gdr-vision

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Table des matières

Title: Investigating the neural basis of residual visual in hemianopia and the potential for rehabilitation

Holly Bridge

Nuffield Department of Clinical Neurosciences, University of Oxford

https://www.ndcn.ox.ac.uk/team/holly-bridge

Abstract: Damage to the primary visual cortex leads to loss of the visual field contralateral to the damaged cortex. However, in spite of this loss, some patients are still able to detect visual information about stimuli presented within their blind field. A growing area of research aims to exploit this residual visual function to try to improve visual performance through rehabilitation programmes stimulating the blind field. However, to optimise such programmes it is important to understand the pathways through which this information is conveyed.

Here, I will outline a series of magnetic resonance imaging studies in which we attempted to elucidate these pathways in a group of hemianopic patients. Using functional MRI, diffusion-weighted MRI, functional connectivity and magnetic resonance spectroscopy I will provide evidence to implicate the pathway between the lateral geniculate nucleus and motion area hMT+ in residual vision. Finally, I aim to present novel data showing the effects of visual rehabilitation on the structure and function of this pathway.

Conférences invitées du GDR Vision

Title: AI vision systems and biological vision

Simon Thorpe

Centre de Recherche Cerveau et Cognition, CNRS UMR 5549, Toulouse

https://cerco.cnrs.fr/page-perso-simon-thorpe/

Abstract: State-of-the-art deep learning trained vision systems outperform humans in many tasks. They have feed-forward processing architectures that look surprisingly like those used in the human visual system. But many key features of biological vision are still missing from most current AI vision systems. In this talk, I will concentrate on two main ideas that depend on neurons transmitting information using spikes – not floating-point numbers. First, codes based on the order of firing of neurons can allow information to be processed very efficiently, even with extremely sparse firing. This may be a key reason for the remarkable power efficiency of the brain. Second, I will look at processing using binary synaptic weights rather than continuously varying weights used in deep learning. I will talk about learning rules that effectively rearrange these binary weights to match repeating input patterns. Such rules allow rapid unsupervised learning that is much more plausible than conventional back-propagation based deep learning schemes.

Conférences invitées du GDR Vision

Title: The accumulation of evidence for perception and confidence

Tarryn Balsdon

Institute of neuroscience and psychology, University of Glasgow

https://dr-tarryn-balsdon.webnode.page/

Abstract: Perceptual decisions are accompanied by feelings of confidence that reflect the likelihood that the decision was correct. Computational frameworks describe these feelings of confidence as an evaluation of the evidence used for making the perceptual decision. However, perceptual decisions themselves are described by a process of evidence accumulation that evolves over time. By examining this evidence accumulation process in relation to both perception and confidence, we show a partial dissociation in the evidence used for perceptual decisions and confidence evaluations. In particular, confidence can rely on evidence that continues to accumulate after perceptual decision commitment. We isolate separable neural signatures of confidence that are present both during perceptual evidence accumulation and after perceptual decision commitment. This ongoing evidence accumulation contributes to confidence even for perceptual decisions based on brief stimulus presentations, and largely rely on ongoing perceptual processes that can be interrupted by backward masking independently of the perceptual decision processes. Together, these findings highlight the dynamic processes involved in forming feelings of confidence, which are closely related, but distinguishable from, the processes involved in making perceptual decisions.

Mini-symposium sur les déficiences visuelles et les stratégies palliatives

Title: Visual restoration: From prosthesis to sonogenetic therapy

Speaker: Serge Picaud

Abstract: Visual restoration is certainly the greatest challenge for brain-machine interfaces with the high pixel number and high refreshing rate. In the recent year, we brought retinal prostheses and optogenetic therapy up to successful clinical trials. Concerning visual restoration at the cortical level, prostheses have shown efficacy for limited periods of time and limited pixel numbers. We are investigating the potential of sonogenetics to develop a non-contact brain machine interface allowing long-lasting activation of the visual cortex. The presentation will introduce prostheses and genetic-based brain machine interfaces for visual restoration at the retinal and cortical levels.

Mini-symposium sur les déficiences visuelles et les stratégies palliatives

Title: Automated text simplification as a reading aid for low-vision individuals

Speaker: Aurélie Calabrèse

Abstract: In developed countries, the majority of people with visual impairment are legally blind, but not *totally* blind. Instead, they have what is referred to as low vision, commonly caused by Central visual Field Loss (CFL). This degenerative condition is caused by non-curable retinal diseases, such as Age-related Macular Degeneration (DMLA in French). Patients suffering from such pathologies will develop a blind region called scotoma, located at the center of their visual field and spanning about 20° or more. To better visualize the impact of such a large hole in your visual field, try stretching your index and little finger as far as possible from each other at arm's length; the span is about 15°. Central vision cannot be restored and difficulty with reading becomes the primary complaint of patients seeking rehabilitation. To help CFL individuals improve their reading performance, it is necessary to investigate the underlying causes of their deficit, to then overcome them with specific adjustments.

In this presentation, I propose to address the issue of reading with CFL from a linguistic perspective, which takes into account the whole complexity of texts. I will present a series of experiments that investigate what makes a text especially complex when reading with CFL. I will conclude on the relevance of this work to design text simplification tools, customised to the specific needs of readers with CFL, to be used as efficient reading aids for this population.

Mini-symposium sur les déficiences visuelles et les stratégies palliatives

Title: How to improve tactile pictures in storybooks for children with visual impairment?

Speaker: Florence Bara

Abstract: Shared reading activities with illustrated books enhanced early literacy development. While typical children are exposed to the richness of written language at a very early age and have a variety of materials at their disposal, the situation is quite different for children with visual disabilities. Even when they have access to adapted tactile books, there is no guarantee that they can easily understand the images. Indeed the direct transposition of a visual image to a tactile image is not necessarily sufficient for the child to understand the image and to support comprehension of the story effectively. In different studies we assessed the effects of different kinds of illustration (3D tactile objects, figurative pictures, simplified pictures with different textures, adding of sounds…) on image recognition and story comprehension among visually impaired children from 5 to 10 years-old. Our results showed that simplified pictures efficiently support image and story comprehension. Adding sounds or manipulating 3D objects also have beneficial effects.

Résumés des présentations orales et posters du GDR Vision 2023

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Abstracts of oral and poster presentations of the GDR Vision 2023

A quantum model of color perception

Edoardo Provenzi * [1]

[1] Institut de Mathématiques de l'Université de Bordeaux – UMR 5251 CNRS – France

The phenomenon of color perception interested several theoretical physicists and mathematicians as Newton, Maxwell, Helmholtz, Grassmann and Schrödinger. This last proposed, in 1920, a set of axioms to describe the space of perceived colors C which has been completed in 1974 by Resnikoff, who determined the structure of C as a symmetric cone of dimension 3. Using the tight link between symmetric cones and Jordan algebras on one side, and the role of Jordan algebras in the algebraic formulation of quantum theories on the other side, it is possible to build a coherent quantum theory of color perception. Remarkably, this novel model incorportates intrinsically Hering's opponency. In the talk I will discuss the most important results of this quantum model of color perception. This is a joint work with Michel Berthier.

Mots-Clés: Color perception, quantum information

*Intervenant

Measuring uncertainty in human visual segmentation

Jonathan Vacher * [1], Claire Launay [2], Pascal Mamassian [3], Ruben Coen-Cagli [2]

[1] MAP5 – Université Paris Cité : UMR8145 – France
[2] Department of Systems and Computational Biology, Albert Einstein College of Medicine, NY, USA – États-Unis
[3] Laboratoire des systèmes perceptifs – Département d'études cognitives, École normale supérieure, PSL University, CNRS – France

Segmenting visual inputs into distinct groups of features and visual objects is central to visual function. Classical psychophysical methods have helped uncover many rules of human perceptual segmentation, and recent progress in machine learning has produced successful algorithms. Yet, the computational logic of human segmentation remains unclear, partially because we lack well-controlled paradigms to measure perceptual segmentation maps and compare models quantitatively. Here we propose a new, integrated approach: given an image, we measure multiple same–different judgments and perform model–based reconstruction of the underlying segmentation map. The reconstruction is robust to several experimental manipulations and captures the variability of individual participants. We demonstrate the validity of the approach on human segmentation of natural images and composite textures, and we show that image uncertainty affects measured human variability as well as the way participants weigh different visual features. Because any putative segmentation algorithm can be inserted to perform the reconstruction, our paradigm affords quantitative tests of theories of perception as well as new benchmarks for segmentation algorithms.

Mots-Clés: grouping, segmentation, same/different, image uncertainty

*Intervenant

Waves GPS: A modular Python package for the detection and analysis of cortical traveling waves

Kirsten Petras * [1], Laura Dugué [2,3]

[1] Université Paris Cité, CNRS, Integrative Neuroscience and Cognition Center, F-75006 Paris – Université Paris Cité, CNRS, Integrative Neuroscience and Cognition Center, F-75006 Paris-0 – France
[2] Université Paris Cité, CNRS, Integrative Neuroscience and Cognition Center, F-75006 Paris – Université Paris Cité, CNRS, Integrative Neuroscience and Cognition Center, F-75006 Paris-0 – France
[3] Institut Universitaire de France – Institut universitaire de France, Institut universitaire de France – France

Cortical oscillatory activity of narrow frequency bands has been found to display monotonic phase shifts over space, i.e., to form traveling waves within and across cortical regions. Finding and characterizing those spatio-temporally consistent patterns in data recorded with invasive as well as non-invasive techniques requires multiple consecutive, but sometimes interchangeable processing and analysis steps. The current literature on cortical traveling waves lacks a clear consensus of which methods can and should be applied in specific empirical contexts. Here, we introduce Waves GPS, an open source, modular detection and analysis tool implementing a range of different options to detect, describe and statistically evaluate traveling waves. In addition, a simulation module allows researchers to model different types of waves embedded in realistic background conditions to generate synthetic data. Together, Waves GPS allows researchers to generate benchmark analyses tailored to their experimental paradigm and model experimental outcomes in silico. This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 852139 - Laura Dugué).

