2.8.3. Withdrawing attention enhances the intensity of afterimages

We replicate a finding that withdrawing attention enhances afterimages (Lou, 2001; Suzuki and Grabowecky, 2003). We used a central, attention-demanding task during adaptation to withdraw attention from the adaptor. We compared the apparent contrast of the afterimage with and without the central task.

Four subjects who were experienced as subjects but naïve to the hypothesis of this experiment and the first author participated. The central task was a continuous digit-counting task at fixation (Suzuki and Grabowecky, 2003), *i.e.* counting the occurrence of '4' embedded in a stream of numbers between 0 to 9. '4' appeared 0 to 9 times. This task was shown to withdraw attention from the adaptor and delay the onset of the afterimage (Suzuki and Grabowecky, 2003). The task difficulty was maintained by a '3-down-one-up' staircase procedure; after each correct answer the presentation time of each digit was decreased by 10 msec, while after each mistake it was increased by 30 msec. This procedure converges to a 79.4% correct performance level (Levitt, 1971). Approximately, subjects performed the task at around 150 msec for each digit presentation.

The apparent contrast of the afterimage was measured by controlling the contrast of a 'physical' isoluminant Gabor patch with a staircase procedure. The physical Gabor had the same orientation but the opposite phase of the adaptor, that is, the same orientation and phase as the negative afterimage. The orientation and phase were randomized for each trial, the spatial frequency was set to 0.6 cpd and the adaptor contrast to 60%. The contrast of the physical Gabor decayed exponentially with a time

constant of 5.0 sec (Kelly and Martinez-Uriegas, 1993). As the appearance of the physical Gabor was comparable to that of the negative afterimage, all subjects felt comfortable with comparing the apparent contrast of the two. We emphasized the importance of comparing the contrasts just after the end of adaptor presentation (in the beginning of the physical Gabor presentation), signaled by a tone. Step size of the staircase for the physical Gabor was set approximately to 1/10 of the threshold, estimated during practice blocks.

Each block contained four independent staircases interleaved randomly. Two staircases controlled the contrast of the physical Gabor that appeared on the left side of fixation and the other two controlled on the right side. Two staircases started from high contrast (~60%) and the other two started from 0% contrast. Each staircase was terminated after 6 reversals, that is, one block terminated after 24 reversals. Arithmetic mean of the last 5 reversal contrasts from 4 staircases was taken as the apparent contrast of the afterimage.

We compared the apparent contrast of the afterimage when the central task was performed (poor attention to the adaptor) and when the central task could be ignored and focal attention was therefore available to the adaptor. The adaptor was either suppressed by CFS or plainly visible without Mondrians (2x2 design). The order of attention/CFS conditions was randomized across subjects.

Using ANOVA, we found a significant main effect of CFS (F = 18.30 P = 0.00058) and attention (F = 4.86, P = 0.0425), but no interaction (F = 0.15, P = 0.702) (Figure 2.11). *Post-hoc* paired two-tailed t-test showed a significant difference for CFS (with central task, t-score = 3.67, $P < 0.03$; without central task, t-score = 3.55, $P < 0.03$),

replicating our main finding that CFS reduces the afterimage. *Post-hoc* test for attention did not reach significance (with CFS, *t*-score = 2.24, *P* = 0.089; without CFS, *t*-score = 2.07, *P* = 0.108).

Though the direction of attentional effects were consistent with Suzuki's study (Suzuki and Grabowecky, 2003), the magnitude of the effects were rather small: performing the central task and thereby 'drawing attention' away from the Gabor increased the intensity of the afterimage. This attentional effect seems independent of awareness of the adaptor, as we found no interaction. We conclude that the lack of attention during CFS-suppressed adaptation does not explain our main findings. Indeed, this experiment supports claims of a dissociation between attention and awareness (Lamme, 2003; Koch, 2004).

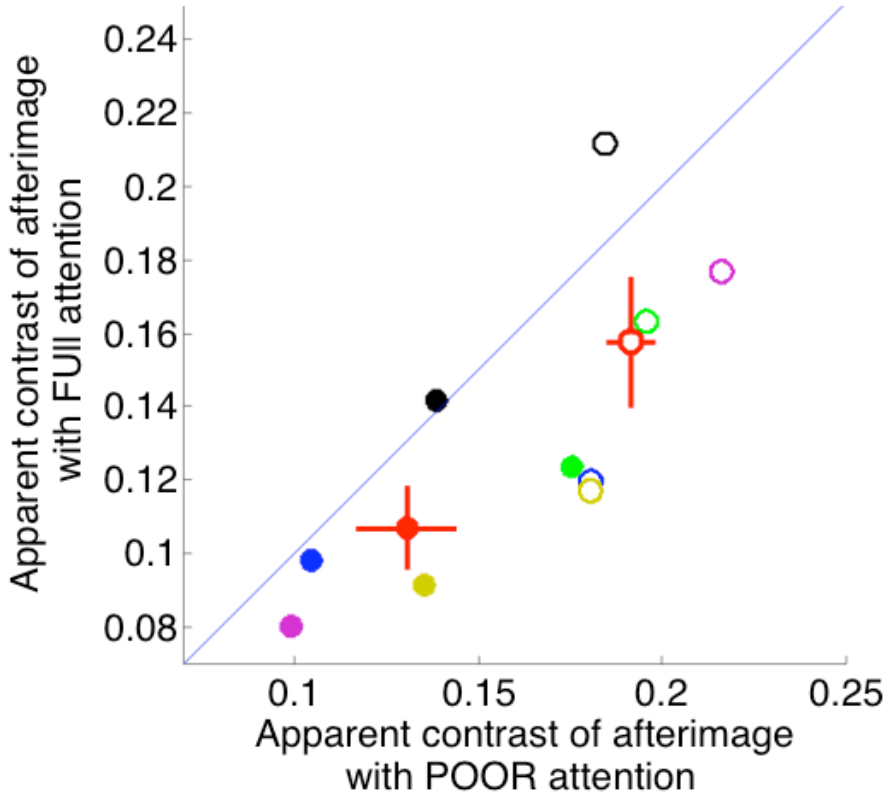

Figure 2.11. Apparent contrast of the afterimage in the presence and in the near-absence of focal attention

The x-axis corresponds to the matching contrast of the physical Gabor when the subject performed the central task, while the y-axis corresponds to the matching contrast when the centrally presented digits were ignored. Points in different colors represent the data from each of 5 subjects. The adaptor was suppressed by CFS (filled circles) or plainly visible (empty circles). Red points correspond to the mean across five subjects. Error bars correspond to s.e.m.