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Supplementary Information for

The time course of spatiotopic updating across saccades

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Experimental Procedures

Experiment 1.

With Experiment 1 we tested the hypothesis that visual information can be spatiotopically updated in a time window as short as the saccade latency. Subjects performed a gaze-contingent version of the high phi illusion (Fig. 1D). Each trial started with a drift check of 500 ms at the central fixation target (target radius ≈ 0.2º, radius of ROI for fixation control = 3º), followed by an additional fixation period of 250-500 ms. Then, an annulus with a random texture appeared, with its center 15º either to the left or to the right of the fixation target (equal probability). Subjects made a saccade to the center of the annulus. To increase the variability of the saccade latencies, we varied the synchrony of stimulus onset and fixation target offset with gaps of -150, 0 or 150 ms, taking advantage of the gap-effect (1). Saccades were slower with longer temporal overlap (Fig. S4). Importantly, before the saccade was executed, the annulus was either static *(Saccade static)* or rotated with 20º/s *(Saccade preview)*. In case of the *Saccade static* condition, the annulus started rotating during the saccade, i.e. as soon as gaze position was ≥3º away from the initial fixation target. The annulus rotated for another 20 or 50 ms after saccade offset (the post-saccadic inducer), i.e. when gaze was detected within ≤2º of the saccade target. Then, the texture of the annulus was rapidly replaced by four different random textures (20 ms/texture). Subjects indicated whether they perceived a rotational step clockwise or counterclockwise (2AFC). Responses were recoded to forward (1) and backward (-1) with respect to the rotation direction of the preceding inducer. Trials were presented in 12 blocks of 48 trials, where the following factors were presented factorially in random order within a block: preview (static/inducer), post-saccadic inducer duration (20/50 ms), inducer rotation direction (CW/CCW), saccade direction (L/R) and gap duration (-150/0/150 ms).

Subjects also performed two control conditions in separate blocks to test whether high phi can also be induced for a transient around fixation but with an inducer in the periphery. In these conditions we matched the visual input as close as possible to the saccade conditions while subjects maintained fixation during the whole trial (Fig. S1A). Subjects were presented a fixation target in the center of the screen. After 250-500 ms of stable fixation, an annulus with a random texture appeared in the periphery, at the same location as in the Saccade conditions. Again, this peripheral annulus was either static *(Fixation static)* or rotated with 20º/s *(Fixation preview)*. For each trial, the duration of the peripheral annulus was sampled from the distribution of saccade latencies that were collected in the saccade conditions. The distributions were estimated via non-parametric kernel density estimation, bounded on the closed interval [80, 500] ms. This sampling procedure was performed per individual subject, to match the durations of visual input between conditions with and without saccades as accurately as possible (Fig. S1B). Next, the peripheral stimulus disappeared, and the screen was blank (apart from the central fixation point) for a duration that was sampled from the smoothed distribution of saccade durations in the conditions with saccades. This sampling procedure was similar to the aforementioned sampling procedure, with the difference that it was bounded on the closed interval [20, 80] ms (Fig. S1C). The blank was followed by an annulus presented around the central fixation target. This annulus had the same random texture as the peripheral annulus and rotated for 20 or 50 ms (akin to the post-saccadic inducer in the conditions with a saccade). Then, the texture was replaced by four other random texture (20 ms/texture), after which subjects gave their response. In the *Fixation static* condition, we implemented an additional 'post-saccadic inducer' duration of 500 ms, to test whether a long, and therefore strong, inducer reliably induces the high phi illusion in every subject. We used the *Fixation preview* condition to test for a spatially invariant effect of the inducer. Blocks with and without saccades were interleaved. Before the start of the experiment, subjects practiced one block with and one without saccades. For the actual experiment subjects completed 6 blocks of the Fixation conditions and 12 blocks of the Saccade conditions.

Experiment 2.

The data from Experiment 1 show that even within a time window as brief as the latency of a visually guided saccade, pre-saccadic perception of a stimulus biases post-saccadic perception of the same spatiotopically localized stimulus. With Experiment 2 we examined whether the duration of the pre-saccadic preview affects the strength of the post-saccadic bias. As suggested previously, spatiotopic updating might become detectable with behavioral measures only when sufficiently long saccade latencies are allowed. Here, we worked the other way around, where we tried to minimize the observed spatiotopically induced bias, since we already observed a bias with short saccade latencies. Therefore, we decoupled saccade latency and preview duration in Experiment 2 by making each preview a mixture of a static preview followed by an inducer preview. Yet note that under natural viewing conditions, the preview duration is as long as the saccade latency (like in Experiment 1). The task in Experiment 2 was similar to Experiment 1. However, rather than being presented with either a static preview or an inducer preview (Experiment 1), subjects were presented with a mixture of both (Fig. 2A). Specifically, when the annulus appeared in the periphery, it started rotating after a delay 0, 50, 100 or 150 ms. Again, subjects were instructed to make a saccade to the center of the annulus immediately after the onset of the annulus. Thus, the total inducer preview duration was determined both by the saccade latency of the subjects and the rotation delay of the stimulus and continued rotating for either 20 or 50 ms after saccade offset. Additionally, subjects performed trials where they maintained fixation, and the inducer and transient were presented around the fixation point. These trials included no peripheral inducers. Subjects practiced one block of the Saccade condition, and one block of the Fixation condition. In the actual experiment, subjects completed 6 blocks of 24 trials of the Fixation condition and 24 blocks of 32 trials of the Saccade condition.

Screening.

Long inducers – The high phi illusion is a subjective, non-random interpretation of a random stimulus: the direction of the transiently changing textures is interpreted as a large rotational step in backwards direction with respect to the preceding rotational motion. To make sure the illusion could successfully be induced in all subjects, we verified the perceptual interpretation of the transient after a long inducer (500 ms) in the *Fixation static* conditions in both experiments. An inducer of 500 ms should evoke a strong percept of a large backward step (cf. Wexler et al. 2013; Fabius et al. 2016). Subjects would be excluded when their binomial confidence interval would include 0, i.e. no clear sign of a successfully induced high phi illusion with a strong inducer. All but 1 subject reliably reported backward jumps with this long inducer (Fig. S2). One subject was excluded from the analysis based on this criterion (Subject 19 in Experiment 1).

