Supporting Information

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SI Materials and Methods

For each observer, each individual parameter combination was presented 16 times in experiment 1 (13 subjects, 9 male, age 18–30 years), 16 times in experiment 2a (8 subjects, 5 male, 18–30 years, 6 participated in experiment 1), at least 24 times in experiment 2b, 8 times in experiment 3 (9 subjects, 6 male, 18–30 years, all participated in experiment 1 and 6 in experiment 2a), and 160 times in experiment 4 (10 subjects, 7 male, 18–30 years, all participated in experiment 1), and 8 times in experiment 5 (9 subjects, 7 male, all participated in experiment 1). All experiments were undertaken with the understanding and written consent of each subject. Experiments were approved by the Institutional Review Board and conformed to the Declaration of Helsinki.

Eye Movements. In all experiments, subjects were told to fixate the central fixation mark throughout the trial, and to avoid making eye movements. In experiment 2b, eye movements were tracked with an infrared monocular eye tracker, EyeLink 1000, at 1,000 Hz. A trial could only be started when the subject fixated for 0.3 s within a 1° radius from the fixation mark. Saccades were detected by the eye tracking system, using a saccade velocity threshold of 35°/s, and a saccade acceleration threshold of 9,500°/s^2. Trials in which a saccade was made were rejected. All remaining trials were visually checked to determine if undetected saccades, or excessively large drifts, contaminated the trial, but no such events were found.

Data Analysis. In experiment 1, invisible trials were included only if the subject had indeed indicated no visibility; low-attention trials were included only when the correct number of Xs were reported (~75% of all trials were included). In experiment 2a, trials were included when the correct number of crosses was reported [~85% of the all trials were included; in experiment 2b, this was ~45%; ~20% of trial were rejected due to incorrect task performance and ~40% due to saccades (there is an overlap between these trials)]. In experiment 3, low-attention trials were included when the subject reported the correct number of Xs, ±1 (this threshold was more lenient than in experiment 1 to have enough trials per subject per condition; however, changing the threshold did not change the qualitative effects). No selection was made on the basis of visibility; ~70% of all trials were included. For experiments 4 and 5, all trials were included.

For the linear regression analysis in experiments 4 and 5, data were sorted according to the reported visibility duration of the inducer, and then for each subject divided into 10 (experiment 4) or 8 (experiment 5) bins with each an equal number of observations. Average visibility and afterimage duration were calculated per bin per subject. Each of the bins was then averaged over subjects. This procedure made sure that each bin had an equal number of trials from all subjects.

What Could Be the Possible Influence of Eye Movements? In experiment 1, subjects performed a task at fixation in the low-attention conditions, while they ignored the task at fixation and monitored visibility of the adaptor in the periphery in the high-attention conditions. Although subjects were asked to keep fixation on the fixation mark, in the latter case, microsaccades toward the peripheral stimulus likely jittered the stimulus on the retina, thereby decreasing adaptation (1) and, consequently, afterimage duration. This might explain some of our results, as fewer microsaccades in the low-attention condition would produce longer-lasting afterimages. Although our inducing Gabor stimuli had low spatial frequency (0.23 cycles/°), making this an unlikely cause for our effect, we nevertheless performed an auxiliary analysis.

Auxiliary Analysis. ***Stimulus layout and potential eye-movement effects.*** The afterimage-inducing Gabor patch had a random orientation on each trial. In addition, the stimulus was presented at eight different locations around the fixation point. On some trials, this caused the orientation of the Gabor to be parallel to the line connecting the fixation point and the center of the Gabor patch (Fig. S1). Microsaccades toward the stimulus will have little effect on the afterimage duration because dark and light areas remain largely unchanged on the retina. On other trials, the orientation of the Gabor was orthogonal to the line connecting the fixation point and the center of the stimulus. In this case, eye movement may partly overlay regions of different contrast polarity before and after refixation, potentially weakening adaptation and the resulting afterimage.

Orthogonality measure reveals no effect of eye movements. Therefore, we calculated the afterimage duration dependent on the orthogonality of the Gabor and the line connecting the fixation point and the center of the stimulus (which is the line along which the eye would move if microsaccades were made to the stimulus). We divided the data into seven equally sized bins (15° each). If the difference between high- and low-attention conditions does not depend on the orthogonality variable, there is little evidence for an influence of eye movements on our data.

