

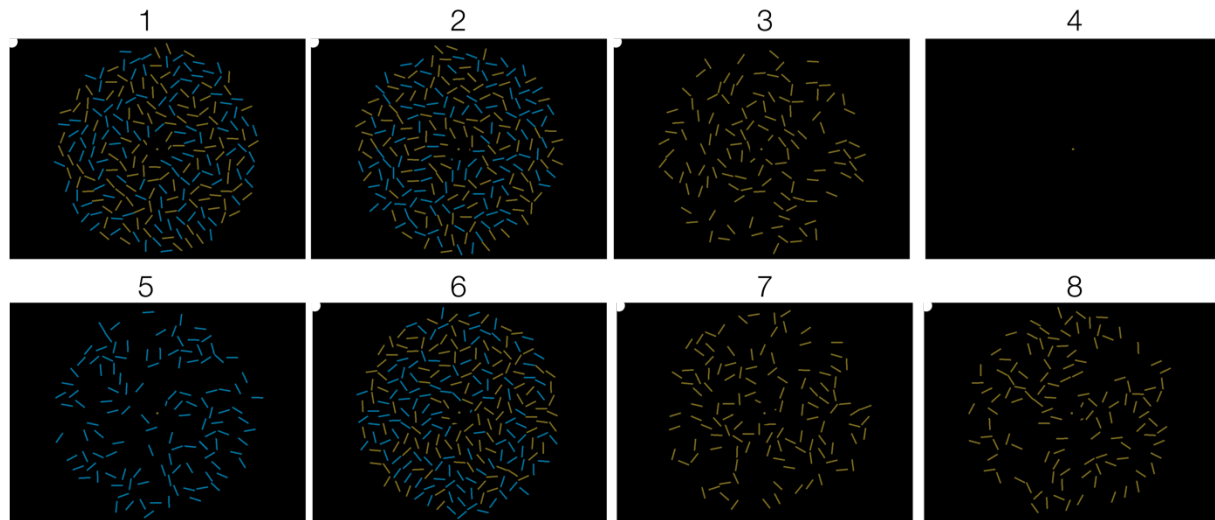
Supplementary Materials

Figure S1. Example frames during the stimulus presentation. Eight example frames (1-8) from the stimulus presentation period illustrate how the flicker was achieved (refresh rate was 120 Hz, so each frame was ~ 8.33 ms). In this example, the attended color is yellow, and the attended frequency is 24 Hz (3 frames on, 2 frames off). Blue is the unattended color (30 Hz; 2 frames on, 2 frames off). The white dot in the upper left-hand corner was used to record the attended frequency flicker using a photodiode (this corner of the screen was covered with thick, opaque black electrical tape so that it was not visible to the participants).

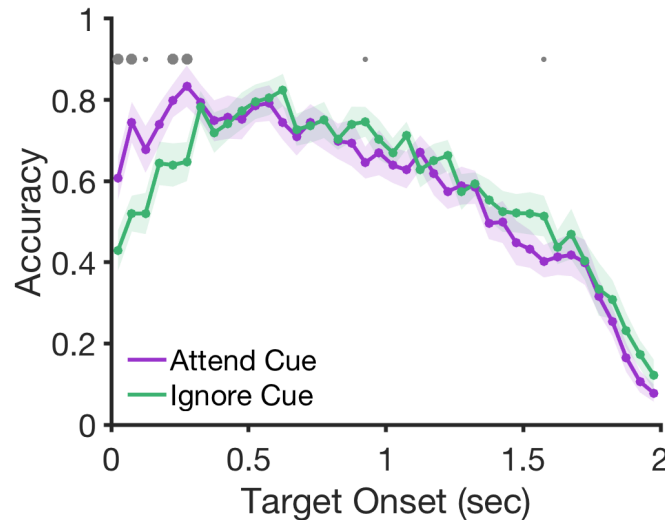


Figure S2. Accuracy for target-present trials as a function of the time between Cue Onset and the Target Onset. For short cue-target intervals (≤ 275 ms), participants were more accurate for attend cues than ignore cues. This pattern suggests that participants were more quickly able to utilize the attend cue than the ignore cue. Shaded error bars indicate ± 1 SEM. Small gray dots indicate $p < .05$ (uncorrected), large dots indicate $p < .001$ (uncorrected).