Large physical step – Because the high phi illusion is a subjective measure, we verified whether subjects were able to accurately dissociate the direction of a physical rotational step – i.e. not illusory – from the rotation direction of a slowly rotating inducer. All subjects performed a screening experiment prior to the main experiment. In the screening, subjects fixated a fixation target on the left (-10º), center (0º) or right (10º) side of the screen. A static annulus appeared after 500 ms of stable fixation at the fixation target (i.e. all recorded gaze samples were within 3º of the fixation target). The annulus remained static for 600 ms, and then rotated clockwise or counterclockwise for 1000 ms., akin to a long inducer in the high phi illusion. Rotational velocity was 20º/sec, i.e. rotational steps of 0.2º presented at 100 Hz (the refresh rate of our monitor). After the rotation, the annulus made a rotational step of 12º and stopped rotating. Subjects indicated the direction of the large step by pressing the left arrow (‘counterclockwise’) or right arrow (‘clockwise’). The direction of the large step, the direction of the preceding rotational motion and the location were counterbalanced over 36 trials (3 repetitions per combination). To assess accuracy, we computed the proportion correct responses over all trials. Every subject performed well above chance level ($p = 0.5$) in Experiment 1 ($M = 0.95$, range = 0.81-1.00) and Experiment 2 ($M = 0.97$, range = 0.75-1.00).

Control experiment

Introduction.

To investigate spatiotopic updating for more peripheral targets we decided to test the preview effect from Experiment 1 with stimuli of different sizes. The rationale here is that although the annuli in Experiment 1 are not stimulating the fovea after the saccade – and so do not coincide with the saccade target – they are closer to the fovea (inner radius of the annulus = 3°) than typically seen in similar experiments on spatiotopic updating, which is usually between 5 and 10 degrees. In this control experiment, we used annuli with different radii than in Experiment 1, one smaller (inner radius = 2.6°, outer radius = 5°) and one larger (inner radius = 6°, outer radius = 9.25°). It is important to remark that the eccentricity range for the large annulus lies in the same eccentricity regimes typically seen in spatiotopic updating experiments (5-10 degrees in the periphery). Most importantly, the larger annulus' distance from the initial fixation point and the saccade target is almost the same on the vertical midline of the screen, i.e. the retinal stimulation before and after the saccade was parafoveally (2). See Figure C1 for an illustration of these sizes. When accounting for the cortical magnification factor, the surface of these two sizes was roughly equal, although smaller than the surface of the stimuli in Exp. 1 and Exp. 2.

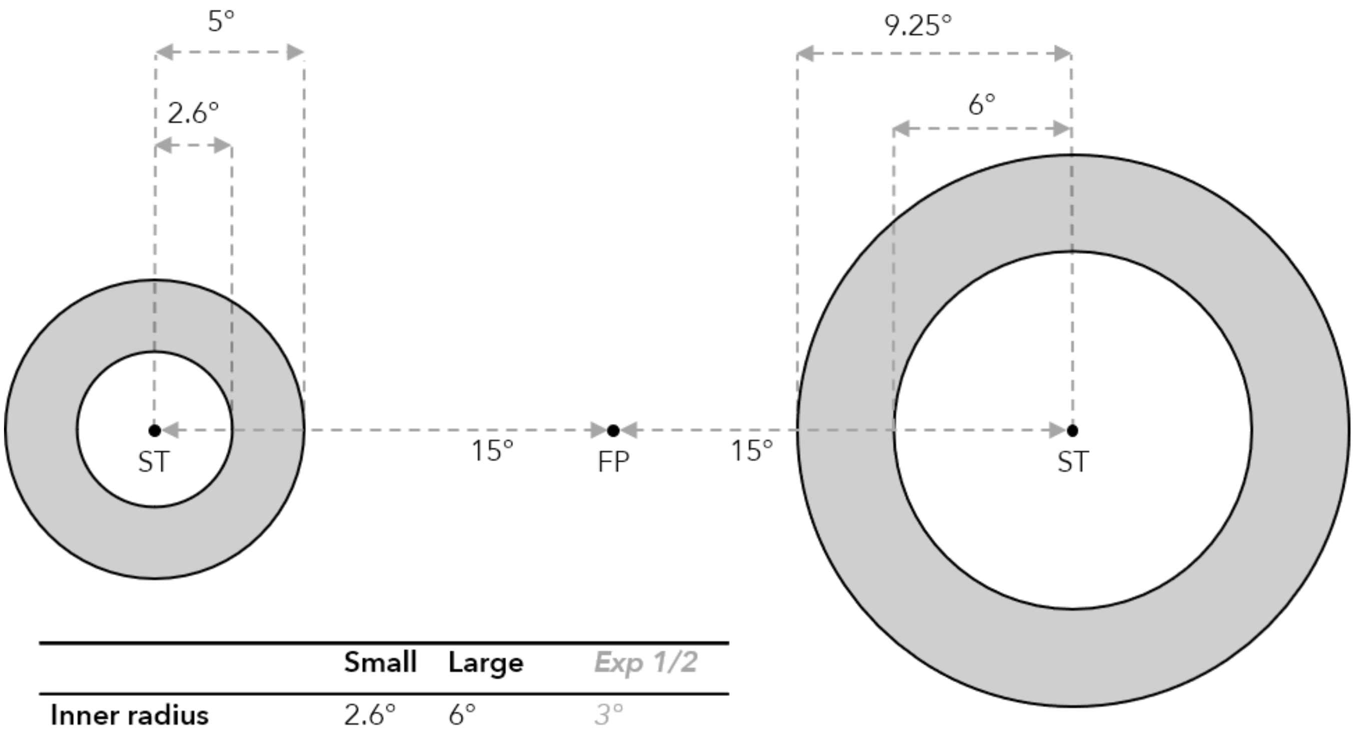
Methods.

We repeated the Saccade conditions from Experiment 1, i.e. 50% of trials contained a preview of the inducer before saccade onset, on the other 50% the inducer was static until the saccade had started. Additionally, the annulus could be large or small. Within a block of 64 trials, all unique combinations of preview (with/without), annulus size (small/large), saccade direction (left/right), rotation direction (cw/ccw) and inducer duration (20/50 ms) were repeated twice. Subjects completed 15 of these blocks.

Additionally, before the Saccade conditions, subjects completed 3 blocks of a Fixation condition, where subjects were required to maintain fixation at a fixation point (either on the left or right side of the screen, similar to the locations used in the Saccade conditions). The High phi illusion was then presented around that fixation point. Each block in the Fixation condition consisted of 48 trials.

Similar to Exp. 1 and Exp. 2, we only included participants who scored above chance level on a screening test, where we presented an inducer of 1 s, followed by a physical step of 12°. Next, we only included data in the analysis from participants who reliably reported backward jumps after a long inducer (500 ms) in an additional Fixation condition. 2/20 subjects were excluded based on the second criterion. Additionally, we applied the same inclusion criteria that are summarized in the *SI Appendix* (*Preprocessing*). In Exp. 3, the 95th percentile of saccade latencies (inclusion criterion 6) was 480 ms, and the 2.5th and 97.5th percentiles of the manual response times were 310 and 1413 ms.