Indeed, Fig. S1 shows no clear dependence of the attentional effects (and thus potential eye movements) on the orthogonality measure (repeated-measures ANOVA: $P > 0.7$, $n = 13$). We repeated the same experiment with an afterimage inducer of higher spatial frequency (3 cycles/°, $n = 2$ subjects) to increase the potential influence of eye movements, but again we found no dependence of afterimage duration on the orthogonality angle (Fig. S1*B*).

Eye movement analysis experiment 2b. In experiment 2b, during the presentation of the afterimage inducer, subjects performed a central task that was either easy or difficult. Afterward they reported the duration of the afterimage, with a button press and release. Eye movements were tracked in this experiment.

We performed several analyses on 10 subjects on eye movements to investigate whether they could have influenced our data. As mentioned in the main text and above, small eye-movements during the adaptation phase might have influenced the subsequent afterimage duration. We analyzed the trials that were included in the analysis of the behavioral results (i.e., trials without saccades and with correct central task performance; about 45% of all trials). Note all of the eye movements analyzed here are of very small magnitude (i.e., drift and microsaccades).

We started our analysis by looking at whether there are more eye movements along the line connecting the fixation point and the stimulus center, or orthogonal to it. As an aggregate measure we used the SDs of eye positions in each of these directions. Overall the SDs parallel or orthogonal to the fixation-stimulus line were not significantly different ($P > 0.4$, one-tailed paired *t* test over subjects). When split out for the different attentional conditions, neither the low-attention condition (with the hard central task, $P > 0.4$) nor the high-attentional condition (with the easy task, $P > 0.4$) showed significant differences depending on the orthogonality to the fixation-stimulus line.

We then looked at whether the duration of the afterimage depended on the SD of eye movements parallel to the orientation of the inducer, or orthogonal to it (much like we have done above in

Auxiliary Analysis but now with the actual eye movements instead of the assumed movements).

To combine the data over subjects, before performing a regression analysis, each trial's SDs and afterimage duration were normalized for each subject individually. Specifically, each trial's SDs (i.e., parallel and orthogonal to the stimulus orientation) were divided by the mean SD (combining parallel and orthogonal directions) across all trials within each subject. A similar normalization was performed for the afterimage durations: each trial's afterimage duration was divided by the mean afterimage duration of the subject. After normalization, the data were combined across subjects, and linear regressions between the normalized SDs of eye movements and the normalized afterimage duration were performed.

We found no dependence of the afterimage duration on the size of the SD in the direction parallel to, or orthogonal to, the inducer's orientation when split out for the different attention conditions (all four *P*'s for the slopes > 0.1). We then looked at the dependence of the afterimage duration on the size of the SDs, combined over the attentional conditions, and found again no dependence (dependence on the SD parallel to the inducer's orientation: $P > 0.8$; dependence on the SD orthogonal to the inducer's orientation: $P > 0.95$). The afterimage was also not dependent on the ratio of the two SDs ($P > 0.95$).

Overall, the small eye-movements that remained after saccades were excluded did not significantly influence afterimage duration in our data.

1. Martinez-Conde S, Macknik SL, Troncoso XG, Dyar TA (2006) Microsaccades counteract visual fading during fixation. *Neuron* 49:297–305.

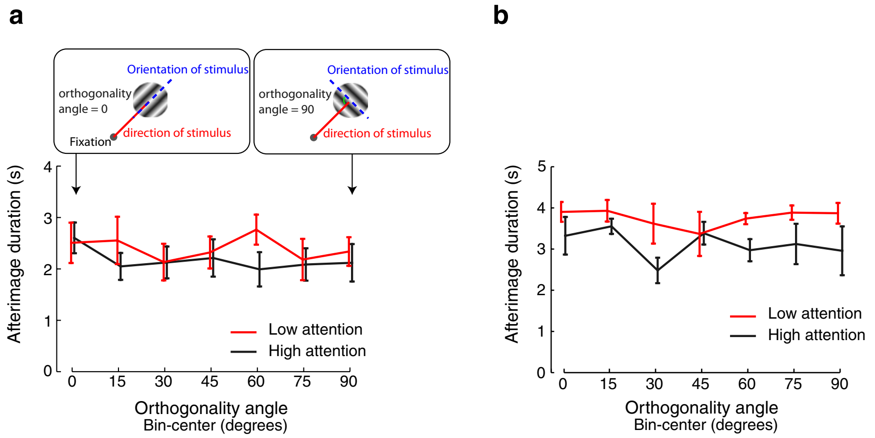

Fig. S1. No dependence of afterimage duration on the orthogonality measure. Afterimage duration in experiment 1 (*A*) and for Gabor patches of higher spatial frequency (*B*) do not depend on the orthogonality measure. These findings therefore indicate that the attentional effect cannot be merely due to the occurrence of microsaccades. Error bars are SEM.

