigate the effects of higher-order factors such as attention in isolation of confounding factors.

Author:
Cai, Yuqing
Affiliation:
Experimental Psychology, Helmholtz Institute, Faculty of Social Sciences, Utrecht University, The Netherlands

Other authors:
Strauch, Christoph, C, Utrecht University
Naber, Marnix, M, Utrecht University

P16

Adaptation To Numerosity Changes Monotonic Responses Of Early Visual Cortex

Humans and many animals can perceive numerosity, the number of visual objects. Recently-viewed numerosities can influence numerosity perception and cause numerosity adaptation aftereffects. In the brain, numerosity produces both early visual responses that monotonically increase with numerosity and later tuned response that peak at different (preferred) numerosities in different neural populations. We have recently shown that the preferred numerosity of numerosity-tuned neural

populations is affected by numerosity adaptation. We have also shown that early visual monotonic responses reflect features of spatial frequency domain image contrast that closely follow numerosity. We therefore hypothesized that adaptation's effects on early visual, contrast-driven monotonic responses to numerosity may precede adaptation's effects on numerosity-tuned response preferences. We measured early visual responses to numerosity during adaptation to both a high numerosity (20) and a low numerosity (1) using ultra-high field (7T) fMRI. We also measured the spatial population receptive fields (pRFs) to determine the visual field maps of the responsive voxels. During adaptation to high numerosities, the monotonic increase in response amplitudes with increasing numerosity is lower than during adaptation to low numerosities throughout early visual cortex (V1-V3, hV4 & LO1). This is consistent with perceived numerosity decreasing during high numerosity adaptation. Furthermore, baseline responses during high numerosity adaptation are higher than during low numerosity adaptation, consistent with a monotonic response to the adapter itself. Therefore, numerosity adaptation effects begin in the earliest, contrast-driven stages of vision, and may depend on contrast normalization mechanisms. The resulting changes in early monotonic responses may underlie later effects on numerosity-tuned responses.

Author:
Liangyou, Zhang
Affiliation:
Utrecht University

Other authors:
Evi Hendrikx, Utrecht University,
Yizhen Wang, South China Normal University,
Serge O. Dumoulin, Amsterdam VU University,
Ben M. Harvey, Utrecht University

P17

A Moment To Remember: Immediate Behavioural Interference Reduces Memory Performance In The Virtual Water Maze Task

Recent studies have shown that narrative episodic memory of movie clips can be retroactively inhibited by presenting two movie clips immediately after each other, whereby presentation of the second clip interferes with the memory of the first. This effect was interpreted in terms of a rapid hippocampal processes related to memory consolidation, triggered by the offset of the first event. Here, we investigated the temporal specificity and extent of the memory interference effect, and whether it could be extended to hippocampus-dependent spatial memory.

Participants were exposed to three configurations of a virtual Morris Water Maze environment in which they learned the location of an invisible target in each maze over three trials. A second spatial navigation task was presented either immediately after finding the target (condition 1), after a 10-second delay (condition2), or no second task was presented (condition 3). In a recall session, performed after either 1 or 24hs, participants indicated the learned location of the target, with no feedback, in 10 'pin-drop' trials for each maze. Spatial memory was measured by the mean distance between pins and the true target location. The results from the 1h-break condition revealed significantly impaired memory performance between conditions 1 and 2, but no significant difference between the other conditions. Thus, the immediate presentation of a second task appeared to inhibit spatial memory. No differences between conditions were found in the 24h-break condition. Additionally, there was no effect of the second task on the learning rate across trials in the first session.

Our findings suggest that processes involved in the early stages of memory consolidation occur within the short time window after the offset of a spatial learning

event. Interfering stimuli presented during this window may inhibit these processes and the cascade of subsequent memory-strengthening processes involved during initial consolidation.