Analysis of the data was identical to the analysis of Experiment 1. We analyzed the data for the small and large stimuli separately with generalized linear mixed effects models. These models had the same fixed and random effects structure as the model that was used to analyze Exp. 1. With these models, we performed non-parametric bootstrapping to obtain 95% confidence interval of the fixed effect coefficients and model predictions.



	Small	Large	*Exp 1/2*
Inner radius	2.6°	6°	*3°*
Outer radius	5°	9.25°	*6°*
Cortical area (mm²)	1772	1760	*2081*

Figure C1. *Design of the control experiment. The size of the stimulus was changed with respect to Experiment 1 and 2. One annulus had a slightly smaller inner and outer radius than the annulus used in Experiments 1 and 2, and the other annulus had an inner radius that was similar to the outer radius as the annulus in Experiment 1 and 2. The surface of these two annuli were roughly comparable when accounting for the cortical magnification factor, although smaller than the stimuli used in Experiment 1 and 2. FP = initial fixation point. ST = saccade target, only one saccade target and stimulus would be shown on each trial. Stimulus sizes were counterbalanced across screen sides.*

Results.

The average median saccade latencies in trials with the small annulus was 161 ms (range = 117-261 ms), and 164 ms in trials with the large annulus (range = 119-276 ms).

Both for the small and the large annulus, the perceived step direction became more biased to backward steps with increased post-saccadic inducer durations (small annulus: $\beta = -0.23$, 95%-CI = [-0.29, -0.16], $F(1, 4953) = 90.58$, $p < 0.001$; large annulus: $\beta = -0.42$, 95%-CI = [-0.51, -0.31], $F(1, 3640) = 88.15$, $p < 0.001$). So, for both annulus sizes, the High phi illusion could reliably be induced.

Regarding the preview effect for the small annulus, the observed bias in the Saccade Static condition was smaller than in the Saccade Preview condition ($\Delta\beta = 0.48$, 95%-CI = [0.29, 0.69], $F(1, 4953) = 5.48$, $p = 0.019$). Similarly, for the large annulus the observed bias in the Saccade Static condition was also smaller than in the Saccade Preview condition ($\Delta\beta = 0.60$, 95%-CI = [0.25, 0.93], $F(1, 3640) = 7.20$, $p = 0.007$). To estimate the size of the preview benefit in time we took the ratio between the effect of the post-saccadic inducer per 10 ms and the difference between the Saccade static and Saccade preview conditions. For the small annulus this preview benefit is 20.9 ms (bootstrapped 95%-CI = [11.6, 32.2] ms), for the large annulus this is 14.3 ms (bootstrapped 95%-CI = [7.4, 24.6] ms). See Figure C2 for an illustration of the estimated perceived step direction per condition and per inducer duration for the two different annulus sizes. See Figure C3 for the bootstrapped model estimates.

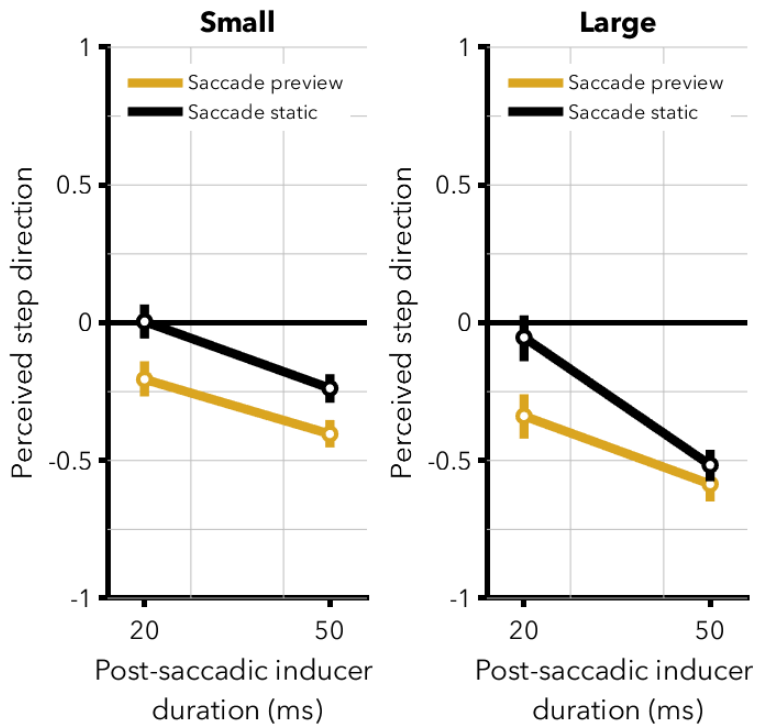


Figure C2. *Model estimates of the average perceived step direction, where the error bars represent the 95%-CI of the estimates obtained with non-parametric bootstrapping. The perceived step direction became more biased to backward steps with increased post-saccadic inducer duration both for the small and the large annulus. Additionally, there was a stronger bias in the Saccade preview condition (yellow) than in the Saccade static condition (black), for both annulus sizes.*