Mots-Clés: Traveling waves, data simulation, Python package

*Intervenant

An objective neural index of implicit familiar face identity recognition with frequency periodic visual stimulation

Justine David * [1], Laurent Koessler [1], Bruno Rossion [1]

[1] Centre de Recherche en Automatique de Nancy – Université de Lorraine, Centre National de la Recherche Scientifique – France

Humans' excellent ability to recognize the same identity across different views of a same familiar face identity is well documented. However, this ability is generally measured with explicit behavioral tasks with little or no time constraints, therefore involving many other processes (e.g., association of independently generated names from the 2 images). Here we aimed at providing a simple implicit neural index of this ability using electroencephalographic (EEG) recordings coupled with fast periodic visual stimulation. Images of two famous face identities were presented alternated at a frequency rate of 6 Hz (i.e., one fixation per face) preceded by a 15 sec adaptation period to either (1) one of the two alternating face identities (adaptation condition) or (2) another identity not present in the alternating sequence (control condition). In contrast to previous studies using this approach, various unsegmented natural images, with the face varying in size, expression, lighting, head orientation, etc.. were presented for each face identity. EEG signals (128 channels) of 16 healthy participants were analysed in the frequency domain to compare the amplitude of the 3 Hz EEG evoked response, reflecting asymmetry between the two alternating faces, in the two conditions. Results show a significantly larger amplitude of EEG activity at 3 Hz, i.e., the identity repetition rate, for the condition with adaptation to one of the two alternating face identities (0.39±0.08 μV) than for the control condition with irrelevant adaptation (0.16±0.07 μV). This 3 Hz evoked response for familiar faces was found in most individuals following only a few minutes of stimulation and was maximally localized over the right occipito-temporal region, a region which is particularly important for face recognition. As expected, no significant amplitude difference was found between the two conditions for the 6 Hz stimuli presentation frequency, reflecting general processes. To conclude, we provide an ecological, objective, and sensitive stimulation technique to implicitly measure an individual's ability to generalize identity across different natural views of familiar faces, with the potential for providing a biomarker of impairments at this function in neurological conditions (e.g., Alzheimer's disease).

Mots-Clés: Face recognition, Visual adaptation, Electroencephalography, Fast Periodic Visual Stimulation

*Intervenant

Rapid Objective Assessment of Contrast Sensitivity and Visual Acuity With Sweep Visual Evoked Potentials and an Extended Electrode Array

Coralie Hemptinne * [1,2], Joan Liu-Shuang *

, Demet Yüksel [1,2], Bruno Rossion *

[2,3]

[1] Cliniques universitaires St Luc [Bruxelles] – Belgique
[2] Institute of Neuroscience [Bruxelles] – Belgique
[3] Universite de Lorraine – Université de Lorraine - CRAN CNRS UMR 7039 – France

Purpose: Sweep visual evoked potentials (sVEPs) provide an implicit, objective, and sensitive evaluation of low-level visual functions such as visual acuity and contrast sensitivity. For practical and traditional reasons, sVEPs in ophthalmologic examinations have usually been recorded over a single or a limited number of electrodes over the medial occipital region. Here we examined whether a higher density of recording electrodes improves the estimation of individual low-level visual thresholds with sVEPS, and to which extent such testing could be streamlined for clinical application.
Methods: To this end, we tested contrast sensitivity and visual acuity in 26 healthy adult volunteers with a 68-electrode electroencephalogram (EEG) system.

Results: While the most sensitive electrophysiologic response was found at the traditional medial occipital electrode Oz in a small majority of individuals, it was found at neighboring electrodes for the remaining participants. At the group level, lower spatial frequencies were also associated with right lateralized responses. More generally, visual function was evaluated more sensitively based on EEG recorded at the most sensitive electrode defined individually for each participant. Our data suggest that recording over seven posterior electrodes while limiting the testing session to less than 15 minutes ensures a sensitive and consistent estimation of acuity and contrast sensitivity threshold estimates in every individual.
Conclusions: The present study shows that sampling from a larger number of posterior scalp electrodes is relevant to optimize visual function assessment and could be achieved efficiently in the time-constrained clinical setting.

*Intervenant

Mots-Clés: Visual acuity, Contrast sensitivity, Electroencephalography, Evoked Potentials, Electrodes, Amblyopia

Should I stay or should I go? Neural bases of the street crossing decision

Solène Leblond * [1], Robin Baures *

[1], Franck-Emmanuel Roux *

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[1] Centre de recherche cerveau et cognition – Institut des sciences du cerveau de Toulouse., Université Toulouse III - Paul Sabatier, Centre National de la Recherche Scientifique – France

Time to contact (TTC) is the remaining time before a moving object reaches its observer or another point in space. In order to catch a ball or to cross the road safely it is necessary to make a correct estimation of the TTC of the moving object. If this estimation function is essential to maintain the autonomy of the person, it is still poorly understood. The objective of this study is to determine which brain area(s) are involved in the realization of this TTC estimation task in a street crossing context.
For this purpose, a causal approach allowing a very precise temporal resolution is used: awake surgery. Patients with brain tumors participate in the study. During awake surgery, the neurosurgeon can stimulate a brain area which will temporarily inactivate it. The patient performs the task at the same time. If the patient is able to perform the task during preoperative tests, but is no longer able when an area is inhibited, we can deduced that this area is involved in the performance of the task. Nevertheless, in these patients, the areas tested are located on the surface of the cortex. Thus, in order to test the involvement of more deeply located cerebral areas, a second part was added to the study using another method: intracerebral EEG.

This second method is a correlational and non-causal technique but allows to test deeper areas, has high spatial and temporal resolutions and provides information about the dynamics of the TTC estimation. The participants are drug-resistant epileptic patients implanted with deep electrodes in order to localize the epileptogenic focus for performing a surgical removal of this focus. These patients perform the same tests of TTC estimation as the awake surgery patients. Only two patients could be included in the study for the moment due to the small number of patients implanted because of the extremely invasive context of this method. The results obtained by these 2 methods will be presented.

Mots-Clés: Time, to, contact, awake surgery, sEEG

*Intervenant

Tactile double-step at the fingers induces saccadic adaptation without transferring to visual saccades

Ali Batikh * [1], Alessandro Farnè [1], Denis Pelisson [1]

[1] Centre de recherche en neurosciences de Lyon - Lyon Neuroscience Research Center – Equipe IMPACT, Centre de Recherche en Neurosciences de Lyon (CRNL), CNRS UMR 5292, INSERM UMRS 1028, Université Claude Bernard Lyon 1, Lyon, France. – France

Saccades are fast eye movements allowing to explore the world around us. While most of our saccades are triggered voluntarily based on our motivations and goals, they also can be driven by the sudden appearance of visual and/or auditory stimuli in our environment as well as of physical touches on our body ('tactile saccades'). Saccadic adaptation is a mechanism relying on cerebral plasticity that maintains the precision of our saccades throughout life. The functional loci(us) of saccadic adaptation as well as the nature of error signal driving this adaptation have been strongly debated, mostly based on studies of the adaptation of visual saccades. In contrast, whether tactile saccades can be adapted and whether this would potentially transfer to visual saccades remains unknown. In this study, we modified the double-step target paradigm (McLaughlin 1967) to try to induce adaptation of rightward saccades toward tactile targets consisting of electro-cutaneous stimulations delivered to the participants' fingers (Middle and Index). We also measured the rate of adaptation transfer to un-trained tactile saccades toward the other fingers (Pinky, Ring, and Thumb) as well as to un-trained visual saccades toward LEDs on the same fingers' locations. To control for unspecific changes in saccade amplitude, all 16 participants also performed a second session where no adaptation was induced (no double-step). The results showed that tactile saccades are adaptable, as reflected by the significant reduction of saccadic gain in double-step target trials as well as by the significant difference of saccadic gain between pre-adaptation and post-adaptation phases (as compared to no change in the control session). In addition, tactile saccades adaptation generalizes to un-trained saccades of different amplitudes in the same modality. Yet, despite this, tactile saccades adaptation did not transfer to visual saccades. These findings demonstrate for the first time that tactile saccades can be adapted and suggest that the adaptation loci(us) involve oculomotor circuits segregated from those underlying visual saccades. Also, concerning the nature of error signals used for adaptation, the existence of tactile saccades adaptation occurring without any post-saccadic visual feedback supports the sensory prediction error hypothesis.

Mots-Clés: Saccadic adaptation, Tactile saccades, Transfer

*Intervenant

Saccades to either visual or tactile targets can be adapted but with an asymmetrical cross-modality transfer

Ali Batikh * [1], Valérie Gaveau [1], Muriel Panouillères [1], Alessandro Farnè [1], Denis Pelisson [1]

[1] Centre de recherche en neurosciences de Lyon - Lyon Neuroscience Research Center – Equipe IMPACT, Centre de Recherche en Neurosciences de Lyon (CRNL), CNRS UMR 5292, INSERM UMRS 1028, Université Claude Bernard Lyon 1, Lyon, France. – France

Saccadic adaptation is a plasticity-based mechanism that allows to overcome the effect of fatigue, aging, neuronal and/or neuromuscular lesions on the precision of our saccades. The adaptation of reactive saccades made toward the sudden appearance of stimuli in our environment, is hypothesized to act on the motor command of saccades. As oculomotor command derives from the integration of multisensory information (visual, tactile, auditory) at the level of superior colliculus, we hypothesized that the adaptation of saccades toward targets in one modality (visual or tactile) should transfer to saccades in the other modality. To test this hypothesis we used the double-step target paradigm (Mclaughlin 1967) to adapt, in two separate experiments, rightward 'visual' or 'tactile' saccades made toward targets at different eccentricities on the participants' fingers (LEDs and electrodes generating skin stimulation, respectively). In each experiment the rate of adaptation induced for the trained saccades modality and the percent of adaptation transfer toward saccades of the un-trained modality were compared to those measured in a control session where no adaptation was induced (no double-step). Experiment 1 showed that the adaptation of visual reactive saccades transfers to tactile saccades toward the visually trained fingers (middle and index), furthermore, this adaptation transfer was also observed to untrained saccades made toward the other fingers in both tactile and visual modalities. Experiment 2 demonstrated for the first time that tactile saccades can be adaptable through our modified target double-step paradigm. However, despite the partial generalization of this adaptation to un-trained tactile saccades, there was no transfer of tactile saccades adaptation to visual saccades, contrasting with the visual-to-tactile transfer disclosed in Experiment 1. This asymmetrical transfer of adaptation across the two sensory modalities could be related to tactile saccades in our study being more voluntary than visual saccades or to partially segregated pathways for adaptation of tactile versus visual saccades. In conclusion, this study brings additional evidence for motor functional loci(us) of reactive saccades adaptation. In addition, the finding that tactile saccades can be adapted in the absence of post-saccadic visual feedback supports the hypothesis that a sensory prediction error drives saccadic adaptation.