Author:
Pahlenkemper, M
Affiliation:
Maastricht University

Other authors:
Bernhard H, Maastricht University
Reithler J, Maastricht University
Roberts M.J. Maastricht University

P18

Affective Touch Perception And Longing For Touch During The Covid-19 Pandemic

Interpersonal touch and affective touch play a crucial role in social interactions and have a positive influence on mental health. The social distancing regulations implemented during the COVID-19 pandemic have reduced the ability to engage in interpersonal touch. This could cause longing for touch, and it might subsequently alter the way in which affective touch is perceived. To investigate this, we conducted an online survey and included 1982 participants, which contained questions regarding the COVID-19 regulations, longing for touch, and the perceived pleasantness of affective and non-affective touch. Results showed that participants reported feelings of longing for touch. This significantly increased with the duration and severity of the COVID-19 regulations. In addition, participants who experienced more longing for touch rated videos of affective and non-affective touch as more pleasant. Current results provide insight in the impact of sudden and prolonged COVID-19 regulations and show that increasing the duration and severity of these regulations is associated with a higher desire for touch, which is associated with increased perceived pleasantness of observing touch.

Author:
Meijer, Larissa
Affiliation:
Utrecht University

Other authors:
Hasenack, Birgit, Utrecht University
Kamps, Jonas C C, Utrecht University
Mahon, Andy, Utrecht University
Titone, Giulia, Utrecht University
Dijkerman, Chris H, Utrecht University
Keizer, Anouk, Utrecht University

P19

Visual And Haptic Pleasantness Of Geometric Patterns

The perception and experience of geometric patterns has been studied extensively in vision, for instance in the form of abstract texture patterns. It is known that the complexity of such patterns can influence how pleasant they are perceived to be. At the same time, recent research on shading patterns due to façade openings suggests that pleasantness relates to naturalness, i.e., to how much a pattern is associated with nature. Here we compared pleasantness, complexity, and naturalness ratings of geometric patterns between vision and touch. To this end, we generated a set of 15 geometric line patterns varying in shape and line orientation intended to vary in

perceived complexity and naturalness. These patterns were presented first only haptically as relief patterns and then visually as black and white patterns in random order and were rated by 20 participants using absolute magnitude estimation. We found that this set of patterns indeed resulted in responses that varied in complexity and naturalness ratings. The results also showed that pleasantness, naturalness, and complexity ratings were systematically higher in the haptic condition than in the visual condition. However, for both modalities we found that pleasantness increased with higher naturalness ratings and decreased with higher complexity ratings. From this we can conclude that although pleasantness, naturalness and complexity ratings differed between modalities, the relation between pleasantness and naturalness and complexity was comparable in both modalities. These findings will be useful for designing patterns that are both visually and haptically pleasing.

Author:
Plaisier, Myrthe
Affiliation:
Eindhoven University of Technology

Other authors:
Quinn van Rooy, Eindhoven University of Technology
Kynthia Chamilothori, Eindhoven University of Technology

P20

Eye-Tracking In Innovative Neuropsychological Assessment Of Visual Working Memory

In both the laboratory and clinical neuropsychological assessment, visual working memory (VWM) is typically assessed by estimating the maximum storage load. However, in daily life, information typically remains available in the external world. We can easily sample information from the environment by making eye-movements, reducing the need to use the maximum VWM storage load. Vice versa, reliance on VWM capacity increases when accessing external information is difficult or costly. This implies a cost-efficient trade-off between sampling and storing, in which the maximum storage capacity might hardly be used in daily life. Therefore, to understand (patients') memory functioning in daily situations, it might be insightful to assess how information is used in addition to how much information can possibly be stored.
We investigated the tendency to sample or store based on the relative ease of sampling and memory functioning. To explore whether memory deficits change how patients use information from the external world, we compared gaze behaviour of individuals with Korsakoff's amnesia (n=24) and neurotypical controls (n=27) on a copy task that was designed to provoke different strategies (sampling vs. storing). Controls successfully shifted from sampling to storing in a condition with high sample costs (long gaze-contingent waiting time) versus low sample costs (no waiting time). Patients shifted strategy too, but failed to memorize more items at once and made more errors. This suggests that successfully switching strategy from sampling to storing is dependent on VWM functionality. These findings identify naturalistic eye-movement biomarkers indicative of memory deficits that are not captured by means of assessing one's maximum storage capacity, but that rather occur in dynamic interaction with our environment.