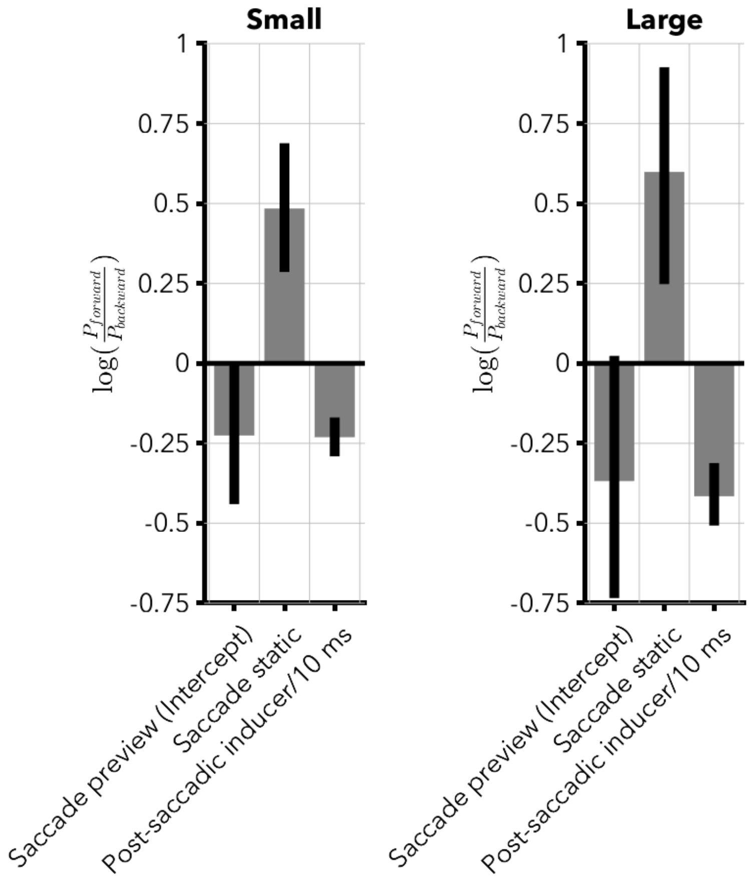


Figure C3. *Bootstrapped coefficient estimates of the generalized linear mixed effects model from trials with a small annulus (left panel) and trials with a large annulus (right panel). Estimates are obtained with non-parametric bootstrapping (2000 samples). Error bars represent empirical 95%-confidence intervals of the estimated coefficients. The estimated coefficients of the 'Saccade static' conditions are relative to the 'Saccade preview' conditions in each panel. The bias to backward steps is observed in the Saccade preview condition is larger than in the Saccade static for both the small and the large annulus.*

Discussion.

In this control experiment, we replicated the spatiotopic preview effect from Experiment 1. Moreover, we measured and observed spatiotopic updating of the inducer effect for an annulus that was presented in the peripheral, parafoveal visual field. This larger annulus stimulated peripheral parts of the visual field in which previous effects of spatiotopic updating have also been observed. These findings demonstrate that rapid spatiotopic updating can be observed at different locations than the saccade target.

Data analysis

Preprocessing.

We only included subjects who could reliably report the direction of rotational steps in the screening (Experiment 1: N = 20/20, Experiment 2: N = 12/12) and whose responses showed a successful induction of the high phi illusion in trials with a long inducer (500 ms) in the *Fixation static* condition (Experiment 1: N = 19/20, Exp. 2: N = 12/12). One subject (Experiment 1) was excluded because she did not report significantly more backward steps when the high phi illusion was presented with this long inducer (Fig. S2). Even though our paradigm was gaze-contingent, we determined post-saccadic inducer durations offline. Saccades were detected offline using the native SR Research saccade detection algorithm. The timing of the onset of the stimuli was determined by the timestamps in the Eyelink datafile, corrected for the input lag of 11 ms of the monitor, as measured with a photodiode (*SI appendix, Synchronization*). Next, we only included trials in the analysis where

1) the primary saccade had an amplitude > 12º
2) the primary saccade started and ended within 2º of the fixation points (or, in case of Fixation conditions, where the median gaze position over 50 ms after preview onset and inducer onset was within 2º of the fixation points)
3) the primary saccade started before the gaze-contingent onset (at least 10 ms)
4) the primary saccade ended after the gaze-contingent onset (at least 10 ms)
5) the primary saccade had a minimum latency of 80 ms after stimulus onset
6) the primary saccade had maximum latency no higher than the 95^{th} percentile of all saccades that were included after applying criteria 1 to 4 (Experiment 1: 320 ms, Experiment 2: 242 ms)
7) where the manual response time was within the 2.5^{th} and 97.5^{th} percentile of all the trials after applying criteria 1 to 4 (Experiment 1: 331-1244 ms, Experiment 2: 320-1240 ms)
8) where the post-saccadic inducer duration was in the closed interval [20, 60] ms in Exp. 1, or [10, 60] in Exp. 2.
9) Another inclusion criterion in Experiment 2 was that the inducer preview duration had to be in the closed interval [10, 140] ms.

With these criteria we included 7962 trials in Experiment 1 (42.9% of all trials) and 5436 trials in Experiment 2 (49.7% of all trials). For the main analysis of Experiment 2, only the trials from the saccade condition were used (3802 trials, 41.3% of all saccade trials).

Synchronization of visual onsets and eye-movements.

Introduction – For the analysis of the reported experiments, we synchronized eye-movement data from the Eyelink data file (EDF) with stimulus onset (as determined by the timestamps in the EDF). During the experiments, timestamps were sent to the EDF immediately after PsychToolbox reported that the vertical retrace had started. That is, we used the function Eyelink('Message') immediately after using Screen('Flip'). With these timestamps in the EDF, we determined in which trials our online-gaze contingent algorithm performed correctly (e.g. starting the rotation of the inducer during the saccade rather than after the saccade in the *Saccade static* condition). Hence, to ensure that we only included trials where the stimulus was indeed rotating before the saccade had ended, we only included trials where the time difference between the timestamp of the onset of the inducer and the offset of the saccade was larger than 10 ms (i.e. the duration of 1 frame at 100 Hz). This criterion was also applied to Induce Preview trials. Thus, we entered only those trials in the analysis where the gaze-contingent onset was at least 10 ms before the offset of the saccade. This method of synchronizing stimulus presentation with eye movement data is only valid if the timestamp in the EDF was indeed synchronized with stimulus onset. However, this is most likely not the case for most LCD monitors because they suffer from input lag (a delay introduced in the hardware of the monitor). To accurately synchronize eye movement data and visual stimulation we measured the input lag of our monitor with a photodiode that was fed directly into the printer port of the Eyelink host PC.

Methods – We used a photodiode (sampling rate = 10 kHz) connected to an Itsy Bitsy microcontroller board (Adafruit Industries, New York City, NY). The output of the Itsy Bitsy was sent to the parallel port (printer port) of the Eyelink host PC, to the 11th pin ('busy' pin). With a custom-written Matlab script, using the Psychophysics toolbox and Eyelink toolbox, we changed the luminance of the screen every frame. We tested 4 transition transitions from full dark to 25%, 50%, 75% or 100% luminance. Luminance thresholds for the output were set to 80% of the required luminance level in a given measurement. After the script commanded a luminance change (with the Psychophysics toolbox's Screen('Flip') function) a message was sent to the Eyelink data file (using the Eyelink toolbox's Eyelink('Message') function). Simultaneously, we recorded the output of the photodiode directly into the Eyelink data file. We should note that our LCD monitor uses a feature that is not common in all LCD monitors, called 'ultra low motion blur' (ULMB). With ULMB turned on, the backlight of the LCD panel is strobing at the same rate as the refresh rate of the monitor, in our case 100 Hz (see Fig. S5 for measurements made with oscilloscope). This makes the monitor effectively similarly suited for visual psychophysics as traditional CRT monitors, as recently described by Zhang and colleagues (2018). Because the backlight is strobing, this means that a transition from 100% bright to 50% bright is in fact a transition from 100% to 0% to 50% luminance. We made several photographs from measurements with an oscilloscope to demonstrate this feature of the screen (Figure S6). Given that the screen is always dark between two frames, and the photodiode is a binary signal, we can only consider changes from dark to a certain luminance value. For each luminance level, we reversed the luminance 2000 times (i.e. 1000 from bright to dark and 1000 from dark to bright). We compared the differences between the timestamp of the message and the time of change in photo diode output.

