

Supplementary Materials

Scene integration without awareness: No conclusive evidence for processing scene congruency during continuous flash suppression.

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In this Supplementary Material, we report on additional analyses for Experiments 1 and 2 as well as an exploratory analysis on the relationship between mean suppression times obtained for each image averaged across observers and four statistical properties of the images.

In Experiment 3, we implemented a post-experimental rating procedure in which participants had to indicate whether they thought a presented scene was unusual or not. This procedure was not implemented in Experiments 1 and 2 and might have influenced the results. Therefore, we invited the participants of the first two experiments to participate in an on-line experiment in which they had to rate all 80 scenes. The data of the first two experiments were then reanalyzed by first excluding incorrectly rated scenes (i.e., an incongruent scene was rated as congruent and vice versa). Second, in Experiment 3, a technical issue was also fixed. That is, due to a bug in the code, after the eye dominance measurement, the CFS mask was always presented to the right eye rather than the dominant eye. For Experiments 1 and 2, we also reanalyzed the data by excluding participants for which the CFS mask was not presented to the dominant eye (i.e., participants for whom the dominant eye was the left one).

Supplementary analysis for Experiment 1

23 out of 45 (51%) participants responded to our invitation to participate in the rating experiment. Figures S1 and S2 depict the results of Experiment 1 for these 23 participants after also excluding all data points from incorrectly rated scenes. The results are very similar to those observed when analyzing the full data set. That is, a two-way repeated measures ANOVA on the mean correct suppression times revealed no main effect of scene congruency ($M_{\text{congruent}} = 2.36$, $M_{\text{incongruent}} = 2.35$; $SD_{\text{congruent}} = 0.94$, $SD_{\text{incongruent}} = 0.88$; $F(1,22) = 0.095$, $p = .76$, $d = 0.05$), a main effect of scene inversion ($M_{\text{upright}} = 2.31$, $M_{\text{inverted}} = 2.40$; $SD_{\text{upright}} = 0.92$, $SD_{\text{inverted}} = 0.90$; $F(1,22) = 5.43$, $p = .03$, $d = -0.37$), and no interaction between scene congruency and scene inversion ($F(1,22) = 0.068$, $p = .78$, $d = -0.05$). The Bayes Factor analysis indicated strong evidence in favor of the absence of a scene congruency effect ($BF = 22$), moderate evidence in favor of the presence of a scene inversion effect ($BF = 6$) and strong evidence for the absence of an interaction effect ($BF = 16$).

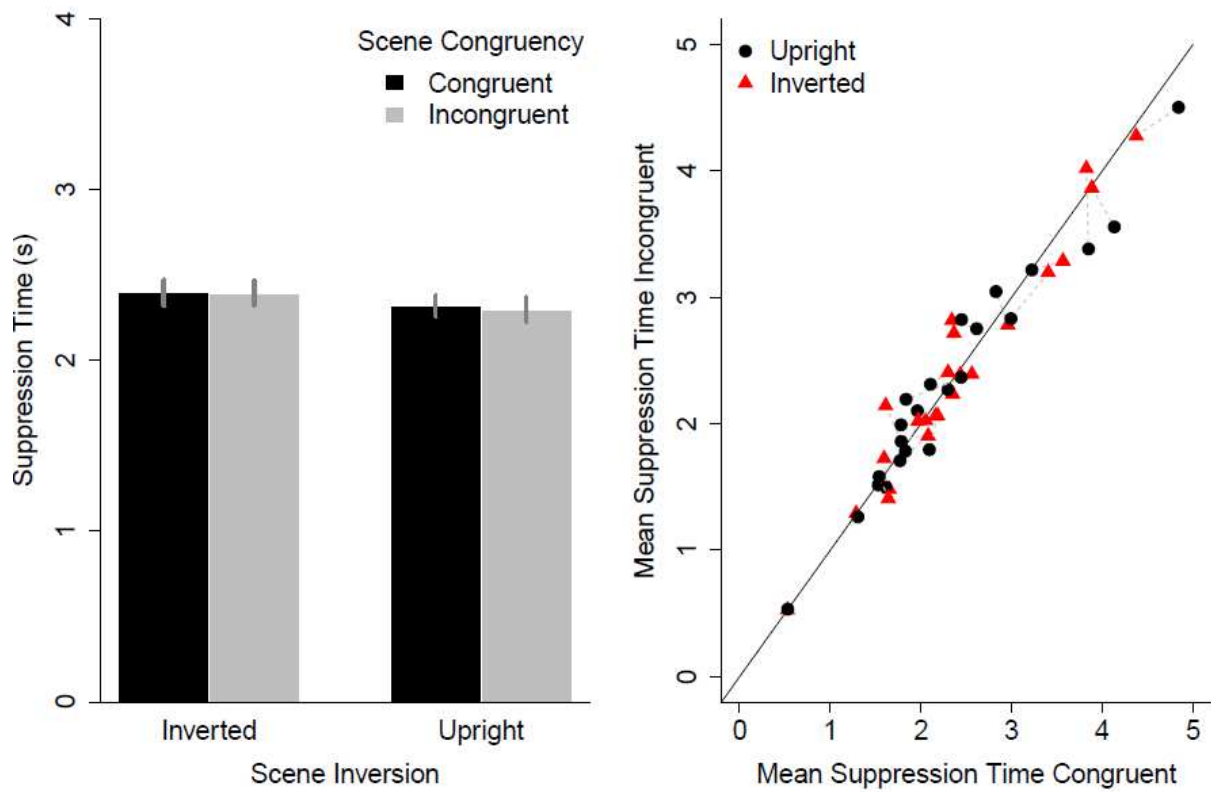


Figure S1. Results of Experiment 1 after removing the incorrectly categorized scenes. Mean suppression time (a) is graphed as a function of scene inversion, separately for congruent and incongruent scenes. Error bars represent within-subjects 95% confidence intervals with the adjustment suggested by [Morey \(2008\)](#). The relationship between mean suppression times for congruent and for incongruent scenes (b) is shown separately for the two scene types. Each dashed line connects the data points for upright and inverted scenes for a single participant. The diagonal line represents equal suppression durations for congruent and incongruent scenes.