Author:
Böing, Sanne
Affiliation:
Department of Experimental Psychology, Helmholtz Institute, Utrecht University

Other authors:
Ten Brink, Teuni, A F
Hoogerbrugge, Alex, A J

Oudman, Erik, E
Postma, Albert, A
Nijboer, Tanja, T C W
Van der Stigchel, Stefan

P21

Statistical Learning Facilitates The Selection Of Stimuli Into Awareness

Human beings are extremely proficient at extracting statistical regularities from sensory inputs to enhance a variety of basic and higher-order cognitive functions, such as attention and working memory. It remains unknown, however, whether statistical learning can facilitate the selection of stimuli into consciousness (i.e., conscious access). To answer this question, we manipulated the probability of target location (left or right side of fixation, Experiment 1) and feature (upright or inverted triangle, Experiment 2), and used the breaking continuous flash (b-CFS) paradigm to measure the speed of conscious access. We find that targets that were initially rendered invisible by CFS masks were reported faster when they appeared at the probable (versus improbable) location or with the probable (versus improbable) feature. While these results suggest that statistical learning may influence conscious access, the differential response times in b-CFS may be attributed to unconscious processing (i.e., differences in conscious access) or conscious processing (i.e., differences emerging after conscious access). We therefore adapted a recently developed detection-discrimination dissociation (DDD) paradigm that allows for excluding effects (of statistical learning) emerging after conscious access. Using this paradigm, we show that [1] probable targets (e.g., upright triangles) are localized better than improbable targets (e.g., downwards triangles), while [2] observers are unable to discriminate between the probable and improbable targets (i.e., downwards vs. upright triangles) in a forced-choice discrimination task. In this way, we established that statistical learning affects the processing of stimuli prior to conscious access. We conclude that the visual system can utilize statistical regularities of sensory inputs to facilitate conscious access of probable events.

Author:
Xu, Luzi
Affiliation:
Utrecht University

Other authors:
Paffen, Chris, C, Utrecht University
Van der Stigchel, Stefan, S, Utrecht University
Gayet, Surya, S, Utrecht University

P22

Soft Robotics In Haptic Interaction

Haptic interaction is being implemented in more and more applications ranging from perception in virtual reality for training, communication and entertainment. Also in teleoperation systems, remote sensing by means of haptic feedback has a large potential. Due to these technological developments more devices and applications become available to study human haptic perception, which gives us new insights in the perceptual processes involving the human hands.

In this constant iterative cycle of developing hardware and studying human perception, we would like to present some of the recent soft robotic haptic interfaces that we developed, e.g. soft robotic thimbles for virtual button clicks, and discuss the requirements for haptic and multimodal perception research using new technologies. This touches upon a very fundamental issue of validating perception research methods as well as validating sensory integration.

Author:
Kuling, Irene
Affiliation:
Eindhoven University of Technology

P23

Active Inference Slows Reversal Learning In Uncertain Environments

Perception is often framed as the inference of hidden states from noisy sensory input. Depending on whether sensory observations are passively sampled or actively generated, prior beliefs guiding the inference process can be informed by probabilistic sensory cues, or by knowledge about action-outcome relationships. Recent studies suggest that humans may hold stronger prior beliefs about the expected outcomes of actions than about sensorily cued observations. However, it remains unclear to what extent this effect interacts with perceptual features of the environment, such as sensory uncertainty. Here, we compared the outcomes of inference for perceptual judgments or goal-directed actions under different conditions of uncertainty. In a probabilistic reversal learning task, participants were either asked to infer a hidden state from computer-sampled observations, or to sample observations determined by a hidden state, while we manipulated the uncertainty of sensory observations. Both tasks required learning of the probabilistic relationship between hidden states and observations, and keeping track of sudden reversals in the hidden state. Critically, participants received identical sequences of evidence for the current hidden state under each instruction. Intermediate results indicate that reversal learning is slower when observations are actively sampled rather than passively monitored, especially when these observations are uncertain. In addition, Bayesian computational modelling demonstrates that participants perceived the environment as less volatile in the active task than in the passive task, regardless of sensory uncertainty. These findings replicate past work showing that humans are slower to update their beliefs on the basis of self-generated observations compared to passively perceived observations. The current study adds that this effect may increase under circumstances of high sensory uncertainty. This could signify a natural outcome of active inference: that by acting, we shape our perception of the inherently uncertain world.