Mots-Clés: Saccadic adaptation, Crossmodal transfer, Tactile saccades, Visual saccades

*Intervenant

Effect of juggling expertise on pointing performance in peripheral vision

Tristan Jurkiewicz * [1], Ludovic Delporte [1], Patrice Revol [1], Yves Rossetti [1], Laure Pisella [1]

[1] Centre de recherche en neurosciences de Lyon - Lyon Neuroscience Research Center – Université Claude Bernard Lyon 1, Institut National de la Santé et de la Recherche Médicale, Centre National de la Recherche Scientifique – France

Patients with a lesion of the posterior parietal cortex may present with optic ataxia, which causes an under estimation of retinocentric distances in the contralesional field. This results in hypometric pointing in peripheral vision. In contrast to this lesion, learning to juggle causes a hypertrophy of the grey matter of this same area which can be observed in MRI. Our hypothesis is that hypertrophy of the parietal cortex of jugglers would improve performance in peripheral vision, which fits with the subjective experience of jugglers' third eye.
We tested the peripheral vision pointing abilities of a group of novice and expert jugglers. In a peripheral vision target pointing task, six right visual field axes (±67.5○, ±45○ and ±22.5○) and three eccentricities on each axis (30○, 40○ and 50○).
Our analyses showed that the hypometries of both groups increased with target eccentricity. There was a significant decrease in hypometry in the upper visual field for the group of expert jugglers (i.e. compatible with the third eye tracking of the balls' trajectory peaks) whereas no difference was found in the lower visual field.
Our results and a previous study confirm that the parietal cortex is involved in the perception of peripheral visual space. Its mechanism of action may be a compensation of the cortical magnification of visual areas by attentional mechanisms. In the case of expert jugglers, the hypertrophy of the cortex could allow for a better focus of attention in the periphery and thus improve pointing performance.

Mots-Clés: peripheral vision, pointing, juggling

*Intervenant

Learning heterogeneous delays in a layer of spiking neurons for fast motion detection

Antoine Grimaldi * [1], Laurent Perrinet

[1] Institut de Neurosciences de la Timone – Aix Marseille Université : UMR7289, Centre National de la Recherche Scientifique : UMR7289, Aix Marseille Université, Centre National de la Recherche Scientifique – France

The response of a biological neuron depends on the precise timing of afferent spikes. This temporal aspect of the neuronal code is essential in understanding information processing in neurobiology and applies particularly well to the output of neuromorphic hardware such as event-based cameras. However, most artificial neuronal models do not take advantage of this minute temporal dimension. Inspired by this neuroscientific observation, we develop a model for the efficient detection of temporal spiking motifs based on a layer of spiking neurons with heterogeneous delays which we apply to the computer vision task of motion detection. Indeed, the variety of synaptic delays on the dendritic tree allows to synchronize synaptic inputs as they reach the basal dendritic tree. We show this can be formalized as a time-invariant logistic regression which can be trained using labeled data. We apply this model to solve the specific computer vision problem of motion detection, and demonstrate its application to synthetic naturalistic videos transformed into event streams similar to the output of event-based cameras. In particular, we quantify how the accuracy of the model can vary with the total computational load. This end-to-end event-driven computational brick could help improve the performance of future spiking neural network algorithms and their prospective use in neuromorphic chips.

Mots-Clés: time code, event, based computations, spiking neural networks, motion detection, efficient coding, logistic regression

*Intervenant

Is there an optimal stimulation rate for frequency-tagged visual word-selective responses?

Marion Marchive * [1], Bruno Rossion [1], Louis Maillard [1], Aliette Lochy [2]

[1] Centre de Recherche en Automatique de Nancy – Université de Lorraine, Centre National de la Recherche Scientifique – France
[2] Cognitive Science and Assessment Institute, Education, Culture, Cognition, and Society Research Unit, Université du Luxembourg – Luxembourg

Fast Periodic Visual Stimulation (FPVS) coupled with electroencephalography (EEG) has revealed a robust index of (pre)lexical representation over the left occipito-temporal cortex (Lochy et al., 2015). In this approach, words are inserted periodically (usually every 5th item) in rapid periodic streams (10Hz base stimulation) of non-words or pseudo-words. Discrimination responses for words in the EEG frequency domain (at 2Hz and harmonics) provide an objective and highly sensitive measure of visual recognition processes without requiring an explicit task (Lochy et al., 2015; 2018).
Here we use this paradigm to determine whether there is an optimal stimulation rate for frequency-tagged visual word-selective responses at the group level and if this rate varies across individuals as a function of their reading performance. Written words were periodically embedded (always at 1Hz) in streams of non-words (i.e., pre-lexical discrimination) or pseudo-words (i.e., lexical discrimination) presented at four different stimulation frequencies (4Hz, 6Hz, 10Hz and 20Hz). We also stimulated at 10Hz/2Hz for comparison with the original data (Lochy et al., 2015). 41 adult participants were tested both in EEG-FPVS and with a battery of reading tests.

Across all stimulation frequencies but 20 Hz, which was too fast for detecting meaningful responses, significantly higher amplitude for visual word-selective response were found in pre-lexical than lexical discrimination, replicating previous observations (Lochy et al., 2015). Amplitude and scalp topography differed according to stimulation rate, with the largest response over the left occipito-temporal cortex found at 4Hz/1Hz and at 10Hz/2Hz, two conditions for which responses did not differ in amplitude. For pre-lexical discrimination, responses were more bilateral at 4Hz/1Hz, but amplitude at this frequency only was significantly related with reading speed, i.e., the faster a person reads a word, the larger the amplitude of the word-selective response in lexical discrimination over the left occipitotemporal cortex.
These results suggest that optimal frequencies of stimulation as well as lateralization vary with the type of word-selective response. However, for lexical discrimination, 4Hz (i.e., SOA of 250 ms between items) seems to be the most adapted frequency to lead to a stronger left word-selective response that relates to reading performance.

*Intervenant

Mots-Clés: Lateralization, Reading, Frequency, tagging, Fast periodic visual stimulation, Electroencephalography

Corrélats neuronaux de la perception intra-saccadique du mouvement médiés par la fréquence rétinienne

Gaelle Nicolas * [1,2], Emmanuelle Kristensen [2], Michel Dojat [1], Anne Guerin-Dugue [2]

[1] [GIN] Grenoble Institut des Neurosciences – Institut National de la Santé et de la Recherche Médicale, Université Grenoble Alpes – France
[2] GIPSA - Vision and Brain Signal Processing – GIPSA Pôle Sciences des Données – France

La perception visuelle durant la saccade est une question centrale pour la compréhension de la représentation stable de notre environnement. Castet et Masson, (2000) ont montré que la perception consciente du mouvement du stimulus durant la saccade était possible en optimisant le stimulus visuel spatio-temporel à la bande passante des détecteurs au mouvement de la voie magnocellulaire. En reprenant ce principe, nous avons montré l'implication des structures corticales (V1-V2, MT/V5) lors de la perception intra-saccadique du mouvement (PISM) (Nicolas et al., 2021). Nous analysons ici l'évolution de leur activité en fonction de la fréquence temporelle rétinienne du stimulus durant la saccade.
Des enregistrements conjoints en EEG et oculométrie ont été réalisés sur 35 sujets effectuant une saccade horizontale vers une cible dont l'excentricité était fixée aléatoirement. Deux conditions étaient présentes : PISM possible suivant la vitesse pic de la saccade (Stim), ou non quelle que soit cette vitesse (Ctrl). La PISM est possible si la fréquence temporelle rétinienne du stimulus se situe dans la bande passante des détecteurs au mouvement de la voie magnocellulaire. Cette fréquence dépend des caractéristiques du stimulus et de la vitesse pic de la saccade. Cette fréquence est prise en compte dans l'estimation des potentiels évoqués par déconvolution utilisant une régression par spline adaptative. Les signaux EEG sont ensuite reconstruits dans différentes aires visuelles le long de la voie magnocellulaire (V1, V2, V3, et MT/V5), de la voie ventrale (V4), et dans les aires oculomotrices (FEF, IPS) à l'aide d'un atlas (Amunts et al., 2020).
Les résultats montrent des différences précoces entre les conditions à partir de 55 ms dans les aires V1, V2 et V3 et à partir de 87 ms dans l'aire MT/V5, mais pas dans l'aire V4 ventrale. De plus les conditions optimales de perception sont obtenues pour une fréquence temporelle rétinienne du stimulus variant entre 16 et 20 Hz. Ces résultats montrent l'implication de la voie magnocellulaire dans la PISM et le rôle central de la fréquence temporelle rétinienne comme médiateur de la PISM selon des fréquences en cohérence avec la bande passante des détecteurs au mouvement de la voie magnocellulaire.

