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Intelligent Audio Visual Thumble Training (IVATT)

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Scotoma is a blind spot or spots that appear in one's eye due to loss of retinal cells. This blind spot badly effects the fixation stability and naturally forces the patient to develop a secondary fixation point called Preferred Retinal Locus (PRL). Here we present a rehabilitation technique for Macular Degeneration (MD) patients called Intelligent Audio Visual Thumble Training (IVATT). The idea is to integrate the audio-proprioceptive information to the residual vision of an individual to help them in developing PRL at the healthy part of retina. IVATT consists of a PCB with a battery, LED and buzzer within a plastic enclosure, used to produce the sound. With this assembly on index finger, participants had to follow a 70 by 70 cm Archimedean spiral drawn on a hard board placed in front of them. 11 MD patients performed this training followed by pre and post visual and audio localization tests. Results about these two tests show an improvement in fixation stability and in sound localization.

Does multistability involve adaptation ?

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The aim of this work was to investigate the presence of neural adaptation in visually ambiguous phenomena. To that end, motion after effect (MAE) and multistability were combined in three experiments, two of which used a cylinder from motion as a stimulus. In the last experiment, the moving plaid stimulus was used.
The two first experiments showed that the durations of the first percept measured while observing the bistable cylinder were too short to allow for a sufficient adaptation and therefore no MAE was observed. In addition, the randomly moving dots,that composed the cylinder, evolved in two opposite directions. This could explain the absence of adaptation.

As for the last experiment, MAE was only observed when adapting to the coherent percept.
This result is compatible with the findings of the two first experiments; the two gratings only allow for neural adaptation when a single coherent movement is perceived whereas the transparent percept, composed of two opposite movements, does not allow for neural adaptation and hence MAE

Impaired perceptual visual localization across saccades in a patient with parietal lesion

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Spatial remapping processes are elicited every time we scan our environment with our eyes in order to explore / act on it. These mechanisms use extra-retinal signals of eye motion to predict the sensory consequences of saccadic eye movements. Studies using double-saccade remapping tasks have emphasized a role of the colliculo-thalamo-frontal pathway (1) and of the parietal cortex (2) in keeping accurate visuomotor behaviour (but see Rath-Wilson & Guitton 2015 (3) suggestion that this may be due to perceptual deficit). However, the perceptual spatial remapping processes underlying our subjective experience of stability across saccades are less understood. A study of saccadic suppression of displacement (SSD) in thalamic patients (4) showed that the colliculo-thalamo-cortical pathway contributes to perceptual visual localization across saccades. A role of the parietal cortex in such perceptual remapping processes has also been suggested by theoretical studies (5) but has not been shown yet. Here, we address this question by testing a patient with a left optic ataxia consecutive to posterior parietal damage in 1) a SSD-task and 2) a localization task in which a bar briefly flashed just before a saccade has to be localized thereafter. Both tasks were performed separately in the left and right hemifields as well as under gaze fixation (perception without remapping) and saccade (perception with remapping) conditions. In addition, in the SSD task, two conditions ('GAP' and 'STEP') were contrasted to specifically assess the integrity of internal monitoring processes. Performances of patient were compared to four age-matched healthy subjects (*Crawford t-test analyses).* In both tasks, the oculomotor behaviour of patient was similar to that of control subjects. In the SSD task, specifically in the ataxic (left) hemifield, the patient exhibited: (1) a perceptive bias asymmetry under gaze fixation irrespective of the condition ('GAP' and 'STEP') , pointing toward an impaired processing of stimulus position and (2) a strong shift of perceptive responses under saccade condition, but only when internal monitoring processes are critical to solve the task ('GAP' condition). In the second localization task, a similar shift of perceptive responses was reported in the left hemifield under saccade condition. Taken together, these findings suggest a role of parietal cortex in trans-saccadic perceptual visual localization, possibly in monitoring internal (extra-retinal) information of saccade execution.