Author:
Lageman, Jet
Affiliation:
Vrije Universiteit Amsterdam

Other authors:
Fahrenfort, Johannes J, Vrije Universiteit Amsterdam
Slagter, Heleen A, Vrije Universiteit Amsterdam

P24

The Effects Of Eccentricity On Attentional Capture

A Visual attention may be captured by an irrelevant, yet salient distractor, thereby slowing search for a relevant target. This phenomenon has been widely studied using the additional singleton paradigm in which search items are typically all presented at one and the same eccentricity. Yet, differences in eccentricity may well bias the competition between target and distractor. Here we investigate how attentional capture is affected by the relative eccentricities of a target and a distractor. Participants searched for a shape-define target in a grid of homogeneous nontargets of the same color. On 75% of trials, one of the nontarget items was replaced by a salient color-defined distractor. Crucially, target and distractor eccentricities were independently manipulated across three levels of eccentricity (i.e. near, middle, far). Replicating previous work, we show that the presence of a distractor slows down search. Interestingly, capture as measured by manual reaction times was not affected

by target and distractor eccentricity whereas capture as measured by the eyes was: items close to fixation were more likely to be selected than items presented further away. Furthermore, the effects of target and distractor eccentricity were largely additive, suggesting that the competition between saliency- and relevance-driven selection was modulated by an independent eccentricity-based spatial component.

Author:
van Heusden, Elle
Affiliation:
Vrije Universiteit Amsterdam

Other authors:
Olivers, Christian N.L, Vrije Universiteit Amsterdam
Donk, Mieke, Vrij Universiteit Amsterdam

P25

Involvement Of Superior Colliculus In Complex Figure Detection Of Mice

Object detection is an essential function of the visual system. Although the visual cortex plays an important role in object detection, the superior colliculus can support detection when the visual cortex is ablated or silenced. Moreover, it has been shown that superficial layers of mouse SC (sSC) encode visual features of complex objects, and that this code is not inherited from the primary visual cortex. This suggests that mouse sSC may provide a significant contribution to complex object vision. Here, we use optogenetics to show that mouse sSC is causally involved in figure detection based on differences in figure contrast, orientation and phase. Additionally, our neural recordings show that in mouse sSC, image elements that belong to a figure elicit stronger activity than those same elements when they are part of the background. The discriminability of this neural code is higher for correct trials than incorrect trials. Our results provide new insight into the behavioral relevance of the visual processing that takes place in sSC.

Author:
Heimel, Alexander
Affiliation:
Netherlands Institute for Neuroscience

Other authors:
Cazemier, Leonie J L, Netherlands Institute for Neuroscience,
Tran, Loan L T K, Netherlands Institute for Neuroscience,
Hsu, Ann A T Y, Netherlands Institute for Neuroscience,
Husić, Medina M, Netherlands Institute for Neuroscience,
Kirchberger, Lisa L, Netherlands Institute for Neuroscience,
Self, Matthew M W, Netherlands Institute for Neuroscience,
Roelfsema, Pieter P R, Netherlands Institute for Neuroscience

P26

Timing Of Tonality And Progression: Anticipation-Related Arousal Speeds Up Subjective Time, Regardless Of Sequential Tonality

The filled duration illusion (FDI) refers to the phenomenon where the perceived duration appears longer when it is filled with stimuli (e.g. sounds, flashes) compared to when it is empty (Buffardi, 1971). While it is among the most consistent findings in the field, the nature of this temporal illusion is still debated (Wearden & Ogden, 2021). To account for this effect, information-processing models of interval timing are utilized which posit that the brain uses an internal clock to track the passage of time, whereby the clock's rate is modulated by attention and cognitive demands, which in turn mediates accumulation of cognitive markers denoting memorized and/or perceived intervals. The FDI is assumed to arise from the increased density of these markers

during the filled interval, leading to longer perception of elapsed time. In this study, we aimed to elucidate the underlying mechanistic principles of the FDI by employing an interval timing task in which the to-be-timed intervals were composed of three tones of varying pitches: altogether constituting a major or minor musical triad. The first and the last tone demarcated the interval, whereas the temporal location of the middle tone varied as being closer to the first/last tone. Participants first learned a long and a short anchor duration, and then bisected intermediate durations as belonging to either category. Durations of subjective equality were compared as a function of the proximity of the middle tone to the first one, and the major/minor tonality of the timed triad (possibly elucidating an effect of emotional arousal on perceived time; Gable et al., 2022). Our results show that the temporal location of the filling tone does indeed impose a parametric effect on perceived duration, but only up to the point of subjective equality, with no discernable effect of major-minor tonality, partially supporting the information-theoretical accounts.