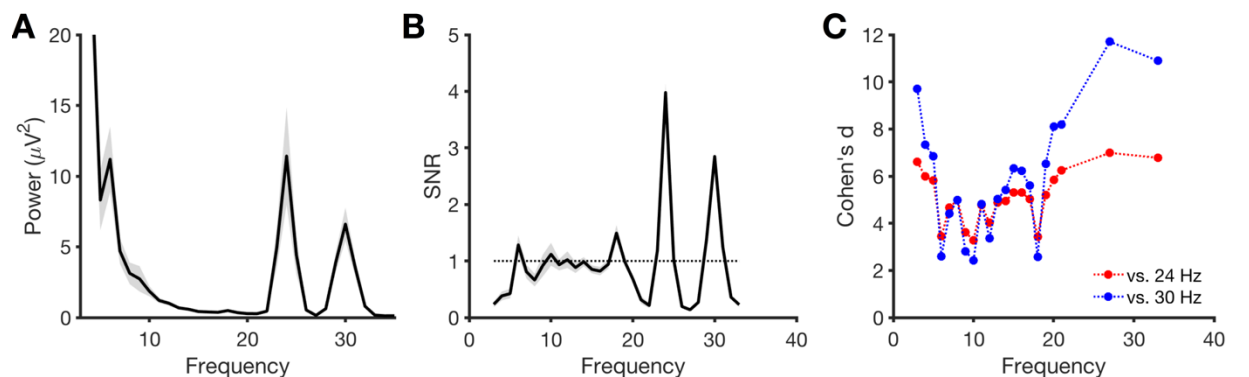


Figure S3. Power and SNR for each frequency. (A) Power for each frequency using the Gaussian wavelet filter analysis. (B) SNR for each frequency, calculated as the power at the frequency (e.g., 24 Hz) divided by the power at the average of the 2 neighboring 1-Hz frequencies on either side (e.g., average of 22, 23, 25, and 26 Hz). The theoretical chance level for SNR is 1 (dotted line), but because SNR is calculated with neighboring frequencies, frequencies that are adjacent to a significant “peak” may have values below 1. (C) Cohen’s d for the comparison between SNR at each of the two target SSVEP frequencies (24 Hz, 30 Hz) relative to other baselined frequencies (3-33 Hz excluding frequencies within ± 2 Hz of the target SSVEP frequencies).

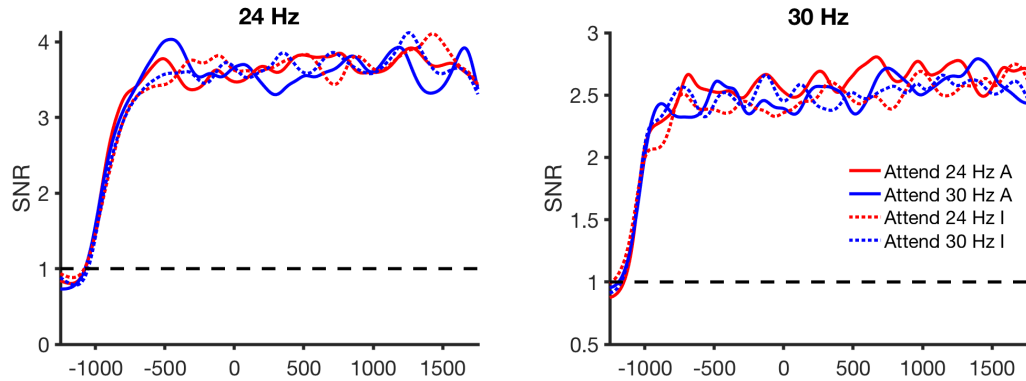


Figure S4. Time-course of SNR for each frequency. The stimulus began flickering at -1,333 ms, and the cue indicating which color to attend appeared at 0 ms. Red lines show when 24 Hz was the attended frequency; Blue lines show when 30 Hz was the attended frequency. Solid lines show data from the “attend cue” condition; Dotted lines show the “ignore cue” condition.