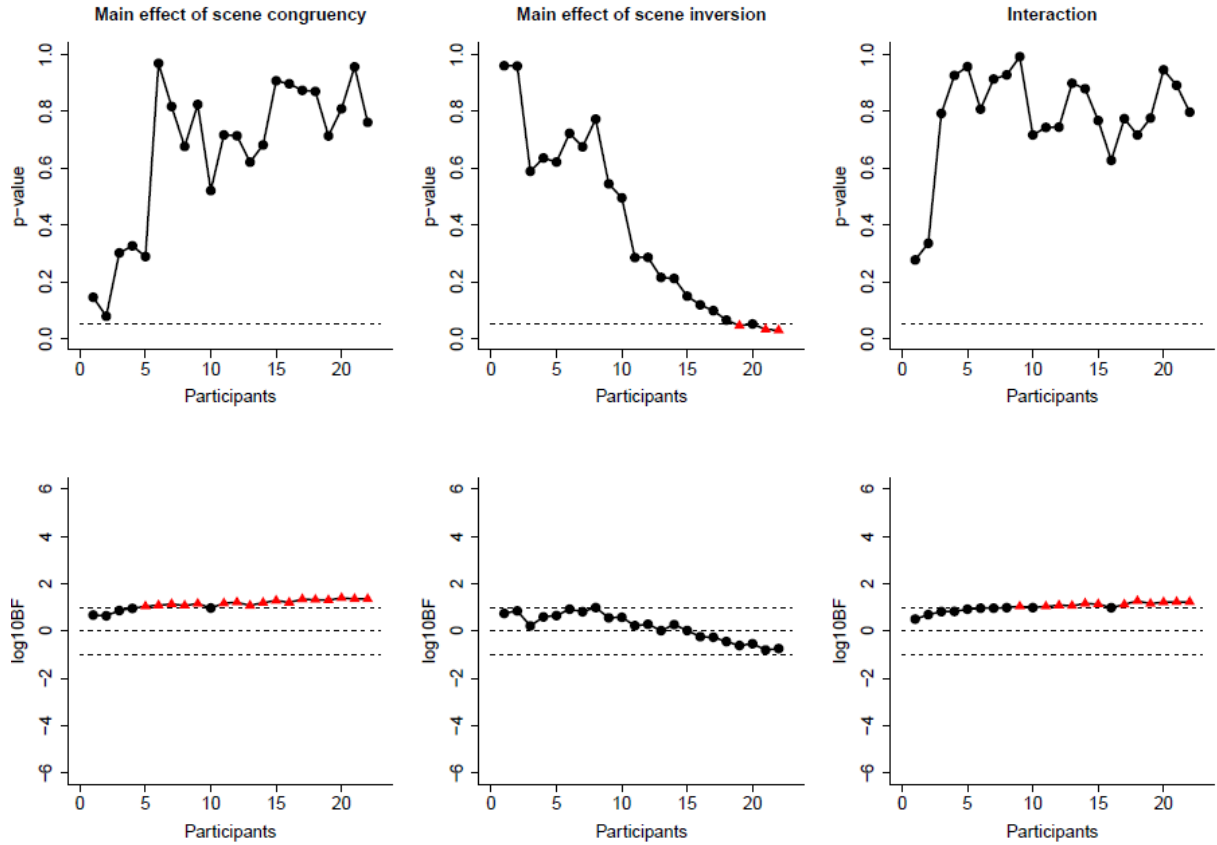


Figure S2. Sequential analysis of the data from Experiment 1 after removing incorrectly categorized scenes. The graphs show p values (top row) and Bayes factor values (bottom row) as a function of the number of participants included in the analysis, separately for the main effect of scene congruency, the main effect of scene inversion, and their interaction. Bayes factors (\log_{10}) greater than 0 indicate evidence for the absence of an effect, whereas Bayes factors smaller than 0 indicate evidence for the presence of an effect.

We conducted the same analysis, but now excluding all participants for which the CFS mask was not presented to the dominant eye. This reduced our sample to 25 participants (20 were excluded). The results of this analysis are depicted in Figures S3 and S4. Again, the results are very similar to those observed when analyzing the full data set. That is, a two-way repeated measures ANOVA on the mean correct suppression times revealed no main effect of scene congruency ($M_{\text{congruent}} = 2.73$, $M_{\text{incongruent}} = 2.67$; $SD_{\text{congruent}} = 1$, $SD_{\text{incongruent}} = 0.97$; $F(1,24) = 2.94$, $p = .1$, $d = 0.21$), no main effect of scene inversion ($M_{\text{upright}} = 2.67$, $M_{\text{inverted}} = 2.73$; $SD_{\text{upright}} = 1.01$, $SD_{\text{inverted}} = 0.96$; $F(1,24) = 2.13$, $p = .16$, $d = -0.20$), and no interaction between scene congruency and scene inversion ($F(1,24) = 0.05$, $p = .82$, $d = -0.05$). The Bayes Factor analysis indicated evidence in favor of the absence of a scene congruency effect ($BF = 6$), evidence in favor of the presence of a scene inversion effect ($BF = 4$) and strong evidence for the absence of an interaction effect ($BF = 17$).