Author:
Karsilar, Hakan
Affiliation:
University of Groningen

Other authors:
Bilgin, Sena N, Graduate School for Social Research, GSSR

P27

Teal & Orange

"Teal & Orange" is a preferred "look" of the Hollywood movie industry.
This palette has been around for ages in the visual arts as "painting in cool and warm."
Are there fundamental reasons for the preference for this particular dichromatic pair?
We find that human anatomy/physiology, the physics of surface scattering, and the ecology of the human Umwelt cooperate to render the teal & orange palette special.
It stands out above other dichromatic axes like green-purple, only the white-black palette competes.
The appeal of the Teal & Orange palette involves world, body and mind and has to be understood in a proper semiotical (biological) setting.
We show some instances from the arts that exemplify this.

Author:
Van Doorn, Andrea
Affiliation:
Utrecht University & KU Leuven

Other authors:
Koenderink, Jan
Utrecht University & KU Leuven

P28

Perceptual grouping in haptic enumeration

Previous studies have shown that haptic enumeration speeds up when to-be-enumerated items can be grouped by e.g. proximity or configurality (Overvliet & Plaisier, 2015; Verlaers & Overvliet, 2013). This is the case when single items are presented to individual fingers, or when participants move a single finger over groups of items. However, it is still unknown whether grouping can speed up enumeration when multiple items are presented to multiple fingers simultaneously. Here we investigated both the effect of configurality and similarity on enumeration speed and accuracy, by presenting varying numbers of Braille dots to varying finger pads of the index, middle and ring fingers of both hands. To test for grouping by configurality, the

dots were presented in a random or in a shape-like configuration. To test for similarity, we presented either the same (configuration of) dots to all fingers, or we presented random configurations to the different fingers. As expected, results show that a higher number of items and the use of more fingers yield higher enumeration times and lower accuracies. Configurality and similarity interact with both number of dots and fingers for both accuracy and enumeration speed, indicating that in some cases grouped items can be processed faster and more accurate compared to randomly placed items. Results will be discussed in terms of fundamental haptic processing, as well as the implications for design of haptic displays.

Author:
Overvliet, Krista
Affiliation:
Utrecht University, Experimental Psychology & Helmholtz Institute

Other authors:
Turner, Linda
Utrecht University, Experimental Psychology & Helmholtz Institute

P29

Objectively positive but subjectively unappealing: visual features of art evaluation

Through art, a person can express their emotional experiences and aim to transmit them to others. Art is therefore thought to be highly personal, as well as our experience and evaluation of it. Still, individuals often agree on what should be considered fine art. This would suggest not only subjective but also objective components to art evaluation. In fact, previous research suggests that there is a strong bottom-up, stimulus driven, objective component to the emotional evaluation of art. This suggests art evaluations should be at least partially predictable from the basic visual properties of the art piece. Here, we tested this hypothesis by using a novel machine learning method to determine the visual characteristics of abstract art paintings that are related to the evaluation of the artwork. Moreover, since different studies tend to ask for different versions of evaluations, we asked raters to indicate both 1) if the painting was perceived as positive or negative as well as 2) if it was perceived as appealing or unappealing. Results show that positive versus negative evaluations are relatively predictable from the spatial frequency spectrum of the paintings within individuals. Moreover, the relevance visual properties for this predictability are consistent between individuals. This is, however, not the case for appealing versus unappealing evaluations, which do not appear to be predictable from the basic visual properties nor consistent between individuals. Our results suggest a degree of objectivity in the valance of abstract art paintings that can be linked to specific parts of the Fourier spectrum. However, the visual properties that drive the personal appeal of an art piece appear to be highly personal and thus subjective.

Author:
Stuit, Sjoerd
Affiliation:
Utrecht University

P30

Sound Appraisal Technology In The Real World

Using soundscape theory based on the notion of audible safety, we implement technology to appraise the sonic environment in a similar way as humans seem to do. In the GLIMI-project we conduct pilot studies to test this technology in a several Dutch towns.

Estimating audible safety allows one to decide whether one must be alert or can be

relaxed. In addition, the event-rate determines the information processing load. The combination of these leads to four quadrants: calm, lively, chaotic, boring.

We use a gammatone filter bank to produce a cochloegram, which we separate into temporal/perceptual layers with four time-constants: 1 hour, 1 minute, 1 second, and 10 ms. We use the information up to = 1 sec to determine audible safety in the form of sounds like speech and bird song. This contributes mainly to a calm or lively appraisal. The information between 1 second and 1 minute contains sources like cars that obscure the audible-safety estimation process and contribute to a chaotic appraisal. Information with a time constant above 1 minute provides a slow background that contributes to a boring/monotonous appraisal.