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L'art pariétal paléolithique européen : apports méthodologiques des neurosciences à l'archéologie

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Objet de l'étude archéologique, la visibilité de l'art des parois paléolithique européen, ou l'étude du public des graphismes pariétaux, se développe depuis une dizaine d'années. Parmi les facteurs influents communément admis se distinguent les techniques de réalisation et l'éclairage des motifs. Pour les étudier, la nécessité d'une méthodologie adaptée et complémentaire nous a incitées à nous diriger vers les neurosciences, discipline étudiant la perception, dont fait partie le concept de visibilité. À l'aide de la méthode psychométrique, une tâche go-no go de catégorisation animal/non animal a été menée sur une cohorte de 24 participants. Nous avons mesuré le temps de réaction et le pourcentage de réussite, en fonction des deux paramètres technique (gravure fine, peinture monochrome rouge, peinture monochrome noire, peinture bichrome rouge et noire, bas-relief) et éclairage (naturel du matin 7h, du midi, du soir 18h, artificiel à la lampe à graisse), sur deux catégories de sujets (experts et novices). Les résultats concernant la gravure indiquent une visibilité peu aisée en éclairage naturel, mais qui augmente avec la lampe à graisse (90% de bonnes réponses et 0.66s de temps de réaction pour cet éclairage, contre 1s en éclairage naturel). La technique du bas-relief semble ne pas être très facile à percevoir, quel que soit le type d'éclairage utilisé, tant au regard du temps d'observation (0.9s de temps de réaction) que du taux de réponses correctes (50%). La peinture monochrome noire est, quant à elle, bien perceptible avec un éclairage naturel et non artificiel (77% contre environ 50% de réponses correctes). L'effet de l'expertise des sujets sur les performances a été évalué par le calcul de *d'*, qui bien que non significativement différent, montre une tendance à un meilleur taux de réussite pour les Experts. Cette expertise est signifiante pour les motifs gravés éclairés avec un éclairage artificiel qui sont plus rapidement perçus par les Experts (0.82s contre 0.92s pour les Novices), ce qui est également valable pour les motifs bichromes en éclairage du soir (0.63s contre 0.76s pour les Novices). Ces résultats ont ensuite été appliqués sur l'abri-sous-roche du Roc-aux-Sorciers (Angles-sur-l'Anglin, France), daté du Magdalénien moyen (18 515 – 16 923 cal. BP). D'une part, la majorité des motifs semblent être à destination d'un public occupant l'abri. D'autre part, deux conditions d'éclairage opposées pour une vision optimale selon les techniques se détachent : certains motifs semblent être vus le jour et d'autres la nuit, ce qui indiquerait des usages variés de ces motifs, liés aux conditions d'éclairage. Ce croisement interdisciplinaire permet d'apporter de nouveaux éléments de réflexion sur le public visé par l'art pariétal de cet abri-sous-roche, et ainsi la fonction socio-culturelle de cette production graphique.

A male advantage in visuomotor tracking: exploring the role of gaze and decision making

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Background: Visual control of hand movement is crucial for success in everyday tasks. Although gender differences have been reported in visuomotor tasks, as well as in visual motion perception tasks, the possibility that men and women use different gaze strategy during eye-hand coordination has not been examined yet. The goal of this study was to investigate the impact of gender on visuomotor tracking, and gaze strategy when completing this task.
Methods: Fifty right-handed participants (25 female+25 male) were tested while tracking a visual target that followed an unpredictable trajectory with a cursor using a joystick with the right hand. Participants were asked to minimize the distance between the cursor and the target. However they received no explicit instructions regarding gaze behavior.

Results: Hand tracking was found less accurate in women who exhibited greater (+15%) cursor-target distance than men. No key difference was found in terms of gaze behavior, with men and women fixating the moving target with similar spatial and temporal accuracy. Moreover men and women exhibited a similar rate of catch-up saccade and saccade duration. Further analyses of hand tracking error showed that the male advantage originated from a smaller temporal lag between cursor and target motion (men=51 vs. women=71 ms). Indeed when compensating for this 20ms difference in timing of hand motion, no more significant difference in hand tracking error was found between men and women.
Conclusions: This study confirms a male adavantage for manual tracking. Our results suggests that this advantage does not stem from a more refined gaze strategy in men. Instead our results suggest that the male advantage lies in a slightly faster decisional process linking visual information of the target with forthcoming hand actions.

Does the spatial organization of brain oscillations modulate perceptual rhythms?