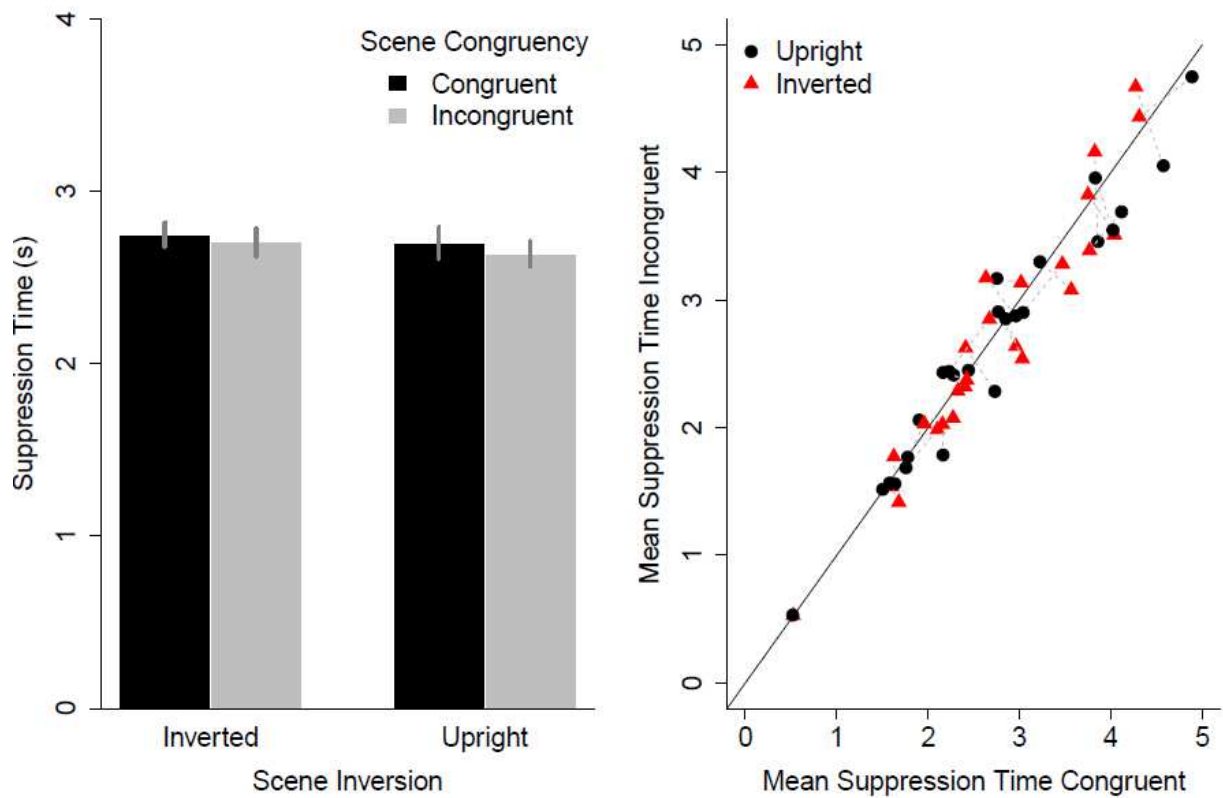


Figure S3. Results of Experiment 1 after removing participants from whom the CFS mask was presented in the nondominant eye. Mean suppression time (a) is graphed as a function of scene inversion, separately for congruent and incongruent scenes. Error bars represent within-subjects 95% confidence intervals with the adjustment suggested by [Morey \(2008\)](#). The relationship between mean suppression times for congruent and for incongruent scenes (b) is shown separately for the two scene types. Each dashed line connects the data points for upright and inverted scenes for a single participant. The diagonal line represents equal suppression durations for congruent and incongruent scenes.

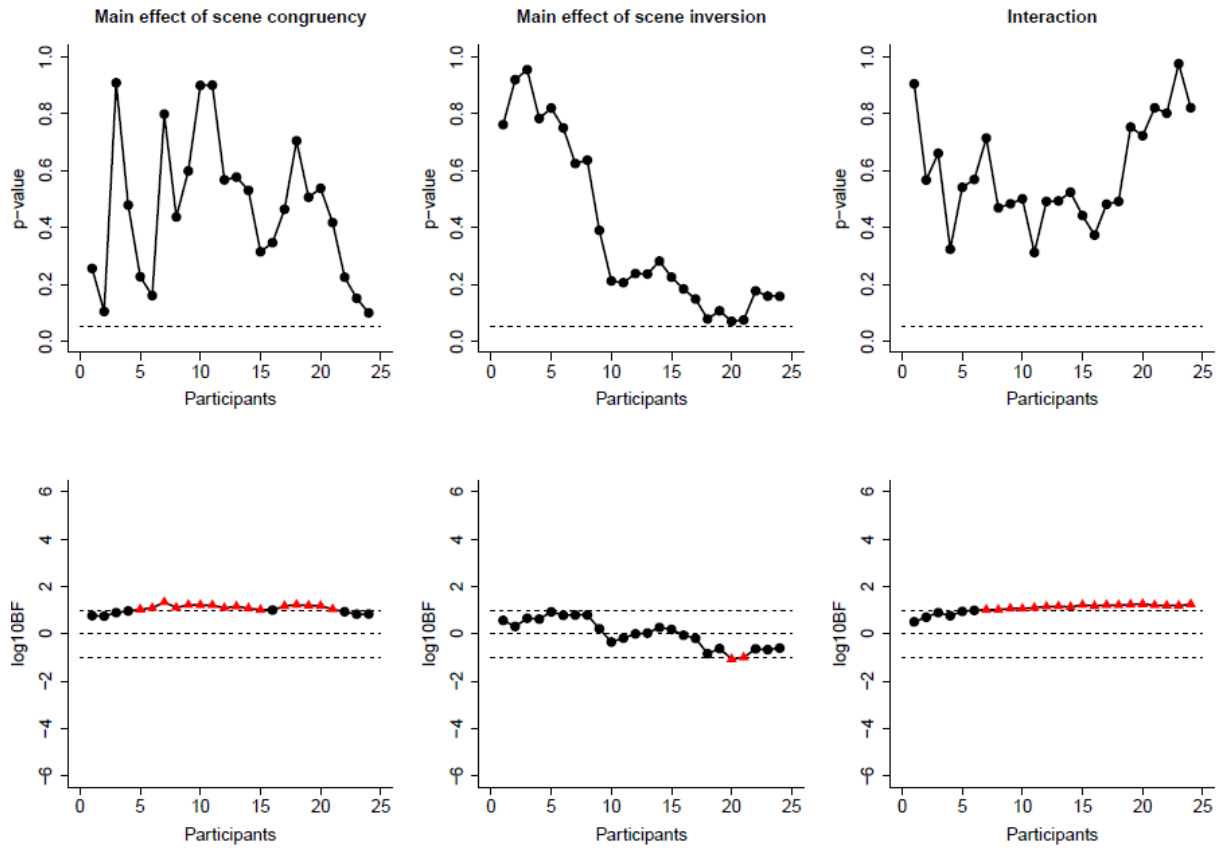


Figure S4. Sequential analysis of the data from Experiment 1 after removing participants for whom the CFS mask was presented in the nondominant eye. The graphs show p values (top row) and Bayes factor values (bottom row) as a function of the number of participants included in the analysis, separately for the main effect of scene congruency, the main effect of scene inversion, and their interaction. Bayes factors (\log_{10}) greater than 0 indicate evidence for the absence of an effect, whereas Bayes factors smaller than 0 indicate evidence for the presence of an effect.

For the sake of completeness, including only those people that responded to the invitation to participate in the rating experiment and those for which the CFS mask was presented to the dominant eye further reduced our sample to 15 participants. This analysis yielded slightly different results compared to the analysis of the full data set and is depicted in Figures S5 and S6. That is, a two-way repeated measures ANOVA on the mean correct suppression times revealed a main effect of scene congruency ($M_{\text{congruent}} = 2.53$, $M_{\text{incongruent}} = 2.43$; $SD_{\text{congruent}} = 1.09$, $SD_{\text{incongruent}} = 1.04$; $F(1,14) = 18.82$, $p = .0007$, $d = 0.61$), no main effect of scene inversion ($M_{\text{upright}} = 2.44$, $M_{\text{inverted}} = 2.52$; $SD_{\text{upright}} = 1.08$, $SD_{\text{inverted}} = 1.05$; $F(1,14) = 3.29$, $p = .09$, $d = -0.37$), and, critically, no interaction between scene congruency and scene inversion ($F(1,14) = 0.33$, $p = .57$, $d = -0.15$). The Bayes Factor analysis did not indicate a preference for the presence or absence of a congruency effect ($BF = 1.3$), nor evidence in favor of the presence or absence of a scene inversion effect ($BF = 0.54$) and indicated strong evidence for the absence of an interaction effect ($BF = 13$).