Results and discussion – There was a consistent delay of 11.0 ms (s.d. = 0.5 ms) between the timestamp and the time of contrast reversal as measured with the photodiode (Fig. S6A). This is numerically similar to the input lag measured by Zhang and colleagues (3). The delays were similar across different vertical locations. To correct for the measured input lag, we added 11 ms to all the timestamps in the EDF that indicated the onset of a visual stimulus before we performed our analyses and before we applied the in/exclusion criteria to individual trials. Timings of post-saccadic inducer onsets over eye-positions are visualized in Fig. S6B.

Statistics Experiment 1

We analyzed the responses from Experiment 1 with four factors in the following model, with a logit link function. The analysis was run in Matlab 2016a, with the 'fitglme' function from the Statistics package.

Model structure.

Experiment 1 was designed to test for effects of post-saccadic inducer duration and differences in offset between conditions. Thus, we constructed a mixed model with two fixed effects, one for condition and one for post-saccadic inducer duration. For completeness, we compared the model with these fixed effects against two alternative models with different fixed effects (see below). For the random effects, we allowed the size of the fixed effects to vary across subjects, because in most psychophysical experiments the effect sizes can vary across observers. Additionally, we added a random effect of rotation direction that we allowed to vary per subject. This third random effect was included to dissociate a perceptual bias from a response bias. There is a two stage rationale for this. First, the number of trials per rotation direction could not be balanced a priori, because the trial exclusion based on saccade parameters was performed pos-hoc. Second, theoretically, subjects could have a default response of, for example, pressing the 'right' button. If a subject with such a bias would also have more trials – after trial exclusion – with counterclockwise rotations, it would seem as though this subject would have a perceptual bias for reporting backward steps, whereas in fact he was just pressing the same button and hence a response bias. We account for this possibility by adding a random effect of rotation direction to vary per subject.

Formula.

```
response ~ condition + inducer + (1 + condition + inducer + rotation | subject)
```

Factors.

	Factor	Class	Levels	Code
0	Response	Categorical	backward forward	0 1
1	Condition	Categorical	saccade preview fixation static fixation preview saccade control	0 1 2 3
2	Post-saccadic inducer duration	Continuous	20 ms ⋮ 60 ms	1 ⋮ 5
3	Inducer rotation direction	Categorical	clockwise counterclockwise	0 1
4	Subject	Categorical	1 ⋮ 19	1 ⋮ 19

Model comparison.

The design of the model for the analysis of Experiment 1 was defined by our experimental questions. However, we did examine whether adding an interaction term to the model would improve the fit. In addition, as a sanity check we compared our model against a model with the same random effects, but without any fixed effects.

Final model

```
response ~ condition + inducer + (1 + condition + inducer + rotation | subject)
```

Interaction model

```
response ~ condition * inducer + (1 + condition + inducer + rotation | subject)
```

Null model

```
response ~ 1 + (1 + condition + inducer + rotation | subject)
```

Final model vs. Interaction model

```
Theoretical Likelihood Ratio Test
    Model             DF  AIC    BIC    LogLik     LRStat  deltaDF  pValue
    finalModel        26  8775   8956.5 -4361.5
    interactionModel  29  8776.8 8979.3 -4359.4    4.155   3        0.2452
```

Final model vs. Null model

```
Theoretical Likelihood Ratio Test
    Model             DF  AIC    BIC    LogLik     LRStat  deltaDF  pValue
    nullModel         22  8795.5 8949.1 -4375.8
    finalModel        26  8775   8956.5 -4361.5    28.543  4        9.6774e-06
```

Bootstrapped GLME estimated coefficients.

Coefficients obtained with non-parametric empirical bootstrapping. For the bootstrapping procedure we randomly sampled an equal number of responses per inducer duration per condition as in the original model (i.e. stratification over the fixed effects), without stratifying over the random effects (i.e. subject and rotation direction). Thus, for each sample we had 7962 observations, and we re-fitted our original model with these random sample of trials. This sampling and re-fitting was repeated 2000 times. To obtain confidence intervals on the estimated coefficients, we calculated empirical confidence intervals. That is, taking the difference between the original model estimates and all the bootstrap estimates: $\boldsymbol{\delta} = \mathbf{b}_{\mathbf{bootstrap}} - \mathbf{b}_{\mathbf{model}}$. The bias-corrected estimate of a given coefficient is defined as $\mathbf{b} = \mathbf{b}_{\mathbf{model}} - \boldsymbol{\delta}_{\mathbf{0.5}}$, and the 95% confidence interval is $[\mathbf{b}_{\mathbf{model}} - \boldsymbol{\delta}_{\mathbf{0.025}}, \mathbf{b}_{\mathbf{model}} - \boldsymbol{\delta}_{\mathbf{0.975}}]$.

Planned comparisons between conditions.

All estimated coefficients in the mixed effects model of Experiment 1 are relative to the *Fixation static* condition with a post-saccadic inducer of 20 ms. However, to answer all our experimental questions we also compared conditions among each other with planned comparisons. The reported p-values are Holm-Bonferroni corrected for multiple comparisons. Stars indicate a significant difference with an alpha of 0.05.

```
Saccade preview  vs Fixation static,  F(1, 7957) = 36.80, p < 0.0001*
Saccade preview  vs Fixation preview, F(1, 7957) = 10.13, p = 0.0059*
Saccade preview  vs Saccade static,   F(1, 7957) = 17.54, p = 0.0001*
Fixation static  vs Fixation preview, F(1, 7957) = 7.85,  p = 0.0153*
Fixation static  vs Saccade static,   F(1, 7957) = 0.90,  p > 0.05
Fixation preview vs Saccade static,   F(1, 7957) = 2.14,  p > 0.05
```

Statistics Experiment 2

Model comparison.