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Our ability to perceive the world appears to be periodic. The probability of stimulus perception would alternate between favorable and less favorable moments, encoded in "good" and "bad" phases of theta (4-7Hz) and alpha (8-12Hz) brain oscillations. Here, we assess whether the phase effect on perceptual performance is modulated by the spatial organization of brain oscillations. We used a psychophysics paradigm based on Sokoliuk and VanRullen (2016) in which participants performed a threshold (50% detection) visual detection task, while their brain activity was recorded with EEG. A small oscillating disc was concurrently presented in the periphery (7.5◦ eccentricity) to entrain brain oscillations at low frequencies (4, 6, 8 and 10 Hz). The target appeared between the fixation cross and the disc at one of three possible eccentricities (4.1◦, 4.5◦, 4.9◦). We tested whether (1) the entrained oscillation, which originates from a precise retinotopic location, modulates detection performance periodically at each target location; (2) the preferred phase shifts as a function of target location; and (3) the frequency of the entrained oscillation modulates this phase effect. Our results provide systematic characterization of the influence of the spatio-temporal organization of low frequency oscillations on visual perception.

Computationnal classification of archeological engravings

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Ancient engravings identified as deliberate suggest an early aestethic experience for human being leading to increasingly complex graphic representation. Through the theory of visual resonance, Hodgson (2006) states that this progressive appearance is linked to functional properties of the visual system.
This study is part of a larger project called ArchéoNeuro seeking to highlight neural bases of cognitive skills needed to produce or recognize symbolic representations.
A database of 50 abstract engravings dating from 31 ky BP to 540 ky BP form the first voluntarily marked signs discovered to date. The main goal is to categorize them in order to find a base of descriptors potentially related to the human visual system. Two transformations are used to get descriptors of our images: the Fourier transform and the Gabor filtering. The energy matrices will then be used to classify images according to 3 different methods: correlation (Euclidean distance), k-means method and an unsupervised learning method (self-organizing maps).
We find constancy in the grouping of some signs according to the three methods and similarities with human categorization, performed by 20 individuals. Some images are not stable in classification and the k-means method is not stable probably due to some outliers or a limited number of images. In future work, it would be interesting to look at the outliers of the image database. Their characteristics could guide the research for new descriptors. Fitting the parameters of Gabor filters to human categorization results would be another direction to take in order to continue the NeuroArcheo project.

EYE movements as a PROXY for physiological, cerebral and cognitive state assessment

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Eye movements are increasingly used to non-invasively assess neurocognitive functions (e.g., visual perception and attention, basic executive functions) but also to detect pathological dysfunctions (e.g., psychiatric, developmental or neurodegenerative disorders). Furthermore, other eye parameters such as pupil size, which is under the direct control of the parasympathetic nervous system, may also inform about the physiological state of subjects.
In this context, we present EYE-PROXY, a translaboratory project under the umbrella of the NeuroCoG idex project of the Univ Grenoble Alpes.

It aims to develop standardized protocols to probe the visual system with well-defined paradigms and record the corresponding eye signals. Such recordings can be performed in conjunction with neuroimaging (EEG and fMRI) recordings. To be routinely used in clinical research, efforts have been done for visual paradigm optimization to limit the duration of data acquisition.
Specific tools have been developped for data fusion and data analysis. EYE-PROXY will provide an unique open database for the definition of signatures characteristic of healthy or pathological conditions. Additionally, it will offer to the research community, standardized protocols and analysis tools to be used in various experimental contexts.