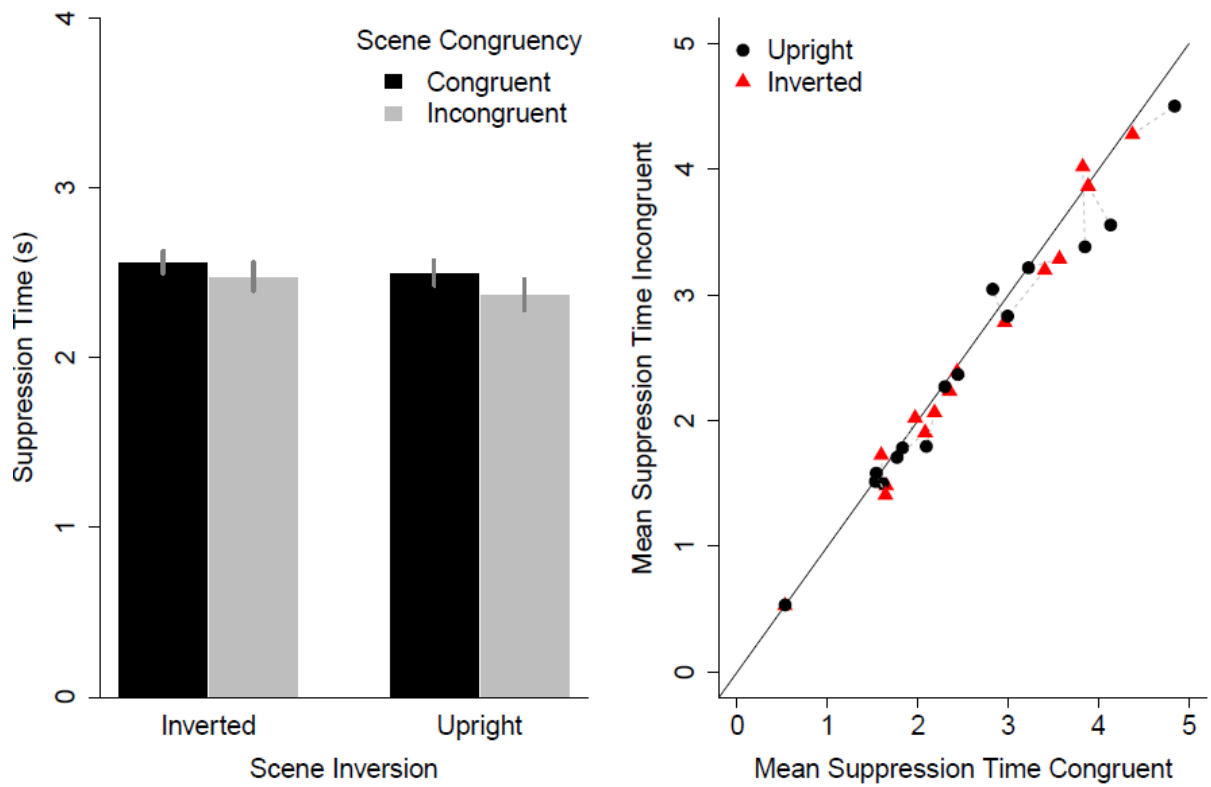


Figure S5. Results of Experiment 1 after removing incorrectly categorized scenes and participants for whom the CFS mask was presented in the nondominant eye. Mean suppression time (a) is graphed as a function of scene inversion, separately for congruent and incongruent scenes. Error bars represent within-subjects 95% confidence intervals with the adjustment suggested by [Morey \(2008\)](#). The relationship between mean suppression times for congruent and for incongruent scenes (b) is shown separately for the two scene types. Each dashed line connects the data points for upright and inverted scenes for a single participant. The diagonal line represents equal suppression durations for congruent and incongruent scenes.