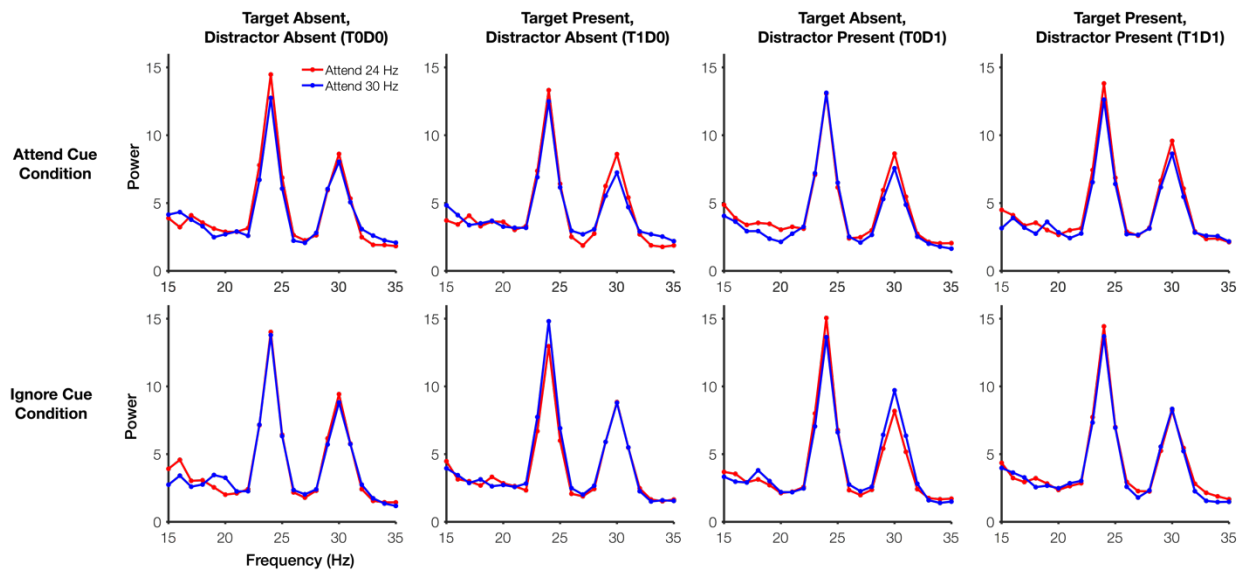


Figure S5. Frequency spectra separately for each target/distractor presence condition. Trials were counterbalanced to have a 50% chance of having a target event (T1) and to have 50% chance of including a distractor event (D1). Thus, 25% of trials had neither a target nor distractor (T0D0), 25% of trials had a target only (T1D0), 25% of trials had a distractor only (T0D1), and 25% of trials had both a target and a distractor (T1D1). Frequency spectra for each sub-condition are shown (Rows: Attend Cue or Ignore Cue, Columns: Each combination of target and distractor present/absent).