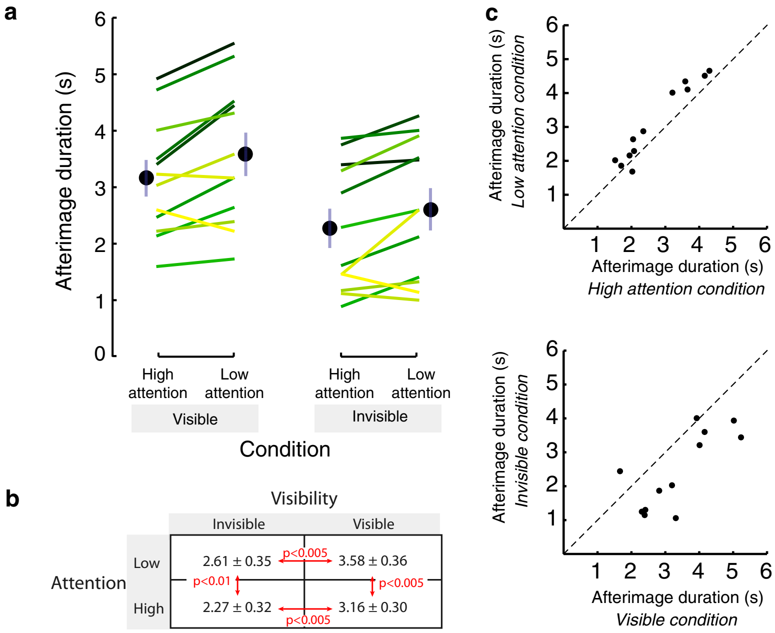

Fig. S2. Effect of attention and visibility on afterimage durations, when trials where subjects report no afterimage were removed (~25% of all trials) from experiment 1. (*A*) Visibility increased afterimage duration in both attended and unattended conditions, and increased levels of attention to the inducer decreased durations in visible and invisible conditions. A two-way repeated-measures ANOVA also revealed main effects of attention and visibility (both $P < 0.002$), and no interaction ($P > 0.5$). (*B*) Mean ± SEM in seconds; unlike the other plots, significance is reported for two-tailed paired *t* tests (compare with Fig. 1*D*). (*C*) There are positive correlations between the afterimage duration in high- and low-attention conditions (Spearman rank correlation: $\rho = 0.95$; $P < 0.001$) and between visible and invisible conditions ($\rho = 0.65$; $P < 0.05$). Note that in the top panel almost all points lie above the diagonal, whereas in the bottom panel almost all points lie below the diagonal. Each dot represents data from an individual subject.

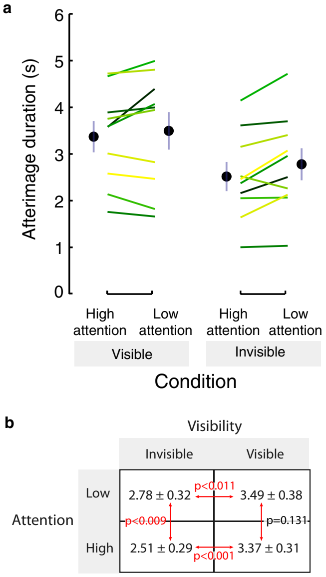

Fig. S3. Effect of attention and visibility on afterimage durations, after excluding trials with saccades or incorrect responses on the central task. (*A*) Attention decreases afterimage durations, whereas perceptual visibility increases durations. Repeated measures ANOVA: main effects of attention ($P = 0.03$) and visibility ($P = 0.005$), with no interaction ($P > 0.25$). (*B*) A table with mean ± SEM afterimage durations, and *P* values of statistical comparisons based on paired one-tailed *t* tests.