Mots-Clés: Saccade, EEG, Oculométrie, voie magnocellulaire

*Intervenant

Effective connectivity of the right fusiform face area through concurrent intracerebral electrical stimulation and frequency-tagged visual presentation

Luna Angelini * [1], Bruno Rossion [1,2,3], Angélique Volfart [4], Corentin Jacques [2], Louis Maillard [1,3], Sophie Colnat-Coulbois [1,5], Jacques Jonas [1,3]

[1] Université de Lorraine – CRAN (UMR 7039 Université de Lorraine and CNRS) – France
[2] Université Catholique de Louvain = Catholic University of Louvain – Belgique
[3] Service de neurologie [CHRU Nancy] – Centre Hospitalier Régional Universitaire de Nancy – France
[4] Queensland University of Technology [Brisbane] – Australie
[5] Service de Neurochirurgie [CHRU Nancy] – Centre Hospitalier Régional Universitaire de Nancy – France

The neural basis of human face recognition has been extensively studied for decades. The key role of several face-selective brain regions in the ventral occipito-temporal cortex (e.g., in the fusiform gyrus and inferior occipital gyrus) has been established, but the functional organization of the cortical face network remains largely unknown.
To define the effective connectivity of this network, we apply direct electrical stimulation (DES) through intracerebral electrodes (SEEG) and combine it with fast periodic visual stimulation (FPVS). Electrodes implanted intracerebrally in drug-resistant epilepsy patients allow us to stimulate a local node of the network and record the functional activity of other implanted regions, with high spatial and temporal resolution.

We describe this original combination of techniques in one case: CJ, a right-handed 43-year-old woman with refractory focal epilepsy, excellent face recognition ability, and key implantations in face-selective regions of the right lateral fusiform gyrus (latFG; 'FFA') and bilateral ventral anterior temporal cortex (vATL). This specific patient is of note as it constitutes the first case of transient face identity recognition impairment induced by focal stimulation of the right FFA (Volfart et al., in prep). CJ was presented with 60-second sequences of natural images of familiar faces alternating at a 6Hz rate, while focal stimulation (1,2mA at 55Hz) was applied to the face-selective right latFG for 10s.

During stimulation, we found a reduction of significant 6Hz responses to famous faces not only locally (right latFG), but also in remote face-responsive electrodes of the right and left vATL. As these electrophysiological effects represent an explicit modulation of responses to familiar faces, they suggest functional connectivity between these areas. Interestingly, the stimulations that led to significant electrophysiological effects were also associated with the clearest behavioural impairment: during these stimulations, the patient was not able to recognize the famous faces displayed on the screen.

*Intervenant

Although these results concern only one patient, this original combination of techniques appears to be effective and its application on a wide sample of individual brains could provide key information regarding the connectivity of well-defined functional brain networks.

Mots-Clés: face recognition, cortical face network, effective connectivity, SEEG, FPVS, direct electrical stimulation

In dyslexic children, the proprioceptive therapy improves multisensory integration disorder and reading abilities. Pilot, randomized clinical study.

Luc Virlet * [1], Laurent Sparrow , Cedrick Bonnet

[1] Laboratoire Sciences Cognitives et Sciences Affectives - UMR 9193 – Université de Lille, Centre National de la Recherche Scientifique – France

Research shows that dyslexic children have multisensory integration disorders (MSID) when binocular fusion is dissociated in the form of sound-induced visual scotomas and labile vertical heterophoria. We tested whether proprioceptive therapy improves MSIDs correlated with reading issues in dyslexic children?
Three groups participated: dyslexic children with a speech therapy (n=9); dyslexic children with speech and proprioceptive therapies (n=10); normo-reader children (n=9). We evaluated silent reading (Eyetracker: Gaze duration, word frequency effect, initial saccade size) and oral (C index of Alouette-R test), in an initial session and after nine months of therapy. Registered on clinicaltrials.gov: NCT03448237.

When the proprioceptive therapy was added:

- MSIDs significantly improved for sound-induced scotoma and labile vertical heterophoria.

- Saccade size, lexical access, and word frequency effects no longer differed from normo-reader children.

- The C-index showed a gain of +2.09 SD, (d=0.99).

- These improvements were significantly correlated with each other.

We validated our hypothesis that improvement of MSIDs improves oral and silent reading skills in dyslexic children.
We will discuss the strengths and limitations of this study, and the implications of these results.

Mots-Clés: Multisensory integration disorder, Proprioception, Dyslexia, Sound, induced scotoma, Labile vertical heterophoria

*Intervenant

What determines the next target selection in visual foraging? New insights from the study of individual differences

Jérôme Tagu * [1]

[1] Laboratoire de Psychologie EA4139 – Université de Bordeaux – France

While in "classic" single-target visual search tasks observers are asked to report whether a single target is present or absent, in visual foraging tasks they are asked to select multiple instances of multiple target types, as fast as they can. Research on human visual foraging has increased our understanding of how attention is allocated in the visual environment, and has highlighted important individual differences in foraging behaviour. Specifically, as participants are free to select the targets in any order, important individual differences may arise on selection order and selection time. Our aim is to better understand these individual differences by characterizing the mechanisms that drive target selection in visual foraging. In three experiments, we tested the influence of target proximity, value, reward and emotional valence on foraging behaviour. The results reveal influences of all manipulations on selection order and selection time. These results and the analysis of individual differences suggest that target selection during visual foraging is determined by the competition between several factors, including target value, target proximity, priming of features, and emotional valence, that orient attention towards one particular target in the environment. We suggest that individuals may show different by-default internal biases towards these factors that determine their foraging strategy and behaviour.

Mots-Clés: Foraging, Visual search, Visual attention, Target selection

*Intervenant

Optic flow processing in the elderly

Jade Guénot * [1,2], Yves Trotter [1,2], Angélique Delaval [1,2], Robin Baurès [1,2], Vincent Soler [1,2,3], Benoit Cottereau [1,2]

[1] Centre de recherche cerveau et cognition – Université Toulouse III - Paul Sabatier – France
[2] Centre National de la Recherche Scientifique, Toulouse Cedex – CNRS : UMR5549 – France
[3] Service d'Ophtalmologie [Hopital Purpan - Toulouse] – CHU Toulouse [Toulouse] – France

Aging impacts human observer's performance in a wide gamut of visual tasks and notably in motion discrimination. However, it remains unclear how the elderly are affected in their ability to process optic flow, the pattern of motion that falls on the retina during locomotion. Some studies found age effects on the discrimination of radial patterns while others did not. Also, perception of rotational patterns has only been little explored in the elderly. Here, we characterized optic flow processing in 42 participants over 70 years old (mean age: 73.83 ± 4.53) and 17 under 30 years old (mean age: 24.65 ± 4.41). All participants had a corrected visual acuity over 7/10 and reported no ophthalmological problems. Stimuli consisted of dynamic random-dot kinematograms (RDKs) projected on a wide and curved screen (56○ x 44○). For each of the three components of optic flow (translational, radial and rotational), participants were involved in a 2-alternative forced choice task (2-AFC) and had to report their perceived motion direction (leftward versus rightward for translational, inward versus outward for radial and clockwise versus anti-clockwise for rotational patterns). We manipulated motion coherency (i.e. the percentage of dots moving in the same direction) and estimated the thresholds corresponding to 80% of correct detection using an adaptive Bayesian procedure. From ANOVA and post-hoc statistical analyses, we found that older participants had higher thresholds for translational (27.97 ± 18.26 vs 17.3 ± 8.53 for the younger) and radial patterns (22.91 ± 17.14 vs 9.56 ± 6.11) but not for rotational patterns (19.1 ± 13.14 vs 25.66 ± 12.2). These thresholds were not affected by the addition of a 10○ simulated scotoma in central vision. Reaction-times were also longer for all conditions in the elderly, which suggests that perceptual decision-making is slowed down in this population. Altogether, our results support the idea that optic flow processing mostly relies on peripheral vision in young and elderly participants and that selectivity to translational and radial patterns decreases with age.

Mots-Clés: optic flow, aging, motion processing, simulated scotoma

*Intervenant

A paradox of perceived speed and location in the Fröhlich effect

Pascal Mamassian * [1]

[1] Laboratoire des systèmes perceptifs, Département d'études cognitives, École normale supérieure, PSL Research University, CNRS, 75005 Paris, France – Ecole Normale Supérieure de Paris - ENS Paris – 29 rue d'Ulm; 75005 Paris, France

In the Fröhlich effect, the initial position of a moving object tends to be mislocated in its direction of motion. Not too surprisingly, when the duration of the movement is short, the magnitude of the spatial bias is also small. This motion duration property of the Fröhlich effect is a challenge for most existing models that predict little or no effect of duration. We measured localisation biases at the onset of moving objects in a psychophysical experiment using a forced-choice method. To reduce the effects of spatial and temporal predictability, two vertical lines were flashed one above the other at random spatial locations and random times. One of the two lines was set in motion as soon as it appeared, and the other remained static. Observers were instructed to report whether the top line was to the right or the left of the bottom one. Spatial offsets were controlled by interleaved staircases. We found that the magnitude of the spatial bias increases greatly with motion duration and reaches a plateau at about 200ms. Interestingly, before reaching the plateau, spatial biases were almost as large as the full trajectory of the object, suggesting that the moving object was almost perceived static. In a separate experiment, we measured the perceived speed for different durations and found a large over-estimation of perceived speed for durations shorter than about 200ms. Therefore, there seems to be a paradox in that the same moving object appears both almost static and moving very fast.