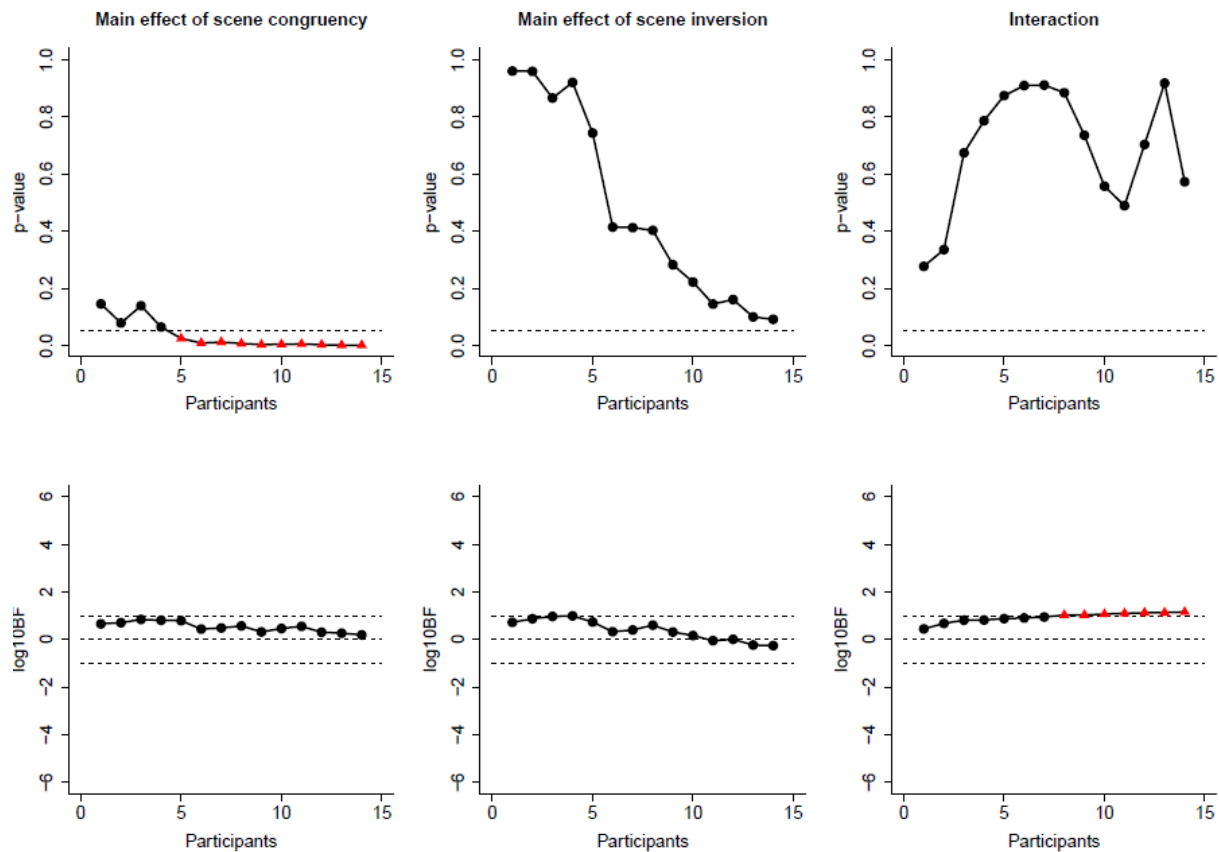


Figure S6. Sequential analysis of the data from Experiment 1. The graphs show p values (top row) and Bayes factor values (bottom row) as a function of the number of participants included in the analysis, separately for the main effect of scene congruency, the main effect of scene inversion, and their interaction. Bayes factors (\log_{10}) greater than 0 indicate evidence for the absence of an effect, whereas Bayes factors smaller than 0 indicate evidence for the presence of an effect.

Supplementary analysis for Experiment 2

We now report on the same reanalysis of the data of Experiment 2 by first considering those participants that performed the rating experiment, then considering those for which the CFS mask was presented in the dominant eye, and ending with combining both exclusion criteria.

18 out of 24 (75%) participants responded to our invitation to participate in the rating experiment. Excluding all incorrectly rated scenes yielded a similar picture as the results for the full data set. That is, no effect of scene congruency was observed neither in the first block ($M_{\text{congruent}} = 2.92$, $M_{\text{incongruent}} = 2.95$; $SD_{\text{congruent}} = 1.12$, $SD_{\text{incongruent}} = 1.07$; $t(17) = -0.36$, $p = .72$, $d = -0.09$) nor when considering the data as a whole ($M_{\text{congruent}} = 2.23$, $M_{\text{incongruent}} = 2.27$; $SD_{\text{congruent}} = 0.71$, $SD_{\text{incongruent}} = 0.70$; $t(17) = -1.37$, $p = .19$, $d = -0.32$). Similarly, a BF analysis of the data always indicated convincing evidence for the absence of a scene congruency effect ($BF = 10$ and $BF = 15$, for the first block and all data, respectively). Figure S7 depicts the results of this analysis.

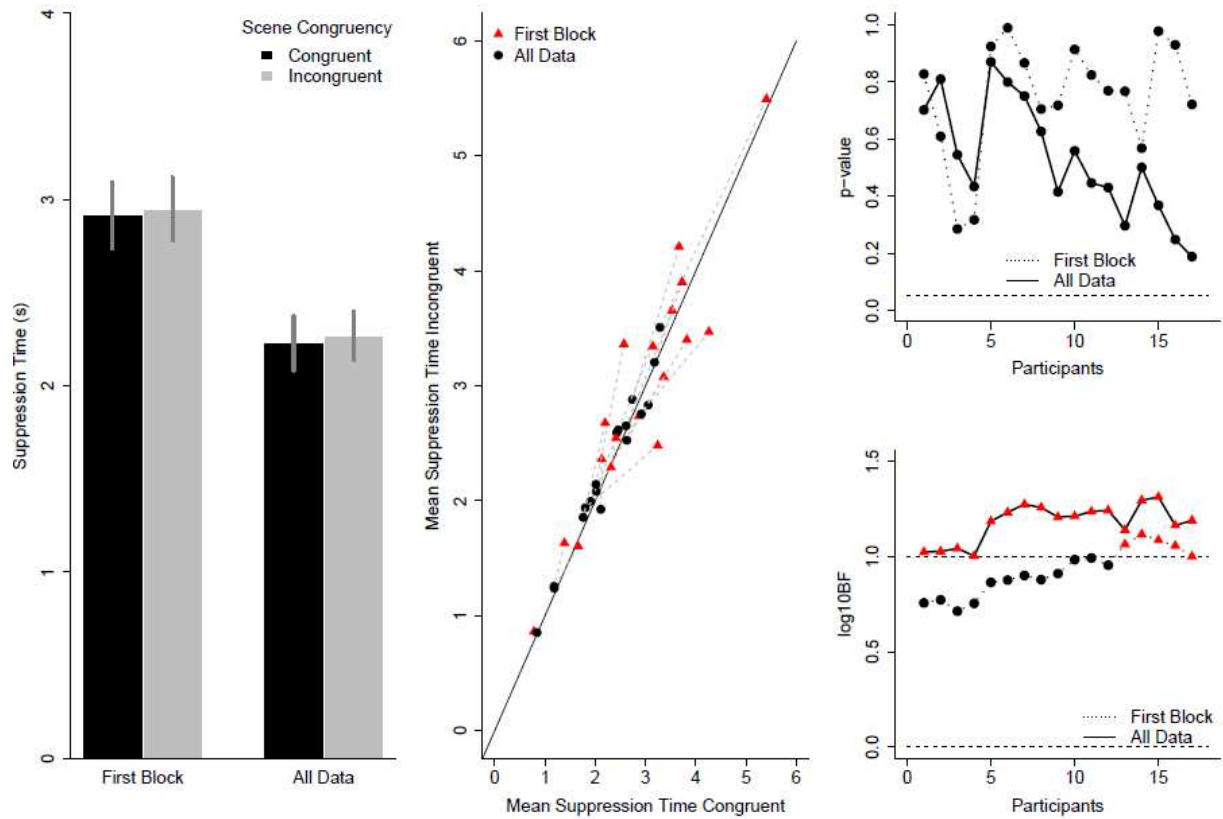


Figure S7. Results of Experiment 2 after removing incorrectly categorized scenes. Mean suppression time (a) is graphed for the first block and for all blocks, separately for congruent and incongruent scenes. Error bars represent within-subjects 95% confidence intervals with the adjustment suggested by [Morey \(2008\)](#). The relationship between mean suppression times for congruent and for incongruent scenes (b) is shown for each participant's performance in the first block and in all blocks. Each dashed line connects the data points for a single participant. The diagonal line represents equal suppression durations for congruent and incongruent scenes. The two other graphs show p values (c) and Bayes factor values (d) as a function of the number of participants in the analysis, separately for the first block and for all blocks. Bayes factors (\log_{10}) greater than 0 indicate evidence for the absence of an effect, whereas Bayes factors smaller than 0 indicate evidence for the presence of an effect.