Quantifying noise perception in computer generated images

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The use of computer generated images (CGI) is constantly increasing, yet our knowledge of the perception of CGI quality is still quite limited. Importantly, the main algorithms used to produce realistic CGIs induce the presence of visual noise, which decreases when the number of samples per pixel (NSPP), and therefore computing time, increases. Critically, the extent to which observers are actually able to detect differences in CGI quality is still unknown. This knowledge would help optimizing the CGI computing time for human perception.
We designed and conducted two experiments in six participants using two sets of CGIs. Within a given set the NSPP was manipulated to induce various levels of noise. Images at the extreme of the set were computed with large NSPP, and were therefore much less noisy. Our goal was to estimate the lowest NSPP necessary to have observers perceiving an image as being similar to the one produced with the largest NSPP.
First, we estimated the 75% perception threshold for each participant. We manipulated each images (800x800) by randomly cutting them either vertically or horizontally and merging them with a reference image (RI). The image with the highest NSPP was used as a RI. Participants were asked to decide whether the pictures are composed of two different images or of a single one. After each trial we used a QUEST+ algorithm to select the next SI. QUEST+ minimizes the Shannon entropy to define the best set of parameters' values. When the algorithm converges and the limit of entropy is reached, the outcome is the estimated individual threshold.
In the second experiment, the task was identical. However, the picture presented to the observer was now composed of a part of the RI and a part of the stimulus image (SI) corresponding to the individual threshold. To probe the used of peripheral vision on the discrimination task, we used a gaze contingent paradigm to present the RI at the gaze location through a gaussian mask on top of the composed picture. For each trial a QUEST+ algorithm was used to compute the spatial extent of the gaussian mask.
Results indicate that the median and quartiles of the 75% perceptual thresholds are within the boundaries of our image sets, mostly corresponding to intermediate NSPP. This indicates that the range of NSPPs were large enough to cover the average threshold across our observers. Moreover, the quartiles and median thresholds were very close, revealing that we are able to estimate a global perceptual threshold. For the second experiment, our results show that a mask with a mean size of about 2 degrees of visual angle was sufficient to strongly impair the observer's ability to report a difference between the RI and the SI. These findings contribute towards a deeper understanding of how an observer detects different CGI qualities. Funding from ANR grant ANR-17-CE38-0009

Does the target path frequency influence its visual tracking? A study in the rhesus macaque monkey

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Multiple behavioral studies report that the ability to smoothly (without saccades) track a moving target depends upon the "predictability" of its path. Visual tracking is saltatory, i.e., composed of several saccades when the path is "unpredictable"; it is "smooth", i.e., uninterrupted when it has become predictable after repeated practice (Bourrelly et al. 2016). When the set of possible paths that a moving target can take is limited, the predictability of one path depends upon the frequency of its occurrence. Thus, the location of a target moving always along the same path is more predictable than when the path is seldom. In this study, we tested in two monkeys how the frequency of occurrence (probability) of a target path influences the triggering and accuracy of tracking eye movements.
After fixating a central static target for a variable interval (750-1500 ms) and a short blank interval (300 ms gap), the central target re-appeared and moved at 20 or 40∘/s along one out of four possible oblique paths. The monkey was rewarded for tracking the target until it disappeared in the peripheral visual field. Considering each target path among four possible paths, five frequencies of occurrence were tested during separate sessions recorded during different days: 10% (rare), 25% (uncertain), 50% (likely), 70% (very likely) and 100% (certain). In the complementary fraction of trials (90%, 75%, 50%, 30% and 0%), the target path was randomly selected among the three remaining options.

After target onset, the eye drifted toward the quadrant where the target moved, more during the "certain" sessions than during the other ones. The latency of interceptive saccades was not influenced by the target path frequency. Their accuracy and precision were not influenced either, neither by the frequency nor by the amount of pre-saccadic drift. After the interceptive saccade, the eye followed the moving target, with no noticeable difference in velocity between the different path frequencies. Regardless of the probability, no consistent difference was observed between the Position—Time landing ratios of interceptive saccades and the post-saccadic pursuit velocities. Catch-up saccades were found to be more accurate and precise than interceptive saccades. A very small but consistent difference of accuracy and precision was found between the "certain" and "uncertain" sessions. No difference was observed between the "uncertain" and the other probabilities.
In conclusion, our results show that in the monkey, the frequency of a target path does not influence the accuracy and precision of interceptive and catch-up saccades. An influence on pre-saccadic slow eye movement is observed, but only when the path is fully or highly predictable.

Retention of saccadic adaptation induced by reinforcement learning

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We have previously shown that saccadic amplitude can be adapted via reinforcement learning and not only via the conventional double-step paradigm (Madelain, Paeye & Wallman, 2011). To disentangle post-saccadic visual error (known to induce saccadic adaptation) from reinforcement, we extinguished the target during saccades and provided rewarding tones whenever saccades met specific amplitude criteria. Such auditory reinforcement induced changes in saccadic amplitude similar to the changes obtained using the double-step paradigm. We proposed that saccadic adaptation might involve a general learning mechanism in which saccades are reinforced by the clear vision of the target.