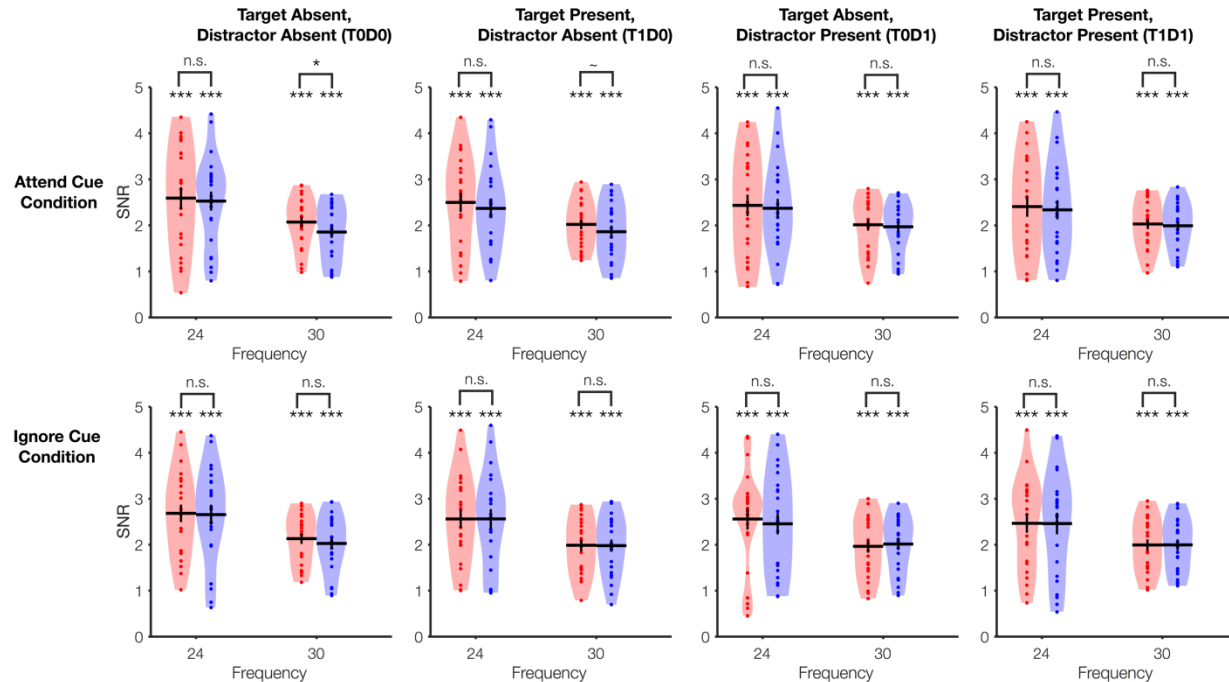


Figure S6. Signal to noise ratio (SNR) values separately for each target/distractor presence condition. Trials were counterbalanced have a 50% chance of having a target event (T1) and to have 50% chance of including a distractor event (D1). Thus, 25% of trials had neither a target nor distractor (T0D0), 25% of trials had a target only (T1D0), 25% of trials had a distractor only (T0D1), and 25% of trials had both a target and a distractor (T1D1). Frequency spectra for each sub-condition are shown (Rows: Attend Cue or Ignore Cue, Columns: Each combination of target and distractor present/absent). The bottom row of asterisks shows post-hoc, uncorrected significance for overall SSVEP signal compared to a null value of 1. The SSVEP signal was overall highly significant (***, $p < .001$). The top row of asterisks shows post-hoc, uncorrected significance for the comparison between the two adjacent bars (n.s. $p > .10$, $\sim p < .10$, * $p < .05$). Note, no conditions showed an attention effect (attended frequency > ignored frequency); the only significant, uncorrected post-hoc comparison was in the wrong direction (ignored > attended).