Including only those participants for which the CFS mask was presented to the dominant eye reduced our sample to 12 observers. The results are summarized in Figure S8 and are very similar to the analyses for the full data set. That is, no effect of scene congruency was observed neither in the first block ($M_{\text{congruent}} = 3.75$, $M_{\text{incongruent}} = 3.71$; $SD_{\text{congruent}} = 0.98$, $SD_{\text{incongruent}} = 0.93$; $t(11) = 0.37$, $p = .72$, $d = 0.11$) nor when considering the data as a whole ($M_{\text{congruent}} = 2.77$, $M_{\text{incongruent}} = 2.80$; $SD_{\text{congruent}} = 0.66$, $SD_{\text{incongruent}} = 0.65$; $t(11) = -0.53$, $p = .61$, $d = -0.15$). Similarly, a BF analysis of the data always indicated convincing evidence for the absence of a scene congruency effect ($BF = 13$ and $BF = 26$, for the first block and all data, respectively).

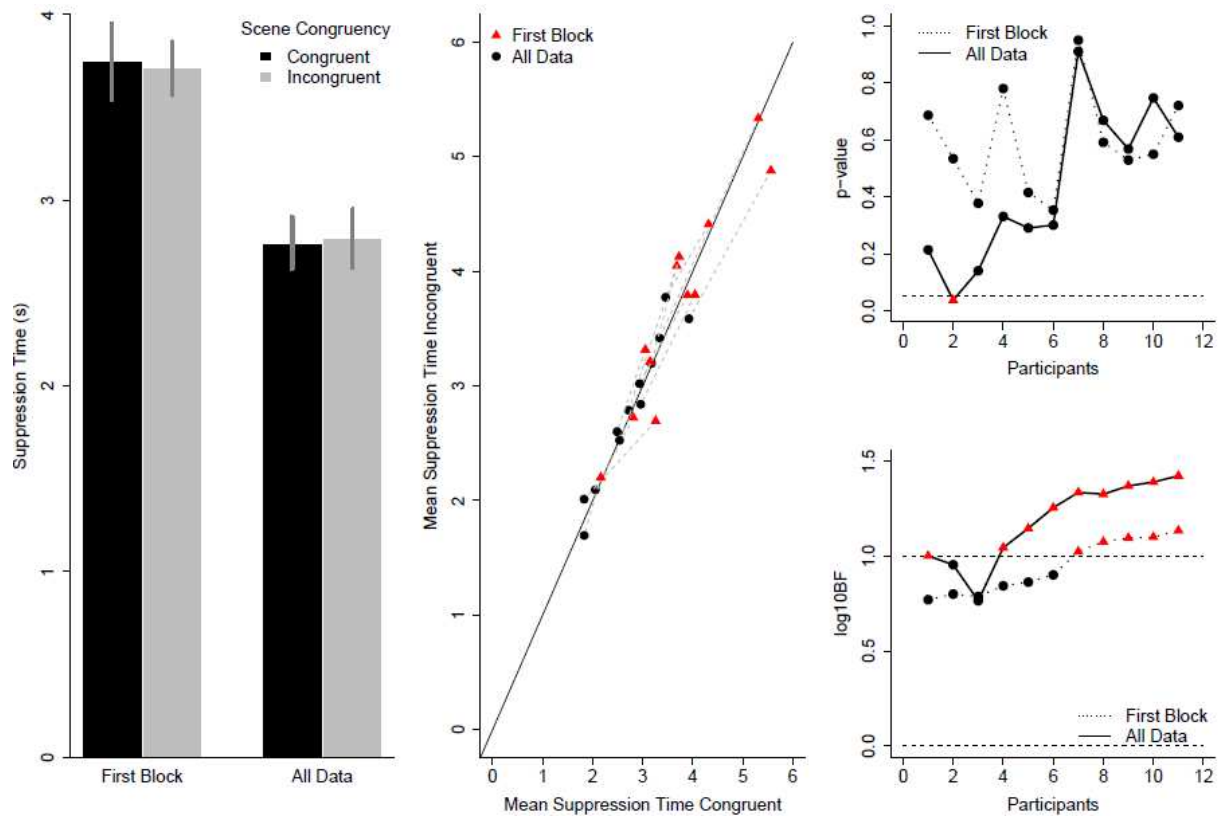


Figure S8. Results of Experiment 2 after removing participants for whom the CFS mask was presented in the nondominant eye. Mean suppression time (a) is graphed for the first block and for all blocks, separately for congruent and incongruent scenes. Error bars represent within-subjects 95% confidence intervals with the adjustment suggested by [Morey \(2008\)](#). The relationship between mean suppression times for congruent and for incongruent scenes (b) is shown for each participant's performance in the first block and in all blocks. Each dashed line connects the data points for a single participant. The diagonal line represents equal suppression durations for congruent and incongruent scenes. The two other graphs show p values (c) and Bayes factor values (d) as a function of the number of participants in the analysis, separately for the first block and for all blocks. Bayes factors (\log_{10}) greater than 0 indicate evidence for the absence of an effect, whereas Bayes factors smaller than 0 indicate evidence for the presence of an effect.

Last, an analysis combining both exclusion criteria further reduced our sample to 9 participants. The results of this analysis are summarized in Figure S9. Again, these results are very similar to those observed for the full data set. No effect of scene congruency was observed neither in the first block ($M_{\text{congruent}} = 3.72$, $M_{\text{incongruent}} = 3.57$; $SD_{\text{congruent}} = 0.75$, $SD_{\text{incongruent}} = 0.90$; $t(8) = 1.02$, $p = .34$, $d = 0.34$) nor when considering the data as a whole ($M_{\text{congruent}} = 2.68$, $M_{\text{incongruent}} = 2.71$; $SD_{\text{congruent}} = 0.51$, $SD_{\text{incongruent}} = 0.49$; $t(8) = -0.57$, $p = .59$, $d = -0.19$). Similarly, a BF analysis of the data always indicated convincing evidence for the absence of a scene congruency effect (BF = 10 and BF = 13, for the first block and all data, respectively).