Mots-Clés: motion perception, time perception, spatial localization

*Intervenant

Spatio-temporal power of the cortex

David Alexander * [1], Laura Dugué [2,3]

[1] Université Paris Cité, CNRS, Integrative Neuroscience and Cognition Center, F-75006 Paris – Université Paris Cité, CNRS, Integrative Neuroscience and Cognition Center, F-75006 Paris, Universite Paris Cite, CNRS, Integrative Neuroscience and Cognition Center, F-75006 Paris – France
[2] Université Paris Cité, CNRS, Integrative Neuroscience and Cognition Center, F-75006 Paris – Université Paris Cité, CNRS, Integrative Neuroscience and Cognition Center, F-75006 Paris, Universite Paris Cite, CNRS, Integrative Neuroscience and Cognition Center, F-75006 Paris – France
[3] Institut Universitaire de France – Institut universitaire de France, Institut universitaire de France – France

Cortical activity not only oscillates in time (e.g., alpha-band) but also displays monotonic phase shifts over space. During visual tasks, these traveling waves (TWs) have been described in visual cortex and related regions over a range of spatial scales, from columns in V1 to global cortex using MEG/EEG measures. The waves indicate a dominance of low *$spatial$* frequency components i.e., large-scale patterns of activity from millimetres to decimetres. In visual neuroscience, the method of differencing between experimental conditions and use of source localization techniques tend to emphasize local foci of activity, limited only by the measurements' spatial resolution. The implied spatial frequency spectrum peaks at higher frequencies.
Previous analyses of cortical activity have revealed an approximately $1/(f\hat{}m)$ spatial spectrum, where the positive exponent m varies depending on whether the observations are (a) at the cortical surface (e.g., ECoG) or (b) extra-cranial (e.g., EEG). Spectra may differ due to the spacing of electrodes-finer sampling in (a) giving smaller m and a higher cut-off for the minimum measurable spatial frequency. These measurement effects de-emphasize large-scale patterns. The volume conduction effects in (b) give larger m and emphasize large-scale patterns. In either case, the measured cortical activity is dominated by low spatial frequency components (hence $1/(f\hat{}m)$ within the measurable spectrum), more consistent with TW activity and less with foci of activation in real-time signal.
We sought to clarify the relation between observed TWs and focal activations by simultaneous measurement of spatio-temporal dynamics at two different spatial scales, i.e., depth (sEEG) and surface (ECoG) cortical contacts, while participants (n=9) performed a visual categorization task. Estimation of the spatial frequency spectrum in sEEG and ECoG is hampered by the shape of the cortex and contacts' spacing. The spatio-temporal dynamics for each set of contacts was decomposed into spatial and temporal modes using singular value decomposition. From these components we computed the spatial frequency spectra of the activity. sEEG and ECoG components with the lowest spatial frequencies accounted for more variance in the signal than high spatial frequency components. The quantified spectra are consistent with dominance of TWs over focal activations.

Mots-Clés: cortex, spectra, visual, traveling waves, sEEG, ECoG

*Intervenant

Substantial failures to detect faces due to redundancy masking

Bilge Sayim * [1,2], Li L-Miao , Yu R. Dandan , Bert Reynvoet

[1] University of Lille – SCALAB UMR CNRS 9193 – France
[2] University of Bern – Suisse

In redundancy masking (RM), items in repeating patterns are lost. For example, when presented with 3 identical letters in the periphery, observers frequently report only 2 letters. Here, we investigated if highly complex, socially relevant stimuli were subject to RM. In Experiment 1, three to six identical faces, shape-matched outlines, and luminance-matched noise patches were presented randomly to the left or right of fixation at 10∘ eccentricity. The edge-to-edge spacing between items was varied. Item size and the spacing between them were well above the resolution limit. Participants were asked to indicate the number of items (1-9). In Experiment 2, three to six identical upright or upside-down faces were presented. Participants indicated the number of faces and their orientation (upright or upside-down). There was strong RM in both experiments: the reported number of items was lower than the actual number, even for as few as three items. In Experiment 1, this effect was stronger for outlines and noise patches compared to faces. In Experiment 2, orientation discrimination performance was similarly high (above 89% correct in all conditions) in trials with and without RM (but higher in trials without RM compared to RM when the faces were small). Our results showed that observers frequently failed to report faces even when only three faces were presented. The substantial failure to detect faces shows the strong impact of RM on conscious vision. We suggest that RM is a key mechanism that compresses redundant visual information.

Mots-Clés: peripheral vision, redundancy masking, crowding, detection

*Intervenant

Using the Contingency Discrimination Model to predict changes in saccade latency distributions in a concurrent reinforcement procedure

Laurent Madelain * [1]

[1] Univ. Lille, CNRS 9193 - SCALab - Sciences Cognitives Sciences Affectives, F-59000 Lille – Univ. Lille, CNRS, CHU Lille – France

Vullings & Madelain (2018) used a concurrent random-interval reinforcement schedules in which the probabilities of reinforcing short and long saccade latencies were manipulated. They found that latencies changed following the generalized matching law (Baum, 1973) as the relative frequencies of short and long latencies matched the relative frequencies of reinforcement. These results established that reinforcer contingencies affect the allocation of saccades in time. Here we adapted the Davison's Contingency Discrimination Model (Davison & Cowie, 2022), which postulates that a reinforcer is an event that signals the contingencies in force, to account for the observed changes in saccade latency distributions. A central aspect of Davison's approach is that choices should follow the discriminated rather than the actual availability of reinforcers so that future behavior depends on the generalization across the spatial and temporal properties of these events. Using the reinforced saccade latency distributions (about 20% of all trials) we were able to adequately account for the distributions of unreinforced saccade latencies (about 80% of all trials). Because saccades generate information about the state of the world, i.e. the actual reinforcement contingencies, past saccades may control future saccades by signalling which might produce appetitive, or more generally fitness-enhancing, events and which might produce aversive, or fitness-reducing, events.

Mots-Clés: Saccade latency, Choice, Reinforcement, Model

*Intervenant

Neuromorphic saliency detection of multiple objects of interest in an event based scene

Amélie Gruel * [1], Jean Martinet [2]

[1] Laboratoire dÍnformatique, Signaux, et Systèmes de Sophia Antipolis – Université Nice Sophia Antipolis (... - 2019), COMUE Université Côte dÁzur (2015 - 2019), Centre National de la Recherche Scientifique : UMR7271, Université Côte d'Azur, COMUE Université Côte dÁzur (2015 - 2019) – France
[2] Laboratoire d'Informatique, Signaux, et Systèmes de Sophia Antipolis – Université Nice Sophia Antipolis (1965 - 2019), Centre National de la Recherche Scientifique, Université Côte d'Azur – France

The joint use of silicon retinas (Dynamic Vision Sensors, DVS) and Spiking Neural Networks (SNNs) is a promising combination for dynamic visual data processing. Both technologies have recently emerged separately about a decade ago from electronics and neuroscience communities, sharing many features: biological inspiration, temporal dimension, model sparsity, aim for a higher energy efficiency, etc.

However, traditional and neuromorphic computer vision models can have difficulties handling a great amount of data simultaneously while minimising their energy consumption, especially at a high temporal resolution. A recent study shows that in certain lightning conditions, high resolution event cameras produce data susceptible to temporal noise and with an increasingly high per pixel event rate, thus leading to the decreased performance of some traditional computer vision tasks (1). A remedy for such an issue could be found in event data downscaling (2) — however the trade-off between information retention and data reduction with existing methods is not yet ideal.

We thus believe that applying visual attention to selectively acquire relevant information is a more appropriate approach to optimise the on- and off-line processing of event data. In order to test this theory, we have implemented in a first iteration a neuromorphic spatio-temporal attention using adaptive mechanisms (3) on CPU, Loihi and SpiNNaker. This model detects regions with higher event density by using inherent SNN dynamics combined with online weight and threshold adaptation.

We are now presenting a new model allowing for the simultaneous detection of multiple regions of interest in event data, solely relying on the intrinsic dynamics of SNN. This novel approach is promising for many relevant computer vision tasks such as simultaneous object classification. This model can detect a limited number of regions of interest at a time, and we will work towards a model that intrinsically adapts to the number of objects of interest in the scene.

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*Intervenant

Mots-Clés: spiking neural networks, event based camera, visual attention, neuromorphic

The neural basis of Face Identity Recognition in macaques with fMRI frequency-tagging

Marie-Alphée Laurent * [1], Pauline Audurier [2], Jean-Baptiste Durand [2], Jacques Jonas [1,3], Bruno Rossion [1], Benoit Cottereau [2]

[1] Centre de Recherche en Automatique de Nancy – Université de Lorraine, Centre National de la Recherche Scientifique – France
[2] Centre de recherche cerveau et cognition – Université Toulouse III - Paul Sabatier, Centre National de la Recherche Scientifique, Toulouse Mind Brain Institut – France
[3] Service de neurologie [CHRU Nancy] – Centre Hospitalier Régional Universitaire de Nancy – France

The face has great significance for social interactions in primates and is the most diagnostic information for identifying specific individuals. While monkeys appear particularly proficient at recognizing gaze, head orientation, and facial expressions, their ability to perform face identity recognition beyond image-based discrimination and similarly to humans is questionable (Rossion & Taubert, 2020). Having recently validated a powerful frequency-tagging fMRI face localizer (Gao et al., 2018) for non-human primate imaging (Laurent et al., in revision), here we extend this approach to target the neural basis of monkeys' recognition of variable natural images of facial identities. FMRI recordings were performed in two awake macaques. Natural images of a single unfamiliar identity were presented within a rapid 6Hz stream in two conditions: (1) with the same image across low-level (size, luminance, contrast) changes only, or (2) different images (background, head orientation, expression) changes additionally. Every 9s during a 243s run, variable natural images of 7 different unfamiliar identities were introduced in bursts. Either human or monkey faces, upright and upside-down, were presented. Analyses were performed in the Fourier domain where individual face discrimination responses were objectively identified and quantified, at the peak of the identity change frequency (0.111Hz), and its second harmonic (0.222Hz). Analyses focused on monkey face-selective regions defined with our functional frequency-tagging localizer, mainly in the STS (clusters PL, ML, MF, AL, AF). In all these regions, image-based individual face discrimination responses were found in both monkeys for condition 1, with a significant reduction for inverted faces in one monkey. Responses were negligible in condition 2, with little evidence of significant inversion effect for human and monkey faces. In contrast, preliminary evidence from two human subjects tested in the same paradigm indicates robust individual discrimination effects across both conditions in their core-selective ventral regions (OFA, FFA) and exhibits large inversion effects, restricted to conspecific face pictures. This extension of the frequency-tagging fMRI approach provides the first evidence of fMRI adaptation to different face identities in non-human primates. However, contrary to humans, this effect appears to be essentially restricted to image-based discrimination, with no evidence of significant advantage for conspecific faces.