Formulae

Final model

```
response ~ preview + inducer + (1 + preview + inducer + rotation | subject)
```

Interaction model

```
response ~ preview * inducer + (1 + preview + inducer + rotation | subject)
```

Null model

```
response ~ inducer + (1 + preview + inducer + rotation | subject)
```

Final model vs. Interaction model

Theoretical Likelihood Ratio Test

Model	DF	AIC	BIC	LogLik	LRStat	deltaDF	pValue
finalModel	*13*	*4041.0*	*4122.2*	*-2007.5*			
interactionModel	*14*	*4040.6*	*4128.0*	*-2006.3*	*2.3889*	*1*	*0.1222*

Final model vs. Null model

Theoretical Likelihood Ratio Test

Model	DF	AIC	BIC	LogLik	LRStat	deltaDF	pValue
nullModel	*12*	*4048.0*	*4122.9*	*-2012*			
finalModel	*13*	*4041.0*	*4122.2*	*-2007.5*	*8.9919*	*1*	*0.0027*

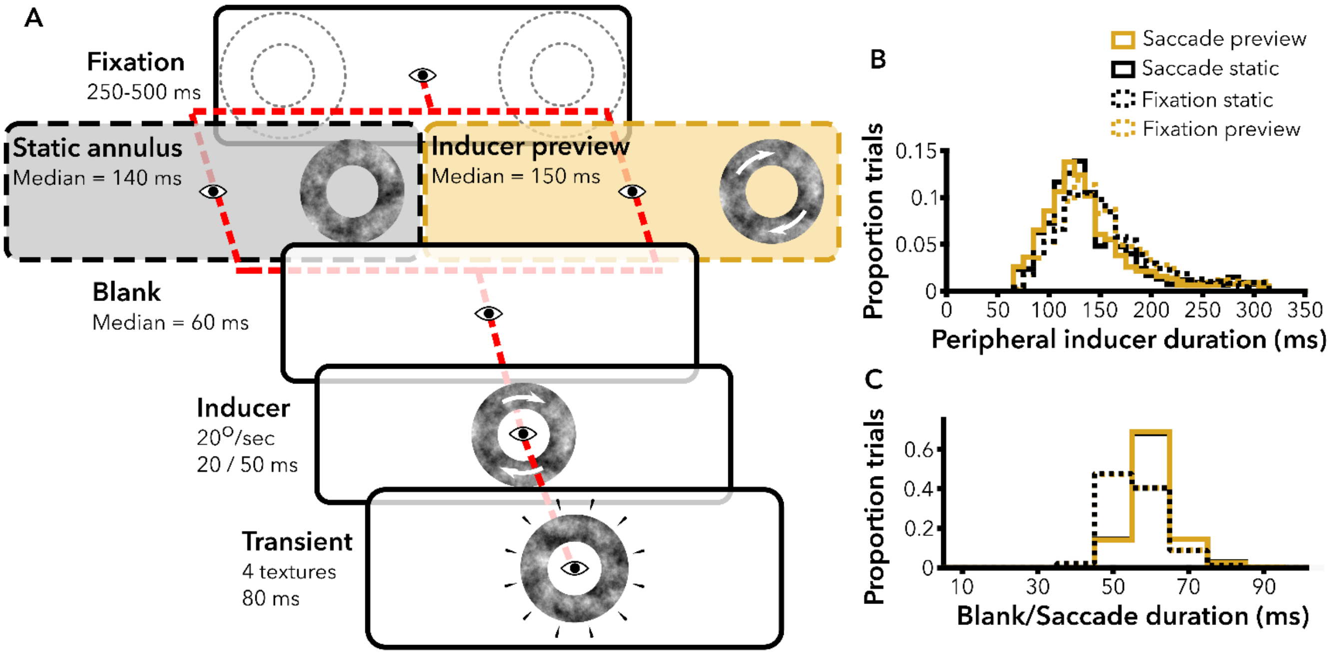


Fig. S1. A) Experiment 1, control conditions. The visual input from the experimental saccade conditions was mimicked as close as possible, without the execution of a saccade. The two control conditions proceeded almost identically, with the only exception that the peripheral annulus (panel 2) remained static (Fixation static) or rotated (Fixation preview). Subjects maintained fixation at a fixation target in the center of the screen over the entire course of a trial. The dotted lines in the first panel were not visible but merely illustrate the stimuli could appear at two locations (equal probability). The eye indicates required gaze position in each panel. Arrows on the annulus illustrates that the annulus rotated in that phase of the trial. Median duration of the peripheral stimulus (panel 2) and the blank (panel 3) were sampled from the saccade parameters from the experimental conditions. **B)** Histogram with durations of peripheral preview in control and experimental conditions from Experiment 1. The duration of the peripheral inducer in the control conditions (dashed lines) was sampled online from the distribution of saccade latencies (for each subject individually. Durations of the saccade latencies (solid lines) are corrected for the delay between timestamp and visual onset. **C)** Histogram with the durations of the blanks in the control conditions (dashed lines) and saccade durations (solid lines) in the experimental conditions. The duration of the blank in the control conditions was sampled from the distribution of the saccade durations in the experimental conditions.

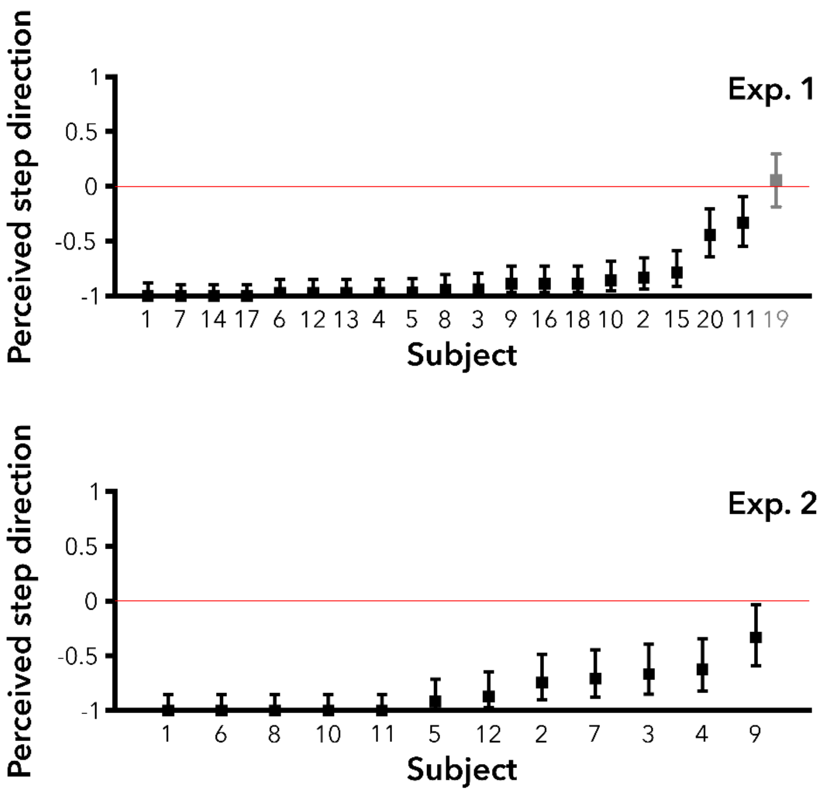


Fig. S2. Perceived step direction in the Fixation static condition with an inducer duration of 500 ms. Upper panel Experiment 1. Lower panel Experiment 2. Forward steps are coded +1 and backward steps -1. The average response for each subject is plotted. Subjects are ordered by the strength of their response bias. Error bars represent the binomial 95%-confidence interval.