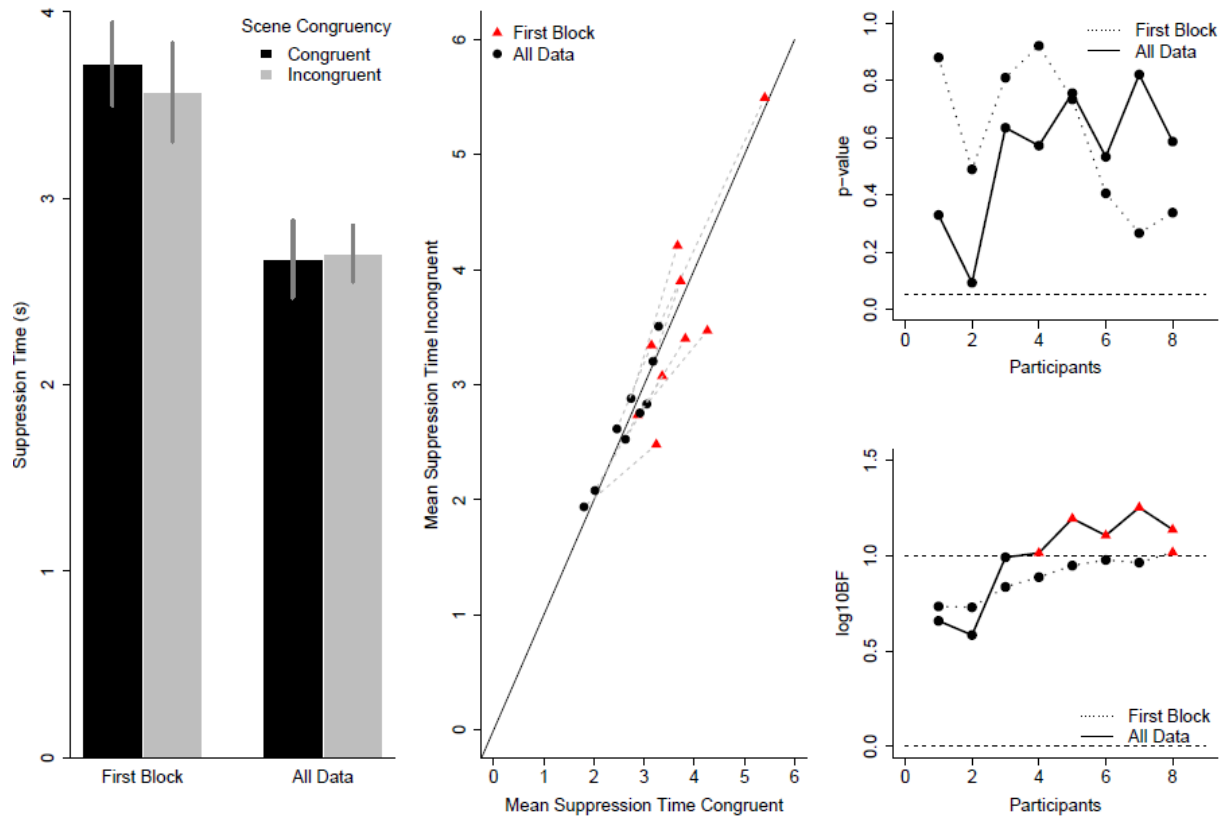


Figure S9. Results of Experiment 2 after removing incorrectly categorized scenes and participants for whom the CFS mask was presented in the nondominant eye. Mean suppression time (a) is graphed for the first block and for all blocks, separately for congruent and incongruent scenes. Error bars represent within-subjects 95% confidence intervals with the adjustment suggested by [Morey \(2008\)](#). The relationship between mean suppression times for congruent and for incongruent scenes (b) is shown for each participant's performance in the first block and in all blocks. Each dashed line connects the data points for a single participant. The diagonal line represents equal suppression durations for congruent and incongruent scenes. The two other graphs show p values (c) and Bayes factor values (d) as a function of the number of participants in the analysis, separately for the first block and for all blocks. Bayes factors (\log_{10}) greater than 0 indicate evidence for the absence of an effect, whereas Bayes factors smaller than 0 indicate evidence for the presence of an effect.

Supplementary analysis for Experiment 3

For Experiment 3, we reported an analysis of the mean suppression times after removing incorrect responses during the main experiment as well as incorrectly categorized stimuli during the post-experimental rating session. Here, we report on the same analysis, yet including the stimuli that were incorrectly categorized during the post-experimental rating session. The results of this analysis were very similar to those excluding the incorrectly categorized stimuli (see Figure 10). No effect of scene congruency was observed ($M_{\text{congruent}} = 2.64$, $M_{\text{incongruent}} = 2.63$; $SD_{\text{congruent}} = 1.12$, $SD_{\text{incongruent}} = 1.06$; $t(49) = 0.11$, $p = .91$, $d = .016$). Similarly, the BF analysis indicated convincing evidence for the absence of a congruency effect ($BF = 24$).