The goal of the present study is to examine the retention of reinforced adaptation. Saccadic amplitude was decreased (backward adaptation) or increased (forward adaptation) using our reinforcement paradigm. Five days after the last reinforcement session, the amount of backward adaptation (n=4) was still significant (-23.1%, SEM=9.4, retention rate: 81%) and forward adaptation (n=4) kept increasing (27.3%, SEM=11.5, retention rate: 145%). Preliminary data also showed retention 12 and 19 days after the last reinforcement session. Overall, the retention was stronger than in conventional adaptation.

These long-lasting effects of reinforced adaptation are consistent with previous findings indicating that the effects of conventional backward adaptation can still be observed two months later (Wang et al., 2012). This provides further argument for the involvement of a general learning mechanism in saccadic adaptation. Presumably, auditory consequences of saccades provided during reinforcement sessions increased context specificity, crucial for sensorimotor adaptation.

Accurate prediction of one's own limb movement is the key to automatic online control

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Fast online control of movement is an essential component of human movement skill as it allows automatic corrections of an inaccurate motor planning. The present study sought to study if these error-correcting mechanisms rely on actual visual feedback from the moving hand, or rather on accurate predicted visual reafferences coming from internal representation of the instantaneous effectors state. The relative contributions of these signals are still discussed because they are naturally intermingled. We addressed this issue by comparing online correction of a planning error that was artificially introduced in two experimental conditions.
In a first experiment 'Prism', a planning error was introduced through prisms that displaced laterally the seen hand prior to hand movement onset. The prism-induced conflict between visual and proprioceptive inputs of the hand also generates an erroneous prediction of the visual reafferences of the moving hand. In a second experiment 'Jump', a planning error was induced by a jump of the target position during the orienting saccade prior to hand movement onset. In that condition, predicted reafferences of the hand remained intact. In both 'Prism' and 'Jump' experiments, vision of the hand after hand movement onset was either allowed or suppressed.

In the 'Prism' Exp., late and reduced corrections of the planning error were observed, even when natural visual feedback of the moving hand was available. In the 'Jump' Exp., early and automatic corrections of the planning error were observed, even in the absence of visual feedback of the moving hand.
Therefore, when the predicted reafferences were accurate ('Jump Exp.'), they allowed rapid and automatic processing of visual feedback. When they were erroneous ('Prism Exp'), the same visual feedback was less efficient and required a voluntary and late control. It clearly demonstrates that in natural environments, accurate prediction is a prerequisite for the preprocessing of visual feedback of fast and accurate movements.

Validation d'un modèle mathématique de l'espace des couleurs perçues via des expériences psycho-physiques

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Le modèle de l'espace des couleurs perçues P de H.L.Resnikoff est un exemple très élégant de psycho-physique théorique. En rajoutant aux axiomes de Schrödinger un nouveu axiome d'homogénéité de P par rapport à un groupe de transformations linéaires, Resnikoff est arrivé à déterminer univoquement la structure géométrique de P et ses métriques. Ce travail, dejà remarquable, a ensuite permit de souligner l'importance des structures hyperbolique dans la théorie de la perception des couleurs contemporaine. L'axiome d'homogénéité de Resnikoff assume implicitement la propriété de linéarité de la perception des couleurs par rapport aux changements de background. Cette hypothèse, à notre connaissance, n'a jamais été testée d'une manière rigoureuse avec des expériences psycho-physiques. Dans l'exposé, le modèle de Resnikoff sera introduit et une proposition pour effectuer l'expérience psycho-physique nécessaire à la validation de l'axiome d'homogénéité sera discutée.

Face processing in V1: coarse-to-fine?