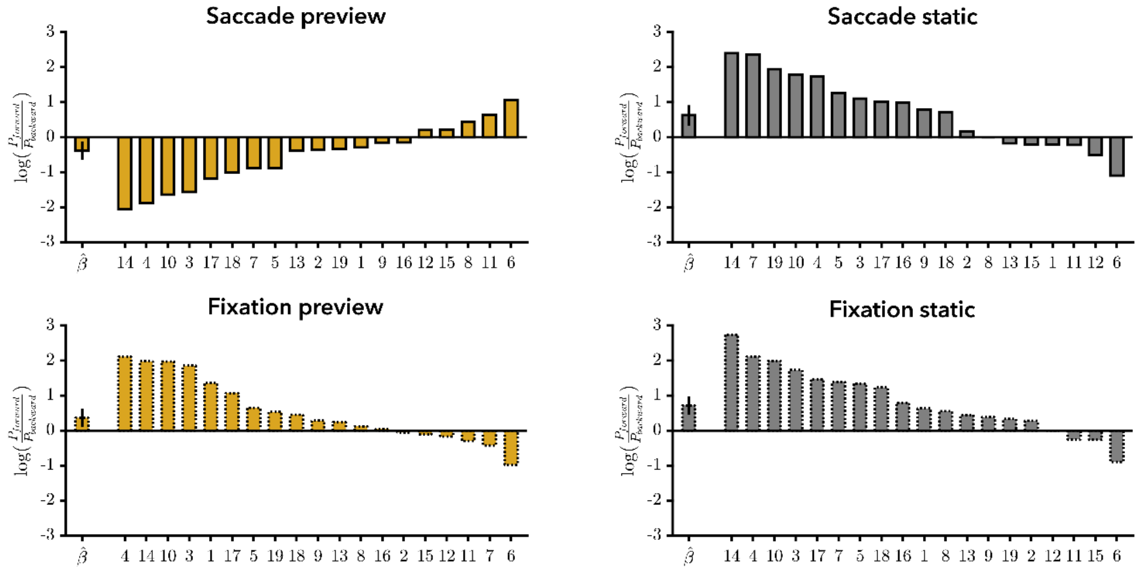


Fig. S3. Individual biases per condition in Experiment 1. First bar is the bias as estimated by the generalized linear mixed effects model (error bars are 95% bootstrapped confidence intervals). X tick labels refer to subject ID. In each panel, subjects are ordered by effect size. For each subject, the average response (converted to log odds) per condition with a post-saccadic inducer of 20 or 50 ms. The difference between these averages was divided by 3 to get an estimate of the effect of the post-saccadic inducer of 10. Then, we took the average response after 20 ms of post-saccadic inducer and subtracted the effect of 10 ms inducer. Thus, we had an estimate of the bias after 10 ms of post-saccadic inducer per condition per subject.

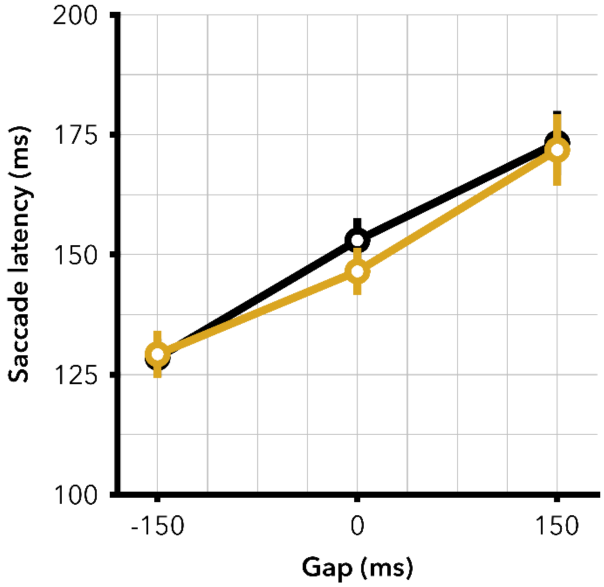


Fig. S4. Average saccade latencies in Experiment 1 in the Saccade Preview (yellow) and Saccade static (black) conditions. Error bars represent 1 standard error of the mean over subjects. Gap duration is defined as the time of fixation target offset minus the time of stimulus onset. A two-way repeated measures analysis of variance showed the gap modulation had a significant effect on saccade latencies ($F(2,36) = 31.815$, $p < 0.001$), with no significant difference between the two preview conditions ($F(1,18) = 1.065$, $p = 0.316$), nor a significant interaction between gap duration and preview condition ($F(2,36) = 1.298$, $p = 0.285$).