A theory-informed sum of these appraisals leads each second to an estimation. Although still far from perfect, a long-term histogram of the computed appraisal values, currently spanning more that 2 months continuously, leads to useful and insightful descriptions of the long-term features of the local soundscape that can be used by citizens and policy makers.

To enrich and validate this soundscape analysis, we combine both objective measurements and subjective experiential data within the GLIMI project. Working with local residents, we gather feedback using soundwalks and a customized GLIMI webportal.

Author:
Andringa, TJeerd
Affiliation:
SoundAppraisal

Other authors:
Ursem, Merel

P31

What Can Visual-Field Deficits Teach Us About Audiovisual Integration?

Multisensory integration is of undisputed benefit for the detection and identification, i.e. perception, of external stimuli in complex environments comprised of an a priori unknown number of possible sources. Compared to unimodal responses, goal-directed actions towards congruent bimodal, e.g. audiovisual, stimuli are characterized by decreased reaction times and increased response accuracy. Neurons responsive to input from multiple modalities have been described in various brain regions ranging from midbrain to neocortex. Based on these behavioral and neurophysiological studies three principles governing audiovisual integration have been uncovered. Here, the principle of inverse effectiveness is the most relevant. The strength of audiovisual integration is inversely related to the efficacy of the independent auditory and visual stimuli. From this, the hypothesis follows that if visual stimuli are presented near the fovea audiovisual integration is less than when stimuli are presented in the visual periphery. Consequently, reduction of visual-field sensitivity, such as observed in glaucoma, should result in more audiovisual integration in the affected areas of the visual field. We hypothesized that audiovisual integration strength, as quantified by 1) a decrease in reaction time, and 2) an increase in localization accuracy, allows for the mapping of visual-field deficits. Using a head-mounted binocular video-eye tracker and a search coil, we quantified audiovisual integration in seven glaucoma patients by measuring reaction times and localization accuracy of saccadic gaze movements to auditory and visual stimuli alone and combined audiovisual stimuli across the frontal hemisphere. By mapping audiovisual integration across the visual field, we aim to construct behavioral response maps of potential retinal damage and its severity. The obtained maps will be comparable with Humphrey field analyzer and eye-movement perimetry results. Our experiment allows us to assess the premise of visual-field

deficit screening using audiovisual integration and may lead to the development of more natural screening tests.

Author:
Bremen, Peter
Affiliation:
Erasmus MC, Rotterdam

Other authors:
Pel, Johan, Erasmus MC Rotterdam
van Wanrooij, Marc, Donders Institute for Brain, Cognition and Behaviour

P32

Concealed familiar face detection with oculomotor measures and EEG in rapid serial visual presentation

Traditional concealed information tests (CIT) work fairly well when people cooperate, but people can still use countermeasures to avoid detection. Presenting the critical stimuli in rapid serial visual presentation (RSVP) while measuring EEG has proven effective against countermeasures. Here we investigated whether measuring oculomotor measures in RSVP are similarly effective as EEG for detecting concealed information, and, if so, which oculomotor measures (pupil size, eye-blinks, or microsaccade rate) work best. In two studies (one with oculomotor measures and one with EEG), 31 and 29 participants, respectively, were asked to search for a target face in an RSVP task while a familiar face, one of their parents' faces, or a control face also appeared in the task. Here, the familiar face served as 'concealed information'. In the first study, we replicated our previous finding that the pupil dilated more in response to the familiar faces, as compared to control faces. We further found that blink rate, blink latency, and microsaccade rate were not noticeably affected by concealed information. We validated these results in a separate dataset that we had previously collected. In the second study, using neural-network decoding, we detected concealed information for each individual with an average hit rate 61.8% and an average correct rejection rate 72.7%. Overall, EEG remained more sensitive than the oculomotor measures, and pupil size is a more sensitive oculomotor measure for concealed information detection compared to blinks and microsaccade rate. Nevertheless, concealed information detection by means of the pupil size was still substantial. Taking practical considerations into account, the application of the pupil size measure in RSVP-based CIT may thus present a viable addition to EEG.

Author:
Chen, Ivory
Affiliation:
University of Groningen