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Coarse-to-fine models propose that primary (V1) and high-level visual regions interact over the course of processing to build up progressively finer representations. We previously observed that face-preferring regions in the fusiform cortex integrate face information in a coarse-to-fine manner. Whether V1 contributes to coarse-to-fine processing remains to be determined. Since face-preferring regions are mainly right-lateralized, we expected to find support for the progressive build-up of faces in the right V1 mainly. To address this, we re-analysed the data of our past fMRI experiment, in which intact and scrambled faces were presented in three spatial frequency (SF) ranges (low, middle, high) for three durations (75, 150, 300ms). We localized individual V1 based on an anatomical atlas combined with a functional localizer. Next, we conducted a univariate analysis of the average response in this region and submitted the beta values to a repeated measure ANOVA. Overall, V1 response decayed as a function of exposure duration. The response to the coarse low SF input drastically decayed between 75 and 150ms post-stimulus onset and bounced back to the initial response level at 300ms of exposure. The decay of V1 response to middle and high SF was shallower and more linear. V1 response was comparable across intact and scrambled stimuli. Considering past evidence that V1 overall responds more strongly to scrambled than intact images, the present absence of difference may reflect a limitation in statistical power. For a finer-grained investigation of the spatiotemporal dynamics of SF integration in the V1, we conducted multivariate pattern analyses (MVPA). We trained and tested a support vector machine on classifying between intact and scrambled face stimuli. Overall, the classification accuracies were close to chance level, again suggesting limited statistical power. In the bilateral V1, the classification algorithm was only successful for low SF exposed at 75ms of exposure and high SF exposed for 300ms. Additionally, we calculated the slope of the linear function relating classification accuracy to exposure duration in each SF condition. We found a negative slope for low SF, whilst middle and high SF showed positive slopes. Similar results were found in the right V1, but not in the left V1. MVPA showed that the pattern of V1 activation to intact and scrambled face images only differed during the early stage of low SF encoding and the late processing of high SF content. These trends suggest that, in V1, like in high-level visual cortex, the coarse structure of images (low SF) is processed before the fine details (high SF) in agreement with coarse-to-fine theories of visual processing. Due to the limited statistical power of the present analyses, the results should however be interpreted with caution. Future investigations are needed to investigate the involvement of V1 in coarse-to-fine processing.

Eye movement dynamics during visual foraging

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A vast amount of research has been carried out to understand how humans visually search for targets in their environment. However, this research has typically involved search for one unique target among several distractors. Although this line of research has yielded important insights into the basic characteristics of how humans explore their visual environment, this may not be a very realistic model for everyday visual orientation. Recently, researchers have used multi-target displays to assess orienting in the visual field. Eye movements in such tasks are however less well understood. Here we investigated oculomotor dynamics during four visual foraging tasks differing in target crypticity (feature-based vs. conjunction-based foraging) and the effector type being used for target selection (mouse-foraging vs. gaze-foraging). Our results show that both target crypticity and effector type affect foraging strategies. These changes are reflected in oculomotor dynamics, feature-foraging being associated with focal exploration (long fixations and short-amplitude saccades) and conjunction-foraging with ambient exploration (short fixations and high-amplitude saccades). These results provide important new information for existing accounts of visual attention and oculomotor control, and emphasize the usefulness of foraging tasks for a better understanding of how humans orient in the visual environment.

Eye movement dynamics during visual foraging

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When we perform saccades, periods of nearly stationary images are punctuated by brief and very fast motion on the retina. In ordinary conditions, we perceive neither motion nor the resulting smear. However, if we remove the stationary images before and/or after the saccade, motion and smear become visible during the saccade. Thus, stationary and clear images before and after the saccadic flow are necessary for the full suppression of motion and smear – but are they also sufficient? In other words, are motion and smear suppressed by stationary images even in the absence of a saccade? This is a difficult question to answer using ordinary displays, because motion at saccadic speeds is badly aliased at typical refresh rates. Using two different projectors that operate at a very high refresh rate (1440 Hz), I have shown that, in the absence of saccades, stationary endpoint images before and after very fast motion at saccadic speeds do mask motion and smear. Motion bounded by stationary endpoints seems 2-3 slower than the same motion without endpoints. Smear without stationary endpoints can be seen clearly, but becomes difficult to detect even for brief stationary endpoints displayed for 10-20 ms. Finally, the effects of stationary endpoints have spatio-temporal limit: the effects disappear above a certain duration that depends on amplitude. This cutoff duration, which increases with amplitude, is closely related to the "main-sequence" duration of saccades at the given amplitude. Thus, these purely visual masking effects are good candidates for mechanisms underlying saccadic suppression.

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