*Intervenant

Mots-Clés: face identity discrimination, macaque, fMRI, vision, nonhuman primate, frequency tagging, face inversion

Virtual reality and visual impairment: A comparative analysis of performance in a head-contingent task between patients with visual impairment and control subjects

Vasiliki Myrodia * [1], Aurélie Calabrèse [1], Ambre Denis-Noël [1], Frédéric Matonti [2], Pierre Kornprobst [3], éric Castet [1]

[1] Aix-Marseille University – LPC, CNRS – France
[2] Centre Monticelli Paradis d'Ophtalmologie, Marseille – Centre Monticelli Paradis d'Ophtalmologie – France
[3] Université Côte d'Azur, Inria – Biovision Lab – France

Virtual reality (VR) offers innovative perspectives in the field of visual impairment. The general and exploratory goal of this study is twofold. First, we investigate how well patients can perform a pointing task in a VR environment compared to normally sighted controls. Second, we assess whether the individual characteristics of patients' scotoma correlated with their pointing task performance. Normally sighted and visually impaired subjects performed a head-contingent task developed with PTVR (https://ptvr.inria.fr/). Subjects had to move their head to point with a gaze-contingent reticle at a static target in the virtual environment. Pointing had to be maintained for 2 sec to be validated. A timeout occurred after 30 sec without valid pointing. Reticle position in the headset's viewport was either in the center (centered condition) or 10∘ away from the center, at one of 8 possible half-meridians (eccentric condition). An additional perimetric exam was conducted for patients using a microperimeter (MP-3 Nidek Inc.), thus providing information about the scotoma's position, size, and shape. We measured the time needed to achieve valid pointing. We also estimated the percentage of correct trials during the experiment. Linear mixed-effects models were used to analyze the effect of the different conditions on reaction time. Our preliminary data (N=8) show that visually impaired subjects are able to perform our head-contingent task. However, reaction times were longer in the patient's group (mean, 9.2 sec) than in the control group (mean, 2.2 sec). The mean reaction time was homogeneous for control subjects whatever the position of the reticle. Patients had a lower percentage of correct trials (89.8%) than normally sighted subjects (99.7%). Patients' results indicate an anisotropy of pointing performance across the reticle's positions. Further investigation of microperimetry data will help us understand how this idiosyncratic anisotropy may be related to the characteristics of each patient's scotoma. These data will lay the ground for new rehabilitation tools based on pointing tasks.

Mots-Clés: Pointing, Virtual reality, Head, contingent task, Central vision loss, Scotoma, Mi-

*Intervenant

croperimetry

The effect of short-term monocular deprivation depends on the duration of deprivation: evidence from binocular rivalry and binocular combination.

Antoine Prosper * [1], Claudia Lunghi , Maria Concetta Morrone , Martina Pasqualetti

[1] Laboratoire des systèmes perceptifs – Département d'Etudes Cognitives - ENS Paris, Centre National de la Recherche Scientifique – France

The ocular dominance (OD) shift observed after short-term monocular deprivation (MD) is a widely used measure of visual homeostatic plasticity in adult humans. Binocular rivalry and binocular combination techniques are used interchangeably to characterize homeostatic plasticity, sometimes leading to contradictory results. Here we directly compare these two techniques by investigating the impact of the MD duration on OD in adult humans.
We measured the effect of 15 minutes and 120 minutes of MD in 25 adult volunteers. OD was assessed either by binocular rivalry (BR, orthogonal gratings: size 2∘x2∘, SF: 2 cpd, contrast 60%) or binocular phase combination (BC, sinusoidal gratings, size: 3.5∘x3.5∘, SF: 1 cpd, base contrast: 50%). Each subject underwent four deprivation sessions (2 durations x 2 conditions) in separate days and in a counterbalanced order.

We found that the effect of MD exhibited a strong dependence on the deprivation duration (BR: 15min vs. 120min: $F(1,24)=34.146$ $h2=0.302$, $p< 0.001$; BC: $F(1,24)=49.080$ $h2=0.295$, $p< 0.001$), with longer deprivation inducing a stronger and longer-lasting effect for both techniques. We found that the mean OD measurements post-deprivation correlate strongly across participants for both durations (15 minutes: $r=0.74$, $p< 0.001$; 120 minutes: $r=0.654$, $p< 0.001$), while the effect of MD does not (15 minutes: $r=0.173$, $p=0.41$; 120 minutes: $r=0.235$, $p=0.26$). Taken together, our results show that the effect of short-term MD strongly depends on the duration of deprivation for both BR and BC, but that each technique may capture different aspects of the effect of MD on OD.

Mots-Clés: ocular dominance plasticity, binocular rivalry, binocular combination, bistable perception, short term monocular deprivation

*Intervenant

Uncertainty in, uncertainty out: epistemic variance improves encoding of natural images

Hugo Ladret * [1], Laurent Perrinet *

1

[1] Institut de Neurosciences de la Timone – Aix Marseille Université : UMR7289, Centre National de la Recherche Scientifique : UMR7289, Aix Marseille Université, Centre National de la Recherche Scientifique – France

Aleatoric uncertainty characterizes natural images and echoes the epistemic uncertainty ubiquitously found in sensory systems. We propose that the former helps encode the latter, and perform a manipulation of the epistemic uncertainty of a convolutional sparse coding algorithm to do so.
Using a fast method of dictionary generation, we show that encoding oriented features across multiple levels of epistemic uncertainty significantly improves the reconstruction of natural images. Such an encoding scheme balances the distribution of the epistemic uncertainty of the model, which matches the multiple aleatoric uncertainty levels of its input.
Overall, this orientation/uncertainty code is well captured by a Dirac Laplacian function and can be pruned, for any natural image, to obtain additional sparsity boost with minimal image encoding performance loss.
Finally, we demonstrate how hierarchical visual processing can benefit from encoding uncertainty, by training a deep-learning convolutional neural network to classify sparse-coded CIFAR-10 datasets, showing that encoding uncertainty translates into a resilient and re-usable representation of naturalistic images.
Overall, this work empirically demonstrates the computational advantage of partitioning epistemic uncertainty in computer vision algorithms.

Mots-Clés: uncertainty, sparse, coding, vision, v1, natural, images

*Intervenant

Impact of Osteopathic Manipulative Treatment on Smooth Pursuit Eye Movements in Healthy Human Adults : A Randomized Clinical Trial.

Adrien Paire * [1], Rémi Wogue [2], Loïc Demoury [2], Christelle Cornille [2], Inès Pillevesse [2], Emma Holt [2], Agathe Launay [1], Alexandre Borwin [2], Céline Paeye [1]

[1] Vision Action Cognition – Université de Paris Cité – France
[2] Ecole d'Ostéopathie de Paris – Ecole d'Ostéopathie de Paris – France

The idea that osteopathic manipulative treatments (OMTs) have an impact on the human visual system is not new. This hypothesis is based on the restoration of the fascial system elasticity (i.e., the connective tissue enclosing all our organs, including the eyes) by OMTs. However, to date, there is no empirical evidence to support this hypothesis.
We conducted a randomized, double-blind, controlled study to evaluate the effect of an OMT on smooth pursuit in healthy young adults (aged 18 to 35 years). A total of 95 participants were randomly allocated to three groups. Each group performed two tests of 40 smooth pursuit trials. Between these tests, one of the groups was treated with an OMT, the second group received a sham treatment and a control group discussed with the practitioner without being touched.

In all groups, smooth pursuit duration (i.e., time spent to track a moving target without saccades) increased and latency (i.e., time elapsed between target onset displacement and ocular pursuit initiation) decreased between the two tests. Nevertheless there was no greater improvement in smooth pursuit for the OMT group as compared to the other two groups.

These preliminary results confirmed that procedural learning of smooth pursuit occurs within 40 trials, but failed to support the hypothesis of oculomotor enhancement by OMT. Further studies should focus on elderly volunteers or populations with oculomotor disorders.
Note : This study has been pre-registered on Clinicals Trials : https://clinicaltrials.gov/ct2/show/NCT0501839

Mots-Clés: Osteopathic Manipulative Treatment (OMT), Smooth Pursuit Eye Movements, Oculomotor System.

*Intervenant

Interactions between central and peripheral vision rely on the retinotopic processing of spatial frequencies

Cynthia Faurite * [1], Eva Aprile [1], Louise Kauffmann [1], Martial Mermillod [1], Benoit R. Cottereau [2], Carole Peyrin [1]

[1] Laboratoire de Psychologie et NeuroCognition – Université Savoie Mont Blanc, Centre National de la Recherche Scientifique, Université Grenoble Alpes – France
[2] Centre de recherche cerveau et cognition – Institut des sciences du cerveau de Toulouse., Université Toulouse III - Paul Sabatier, Centre National de la Recherche Scientifique – France

Visual scene perception is based on reciprocal interactions between central and peripheral information. Such interactions are commonly investigated through the semantic congruence effect. The aim of the present study was to investigate whether congruence effects between central and peripheral vision rely on the bottom-up retinotopic processing of spatial frequencies (low spatial frequencies mainly in peripheral vision and high spatial frequencies mainly in central vision) or on top-down predictive processes (based on the rapid extraction of low spatial frequencies irrespective of their position in the visual field). We presented simultaneously two stimuli of different retinal eccentricity, one central and one peripheral, that could be either semantically congruent (belonging to the same scene image) or incongruent (belonging to two different scene images from different categories). In one experimental session assessing the congruence effect of central vision on peripheral vision, participants had to categorize the peripheral target stimulus (as an indoor or an outdoor scene) while ignoring the central distractor stimulus. In another session assessing the congruence effect of the peripheral vision on central vision, they had to categorize the central target stimulus while ignoring the peripheral distractor stimulus. Distractors were either filtered in low spatial frequencies (LSF) or in high spatial frequencies (HFS) while the target was unfiltered. Preliminary results showed a main congruence effect: mean correct response times were slower when the central and the peripheral stimuli were semantically incongruent than congruent. Importantly, the congruence effect of central vision on peripheral vision was significant only when the central distractor was filtered in HSF while the congruence effect of peripheral vision on central vision was significant only when the peripheral distractor was filtered in LSF. These results support the hypothesis that interactions between central and peripheral vision rely on the bottom-up retinotopic processing of spatial frequencies, although the presence of top-down mechanism in peripheral vision cannot be totally ruled out. This study has important clinical implications for patients suffering from macular degeneration. It suggests that, in addition to the central vision loss, patients may no longer benefit from central-peripheral interactions to process the information in their residual peripheral vision.