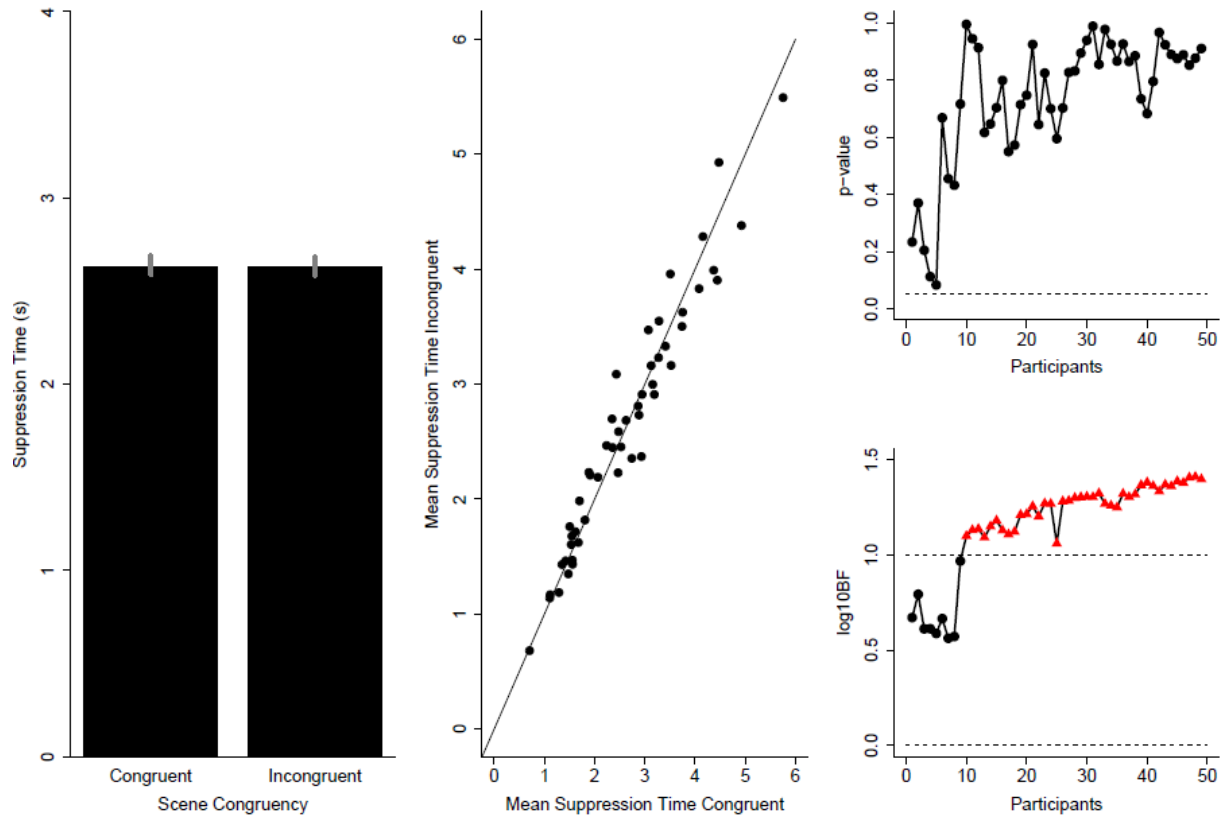


Figure S10. Results of Experiment 3 after including incorrectly categorized scenes. Mean suppression time (a) is graphed separately for congruent and incongruent scenes. Error bars represent within-subjects 95% confidence intervals with the adjustment suggested by [Morey \(2008\)](#). The relationship between mean suppression times for congruent and for incongruent scenes (b) is shown. The diagonal line represents equal suppression durations for congruent and incongruent scenes. The two other graphs show p values (c) and Bayes factor values (d) as a function of the number of participants in the analysis. Bayes factors (\log_{10}) greater than 0 indicate evidence for the absence of a congruency effect, whereas Bayes factors smaller than 0 indicate evidence for the presence of a congruency effect.

Correlation between suppression times and statistical properties of the images

A final exploratory analysis pertains to the relationship between mean suppression times obtained for each image averaged across observers and four statistical properties of the images. These four statistical measures include the intercept (IC) and slope (SL) derived from a regression line fitted to the Fourier amplitude spectrum of each image in log-log space. Furthermore, for each image, we obtained measures of contrast energy (CE) and spatial coherence (SC) as reported in Groen, Ghebreab, Prins, Lamme, and Scholte (2013). These measures involve approximations of a Weibull fit to the histograms of local contrast filter responses. Note that high values of SC indicate cluttered images, whereas low values indicate images that are spatially coherent.

Figure S11 depicts the correlation matrices for all measures considered and mean suppression time (ST) for each item, averaged across observers and scene congruency. For all experiments, the highest correlation of interest that was observed was the one between suppression time and spatial coherence (Experiment 1: $r = 0.45$; Experiment 2: $r = 0.53$; Experiment 3: $r = 0.49$). This correlation was also

the only one (of the ones that included suppression time) that exceeded a Bayes Factor of 3 for all experiments (Wetzels & Wagenmakers, 2012).

This supplementary exploratory analysis indicates that the observed suppression durations correlate with a measure of spatial coherence of the images, indicating that cluttered images on average yield slower suppression times compared to spatially coherent, less fragmented images.

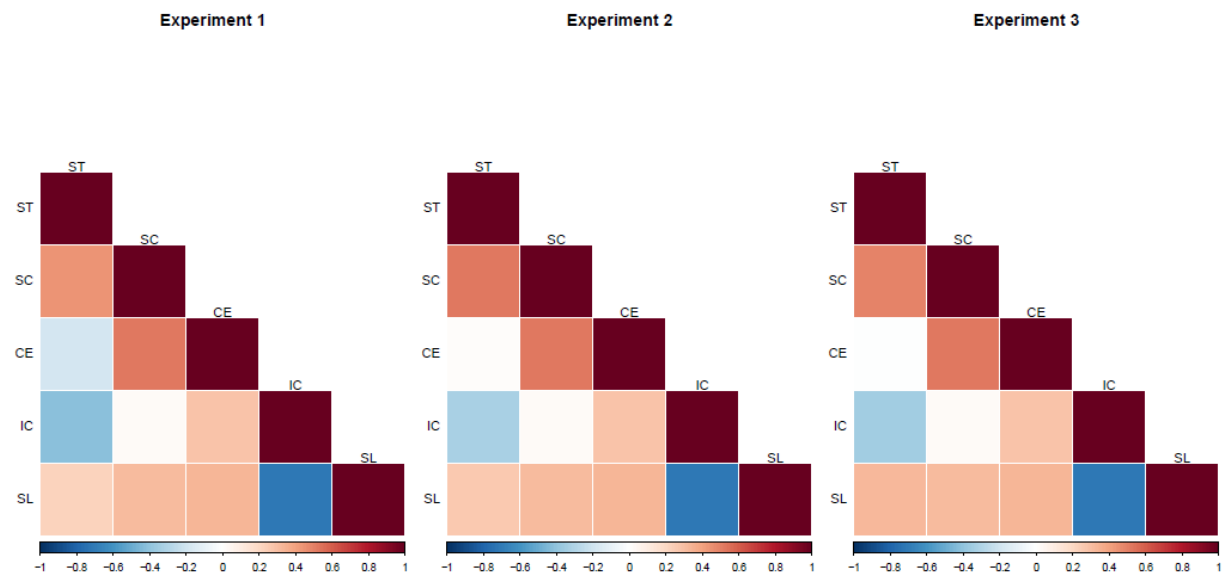


Figure S11. Relationship between suppression times and image characteristics. Correlation matrices for all four measures and suppression time, for both experiments. ST = suppression time, SC = spatial coherence, CE = contrast energy, IC = intercept, SL = slope.

Table S1. Bayes Factors for correlations between suppression time and each image statistic.

Statistic	Experiment 1	Experiment 2	Experiment 3
SC	7.6	53	21
CE	0.23	0.12	0.12
IC	4.2	0.97	1.27
SL	0.32	0.49	0.97

Note. Bayes Factors > 1 indicate evidence for a correlation being different from zero.

REFERENCES

- Groen, I. I. A., Ghebreab, S., Prins, H., Lamme, V. A. F., & Scholte, H. S. (2013). From Image Statistics to scene gist: Evoked neural activity reveals transition from low-level natural image structure to scene category. *The Journal of Neuroscience*, 33(48), 18814–18824. <http://doi.org/10.1523/JNEUROSCI.3128-13.2013>
- Wetzels, R., & Wagenmakers, E.-J. (2012). A default Bayesian hypothesis test for correlations and partial correlations. *Psychonomic Bulletin & Review*, 19(6), 1057–1064. <http://doi.org/10.3758/s13423-012-0295-x>