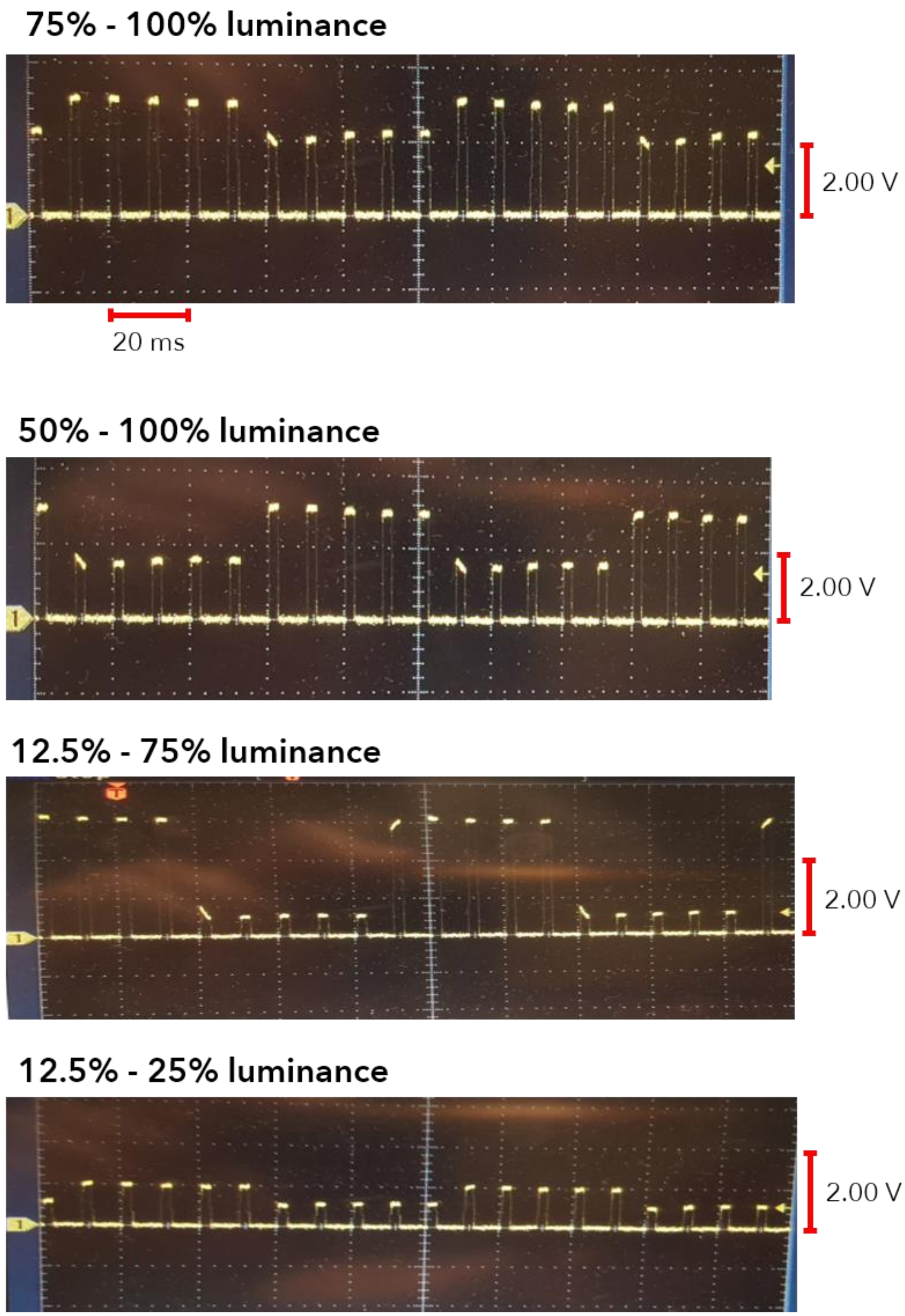


Fig. S5. Photographs of oscilloscope measurements of different luminance transitions. Luminance was changed every 5 frames while the monitor was running at 100 Hz, and with the native backlight strobing feature enabled with pulse width of 100%. The desired luminance level was reached within the first frame when the luminance was changed. For large transitions there was a small ramp within the first frame (best visible in the third panel, 12.5% - 75% luminance).

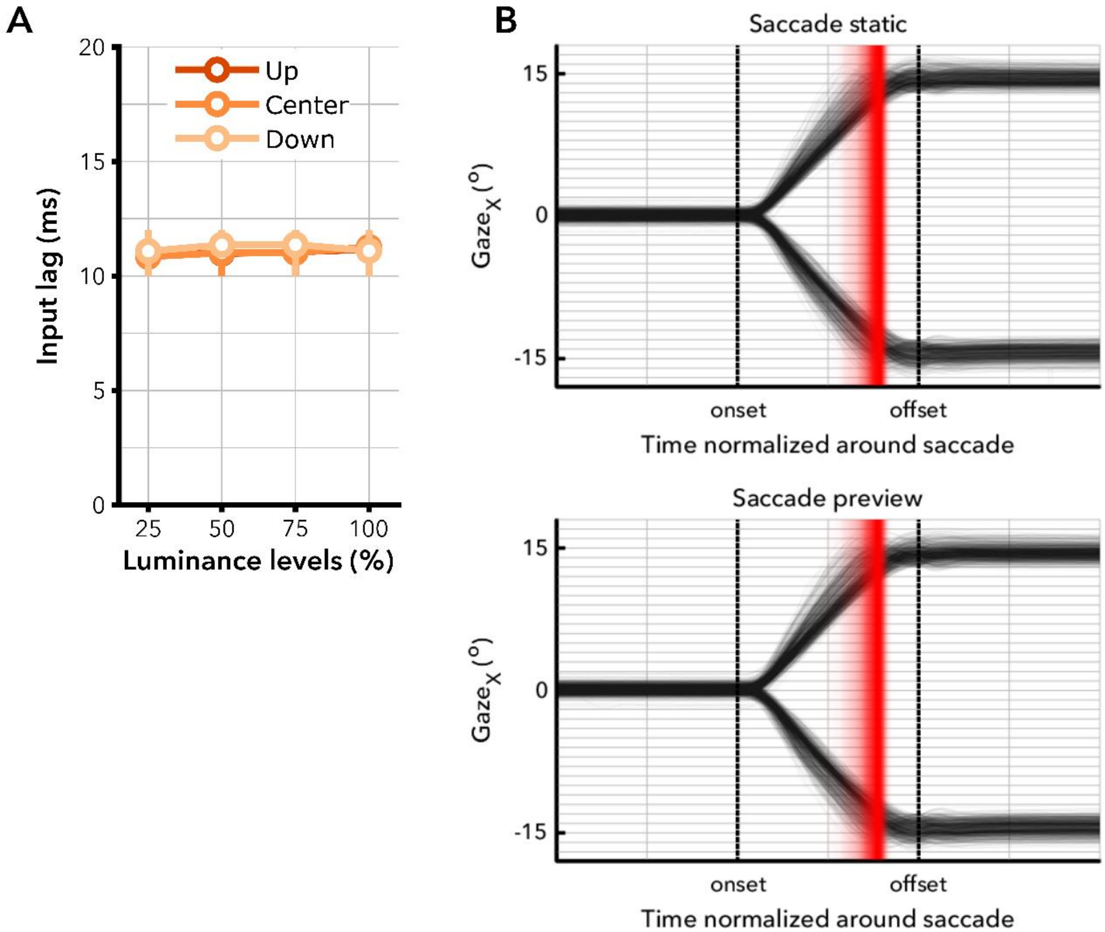


Fig. S6. Synchronization of visual onsets and timestamps in Eyelink datafile (EDF). **A)** Average input lag in ms between visual onset (as measured with a photodiode) and the timestamp in the EDF. Lags were measured at three different locations on the left side of the screen (see legend). Delays were measured from black to different luminance levels (see x-axis). Error bars represent interval including 95% measured delays. Rounded to whole milliseconds, all measured input lags were 11 ms. **B)** Horizontal gaze position over time, where time is normalized to saccade onset and offset. Red patch is the onset of the post-saccadic inducer in all trials that were included in the analysis, where the transparency reflects the density of onsets. This onset is the based on the timestamp in the EDF and corrected by 11 ms based on the photodiode measurement as displayed in A. The upper panel includes all trials from the Saccade static condition. The bottom panel includes all trials from the Saccade preview condition.

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