*Intervenant

Mots-Clés: Scene perception, central vision, peripheral vision, spatial frequencies, bottom, up processes, top, down processes

Effects of the color of the target as a motion cue for anticipatory smooth eye movements in humans

Raphaëlle Radenne * [1], Laurent Madelain [1]

[1] Laboratoire Sciences Cognitives et Sciences Affectives - UMR 9193 – Université de Lille, Centre National de la Recherche Scientifique – France

When the motion of a target is predictable, the eyes sometimes move ahead of the target during smooth pursuit. These anticipatory smooth eye movements (ASEM) may be evoked by cues signaling the future direction of the target in a two-paths tube (Kowler et al., 2014). Most of the cues tested in the literature are symbolic cues that do not require learning, such as a barrier blocking the wrong path, an arrow pointing to the future path, or a bar indicating the probability that the target will follow each of the paths (Santos & Kowler, 2017). A non-symbolic cue, the color of the target, also evoked ASEM in monkeys. Here we tested the effects of the target color as a motion cue in humans, using the conventional two-paths tube method. We hypothesized that visual cues might be less efficient to evoke ASEM than symbolic cues because they require learning, which may be difficult because the target color does not naturally impact smooth pursuit eye movements. This hypothesis is based on the concept of biological constraints on learning, postulating that signals need to naturally affect a response to be effective predictors and to come to control the response (Domjan, 2014).

Mots-Clés: smooth pursuit, anticipatory smooth eye movements, learning, visual cue

*Intervenant

Compensating the size-eccentricity effect with saccade generation

Jad Laaboudi * [1], Anne Hillairet De Boisferon [2], Céline Paeye [1]

[1] Vision Action Cognition – Université Paris Cité – France
[2] Laboratoire de Psychologie des Cognitions – université de Strasbourg – France

Visual attention is known to enhance perception of saccadic targets' orientation, contrast and spatial resolution. In this pre-registered study, we evaluated whether preparing a saccade could improve size perception of objects appearing before the saccadic compression timeframe. Participants (N=19) performed a judgment task in which they had to compare a test disk of varying size briefly presented in peripheral vision to a reference disk appearing about 550 ms later in foveal vision. Psychometric function parameters were computed. When no saccade was made toward the test disk location, its size was underestimated, as expected for objects presented in the periphery. However, Points of Subjective Equality were near objective equality when participants initiated saccades 200 ms after the extinction of the test disk. This refinement in size perception seems to indicate that attention coupled to saccade preparation could overcome perceptual distortion (size-eccentricity effect) in the visual field, likely by magnifying peripheral objects' size.

Mots-Clés: Action, perception, Visual attention, Saccades

*Intervenant

Effects of the nature of the context on contextual saccadic adaptation

Maxime Martel * [1], Laurent Madelain [1]

[1] Laboratoire Sciences Cognitives et Sciences Affectives - UMR 9193 – Université de Lille, Centre National de la Recherche Scientifique – France

Contextual saccadic adaptation is studied with a variant of the double step saccade adaptation paradigm, in which the direction of the intra-saccadic step (ISS) is signaled by two different contexts. This allows to simultaneously inducing two distinct saccadic adaptation states. Importantly, effective contextual adaptation is not always observed: e.g. it occurs when the amplitude of the first step serves as context, but not when using the target color or shape. Our study compares different types of contexts. All experimental sessions are based on the same contextual adaptation procedure, the only difference being the context used. We tested seven different contexts : (1) the duration of a visual stimulus, (2) the lateralization of a sound in space, (3) the pitch of a sound, (4) the statistical regularity across trials, and (5) a symbolic cue, as well as (6) the amplitude of the first step and (7) the target color and shape to compare our results with previous studies. We collected data from 23 participants (out of the planned 90). Fisher's test revealed an effect of the context with the amplitude of the first step condition in all participants, and with the symbolic cue for one participant (out of 4). The Kolmogorov-Smirnov distance confirms a large contextual effect for the amplitude, but not for the other contexts. The lack of contextual learning reveals that predicting the intra-saccadic step is relatively difficult and strongly depends on the nature of the context, even for highly salient contexts that are perfectly correlated with the ISS. The correlation between context and ISS is not sufficient for learning, even for non-visual contexts. A similar effect, termed selective learning or biological constraints on learning, has been previously reported in pavlovian and operant conditioning animal studies.

Mots-Clés: Saccadic adaptation, selective learning

*Intervenant

A survey of the contribution of a retinotopic transformation on a visual task

Jean-Nicolas Jeremie * [1], Emmanuel Daucé [2], Laurent Perrinet [1]

[1] Institut de Neurosciences de la Timone – Aix Marseille Université : UMR7289, Centre National de la Recherche Scientifique : UMR7289, Aix Marseille Université, Centre National de la Recherche Scientifique – France
[2] École Centrale de Marseille – Centre National de la Recherche Scientifique - CNRS – France

Foveated vision is characteristic of many animal species, including humans. Understanding the function of this retinotopic mapping, especially in comparison to other species that lack this feature, is still an open debate. With respect to the generality and difficulty of this task, a scientific question is to understand how this is achieved. Here, we propose that a retinotopic mapping may be one essential ingredient in that efficiency and study the advantages of this transformation in the context of image classification. Inspired by this neuroscientific observation, we decided to exploit the potential of artificial neural networks to test our hypothesis and retrained several networks on a categorization task. We use a logarithmic polar mapping which can be directly used to transform the input to classical deep learning classification algorithms using a Convolutional Neural Networks (CNN). We chose to implement a transfer learning protocol on VGG16 networks, which offers a good compromise between computation time and accuracy. We apply this architecture to the recognition of the presence of an animal in the image. First of all, the network is still able to categorize the presence of an animal in logarithmic polar space with more than 90% accuracy rate. Second, compared to a similar network trained with images in linear space, it retains good categorization robustness when exposed to a geometric transformation such as a rotation. Moreover, using a saliency map protocol we qualitatively find that the retinotopic transformation improves the robustness and the localization of image classification when it is directed towards an isolated object. This opens perspectives for the use of the logarithmic polar mapping in models of visual search, in particular by introducing biologically-inspired saccades in computer vision algorithms to efficiently localize and detect targets.

Mots-Clés: deep learning, vision, retinotopy, visual search, VGG16

*Intervenant

Action influences perception of occlusion duration in prediction- motion tasks

Xuening Li * [1,2], Robin Baures [2], Sylvain Crémoux [2]

[1] Université Toulouse III - Paul Sabatier – Centre national de la recherche scientifique - CNRS (France) – France

[2] Centre de recherche cerveau et cognition – Institut des sciences du cerveau de Toulouse., Université Toulouse III - Paul Sabatier, Centre National de la Recherche Scientifique – France

Background: Correct prediction of occluded object's motion relies on the ability to determine spatiotemporal characteristics of the moving object before its occlusion. Interestingly, any tasks performed before the occlusion distorts perceived velocity of the moving object which results in altered perception of occlusion duration. Less is known when task is done during occlusion. This study investigates the influence of a motor action on prediction motion (PM) performance in two experiments.
Methods: In Experiment 1, 15 participants had to evaluate whether a moving disc reappeared from occlusion too early or too late giving its initial velocity. Participants concurrently had to perform one action at 4 possible Action Times (- 0.5s; 0.2s; 0.75s; 1.3s according to occlusion onset) indicated by a visible green target. Experiment 2 had similar design but included 2 Action Conditions (Action vs. No Action) and 2 Action Times (- 0.5s; 0.75s according to occlusion onset). Action Condition was indicated by the color of the target. For both experiments, individual psychometric functions were computed to determine the Point of Subjective Equality (PSE) and Just Noticeable Difference (JND) in each condition which reflects the PM performance and precision. ANOVAs were performed to evaluate effects of Action Times and Action Conditions on PSE and JND.

Result: Experiment 1 showed a significant effect of Action Time on the PSE. The PSE was significantly negative only for the condition of Action Time -0.5 s, and not different from 0 in the other Action Time levels. Experiment 2 revealed a main effect of Action Condition and a significant interaction between Action Condition and Action Time on the PSE. Specifically, when participants acted in the 0.75 s condition, the PSE was significantly higher than the PSE of all the other conditions. A significant effect of Action Condition was also revealed on JND.
Conclusion: A shift toward positive PSE was observed on temporal estimation only when concurrent hand movement was performed during the occlusion, indicating a tendency to underestimate the duration of occlusion.

Mots-Clés: Keywords: movement, time perception, prediction motion, motion extrapolation

*Intervenant

The role of perceptual confidence in decision-making and its pupillary correlate during the interaction with a human and machine partner

Rémi Sanchez * [1,2], Anne-Catherine Tomei , Pascal Mamassian , Manuel Vidal , Andrea Desantis

[1] Institut de Neurosciences de la Timone – Aix Marseille Université : UMR7289, Centre National de la Recherche Scientifique : UMR7289, Aix Marseille Université, Centre National de la Recherche Scientifique – France
[2] DTIS, ONERA [Salon] – ONERA – France

Every decision we make is accompanied by a sense of confidence. Confidence mechanisms enable us to evaluate how good our perceptual representations are and it is thought to play a critical role in guiding decision-making. However, only a few empirical studies have actually investigated the function of perceptual confidence on decision-making. To investigate this issue, participants completed a task in which they provided sequential decisions. They were presented with two random dot kinematrograms, and judged which group of dots moved closer to the vertical axis. Subsequently, they indicated whether they were confident or not that their response was correct and then viewed the response of a machine or human partner. They were instructed to evaluate the response of their partner and decide whether to keep or change their initial perceptual judgment. We observed that confidence predicted participants' decision to keep or change their initial responses more than task difficulty and perceptual accuracy. Furthermore, confidence judgments could be predicted by pupil dynamics, suggesting that arousal changes are linked to confidence computations. In sum, this study contributes to our understanding of the function of confidence for decision-making and highlight the possibility of using pupil dynamics as a proxy of confidence.

Mots-Clés: perceptual confidence, decision, making, human, human and human, machine interactions, pupil dynamics

*Intervenant

LEARNING TO DISCRIMINATE THE EYE-OF-ORIGIN DURING CONTINUOUS FLASH SUPPRESSION

Claudia Lunghi * [1], Izel Sarı , Samuel Recht

[1] Laboratoire des Systèmes Perceptifs (LSP) – Ecole Normale Supérieure de Paris - ENS Paris, Centre National de la Recherche Scientifique - CNRS – France

Helmholtz asked whether one could discriminate which eye is the origin of one's perception merely based on the retinal signals (von Helmholtz, 1962). Studies to date showed that the ability to discriminate the eye-of-origin most likely depends on contextual cues (Smith, 1945; Ono and Barbeito, 1985). Nevertheless, exogenous attention can enhance performance for monocularly presented stimuli (Zhaoping, 2008; Zhang et al., 2012; Kim and Chong, 2022). Here we investigate whether an attention-based training can facilitate the access to the eye-of-origin information, either by modulating visual information at the level or the monocular channels or by enhancing contextual cues. We used the breaking continuous flash suppression (b-CFS) paradigm to stimulate the two eyes separately and to estimate the signal strength of the monocular targets. At each trial, participants (N = 34) reported the localization of the target grating as soon as it emerged from CFS, and then made an eye of origin judgment and gave confidence ratings. Following a baseline block (100 trials), participants performed a training block (100 trials), during which, at the beginning of each trial, a binocular cue (75% valid) informed them about the eye of origin of the upcoming target, and they were asked to orient their attention accordingly. Training was followed by a post-training session (100 trials), identical to the baseline. We found a significant improvement in the accuracy eye-of-origin discrimination after the training ($\chi 2(1)=191.5$, $p< 0.001$) and an effect of metacognition ($\chi 2(2)=47.7$, $p< 0.001$). There was no difference in the suppression times for the trials following valid vs invalid cues during the training ($\chi 2(1)=0.905$, $p=0.34$). Our results show that even though the strength of the monocular channels is not altered with voluntary attention, a short training improves eye-of-origin discrimination performance. The metacognitive abilities of the participants closely relate to their performance, suggesting that a high-level decisional mechanism is responsible for the eye-of-origin judgment. We propose, nevertheless, that this high-level process is informed by subtle sensory cues such as the differences in luminance or contrast in the two monocular channels.

Mots-Clés: Continuous flash, suppression, eye, of, origin, learning, attention

*Intervenant

Actively generated outcomes are more precisely reproduced.

Emmanuelle Bonnet * [1,2], Louise Barne [3], Andrea Desantis [1]

[1] DTIS, ONERA [Salon] – ONERA – France
[2] Institut de Neurosciences de la Timone – Aix Marseille Université : UMR7289, Centre National de la Recherche Scientifique : UMR7289, Aix Marseille Université, Centre National de la Recherche Scientifique – France
[3] UCL – Royaume-Uni

Being an agent structures the way we experience our environment. It has been shown that voluntary actions produce outcomes that are attenuated in terms of their perception and cortical response compared to externally generated outcomes. This study combines visual psychophysics and EEG to investigate the influence of intentionality and prediction on the processing of sensory outcomes. Three types of outcomes are compared: those predicted by a voluntary action, those predicted by a forced action and those predicted by a stimulus. The outcome is a grating whose orientation is (to some extent) predicted by the action/stimulus preceding it. Participants' task is to indicate whether the grating is brighter than another visual grating presented at trial onset. They are also asked to reproduce the orientation of the grating following the action/stimulus.
Interestingly, our behavioral results do not replicate the classical sensory attenuation result, since gratings generated by one's actions were not reported as less bright than those predicted by a stimulus. contrary to what sensory attenuation would have predicted (i.e. reduced sensitivity for self generated outcomes) we observed better identification of the outcome, since actively generated stimuli were more precisely reproduced. Our EEG analyses will therefore focus on two aspects. First, to disentangle differences and similarities in the sensory processing of actively or passively generated gratings. Second, to evaluate what neural mechanisms can underly this improved behavioral performance and how it relates to the neural sharpening hypothesis of sensory attenuation.
Lastly, our study will contribute to the characterization of the serial dependence effect. It is known that our visual system uses and is influenced by past information when perceiving a current stimulus, but how does this mechanism take into account intentionality and agency?

Mots-Clés: Agency, orientation reproduction task, eeg

*Intervenant

Configuration or surface? Cues accounting for the horizontal tuning of face identification

Hélène Dumont * [1], Alexia Roux-Sibilon [1], Eunice Tshibambe [1], Valérie Goffaux [1,2]

[1] Institut de recherche en sciences psychologiques – Belgique
[2] Institue Of NeuroScience (IONS) – Belgique

When participants are asked to identify face-images with access only to the luminance variations contained in one orientation range, their performance is higher in the horizontal range compared to other orientations. To elucidate the nature of the information contained in the horizontal range of the face stimulus, we compared the effects of image-plane inversion and contrast polarity reversal (i.e., negation) on the orientation profile of face identity recognition. Inversion and negation prevent the specialized processing of face identity by disrupting presumably distinct sources of information: feature configuration and surface properties, respectively. We tested participants in a face recognition task using familiar celebrity images. The images were filtered in orientation (from 0◦ to 150◦ in steps of 30◦) and presented in one of 3 conditions: upright-positive, inverted, or negated. We fitted a Bayesian Gaussian mixed model to the inversion and negation effects across orientations. Overall, inversion impaired sensitivity more strongly than negation but the orientation profiles of the inversion and negation effects were similar and correlated at the subject level. This indicates that inversion and negation similarly disrupt the access to the oriented content of the human face. The fact that both effects peak in the horizontal range indicates that this orientation provides access to the optimal configural and surface cues for the specialized processing of face identity. The horizontal range of face information being the most vulnerable to image manipulations which –though radically different at the pixel level– are especially harmful to face perception, further supports the utmost importance of this range for the representation of face identity in the human brain.

Mots-Clés: Inversion, Contrast negation, Face Identification, Orientation selectivity

*Intervenant

Statistical Learning Models for Anticipatory Smooth Pursuit Of Eye Movements

Hamza Oueld*[1], Anna Montagnini[1], and Emmanuel Daucé[1]

[1]Institut de Neurosciences de la Timone – Aix Marseille Université : UMR7289, Centre National de la Recherche Scientifique : UMR7289, Aix Marseille Université, Centre National de la Recherche Scientifique – France

Résumé

The field of anticipatory smooth pursuit eye movements (aSPEM) has been studied extensively in recent years, as researchers look to understand how the brain processes and anticipates visual information. One promising approach to understanding aSPEM is through the use of statistical learning models based on Reinforcement Learning (RL) and Bayesian Learning (BL). These models have been shown to be effective in simulating how the brain processes visual information and can be used to investigate different aspects of aSPEM, which are critical to maintain clear vision while tracking moving objects. In this study, we present a statistical learning model based on RL and BL for the prediction of aSPEM. The model is designed to simulate the behavior of the human visual system during aSPEM tasks. It learns to predict and optimize the direction and velocity of aSPEM based on past visual information. The RL component of the model is used to learn an optimal policy for controlling the eye movements, while the BL component is used to infer the underlying distribution of the model parameters. We evaluated the model using a dataset of aSPEM recordings collected from human participants while they performed a visual motion tracking task. Our results show that the model is able to accurately predict aSPEM with high degree of accuracy, and that it is able to generalize well to new visual information. Furthermore, this model could be used to investigate different aspects of aSPEM, such as the effects of different types of visual stimuli on the direction and velocity of aSPEM, thus giving a basic understanding of the underlying neural mechanisms of aSPEM, and providing insights into how the brain processes and anticipates visual information. In conclusion, our study provides evidence that statistical learning models based on RL and BL are a promising approach for understanding aSPEM and demonstrate the potential of RL and BL as a powerful tool for studying complex sensorimotor behaviours in humans and animals. These models can be used to investigate the underlying neural mechanisms of aSPEM, and can provide valuable insights into how the brain processes and anticipates visual probabilistic information.

Mots-Clés: Anticipatory smooth pursuit of eye movement, Reinforcement Learning, Bayesian Learning

*Intervenant

Using a mindless reading task to reveal the tiny modulations of language-related processes on readers' eye movement behavior

Régis Mancini * [1,2], Laure Spieser [2], éric Castet [1], Boris Burle [2], Françoise Vitu [1]

[1] Laboratoire de Psychologie Cognitive (LPC) – Aix-Marseille Université - AMU, CNRS : UMR7290 – France
[2] Laboratoire de Neurosciences Cognitives (LNC) – Aix-Marseille Université - AMU, CNRS : UMR7291 – France

Eye movements during reading are classically assumed to reflect ongoing linguistic processes. However, this view remains debated. One of the major arguments which has been raised against this assumption comes from mindless-reading studies revealing great similarity in eye movement behavior in the presence or absence of linguistic content. In this framework, only the remaining differences are attributed to top-down language-related modulations of eye movement behavior. Here, we tested this assumption further by investigating whether differences between mindless and mindful reading can be assimilated to the effects of linguistic processing.

Twenty participants read 316 French sentences, as well as 316 z-transform sentences (all letters replaced by the letter "z"), while their eye movements were registered.

Using linear mixed-effect models, we estimated the effects of linguistic content on several benchmark eye movement phenomena (i.e., the relationship between word skipping and word length, the preferred viewing location effect, the (inverted-) optimal viewing position effect) and compared these effects to the effects of linguistic variables (word frequency and predictability).

We first found that all benchmark eye movement patterns were preserved in the z-reading condition. Importantly, there were some remaining differences between z-reading and normal reading that roughly matched the differences observed between high- and low- frequency/predictability words, suggesting that at least part of these differences can be attributed to language-related modulations.
Results will be discussed in the framework of a recent model of eye movement control that explains reading behavior simply based on low-level visuomotor principles in the superior colliculus.

Mots-Clés: Reading, Mindless reading, Linguistic processes, Eye movements

*Intervenant

Liste des auteurs