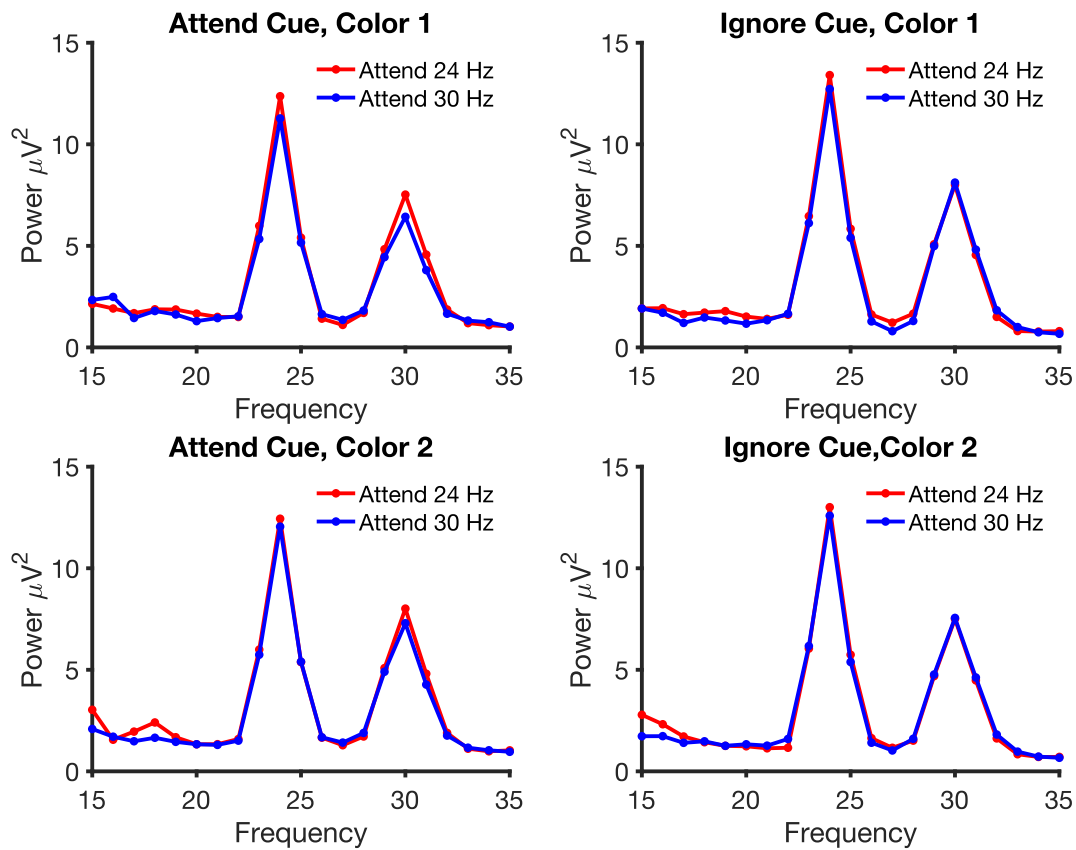


Figure S7. Power by frequency separately for each color distance condition. Target and distractor colors were randomly assigned on each trial from a pool of 5 possible colors. Thus, the target and distractor colors could be either 72 or 144 degrees apart on a color wheel. We found no evidence of an attention effect in either color distance condition.

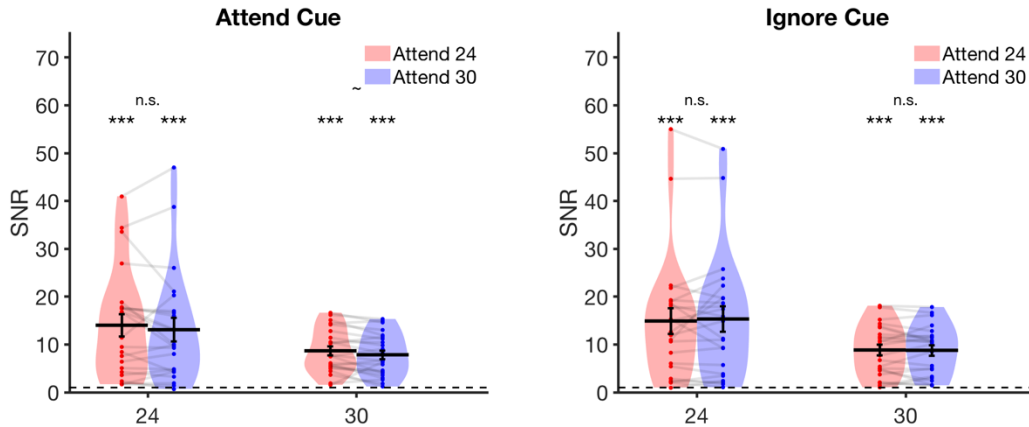


Figure S8. An additional analysis variant for the main SNR measure: skipping the first bin for computing SNR. Rather than using the pre-registered frequencies of ± 1 and ± 2 Hz for computing SNR, we instead skipped the first 1 Hz bin. Since ± 1 Hz had greater than baseline power, we may have attenuated our ability to observe SSVEP-related differences by including this bin in our SNR subtraction. For this analysis variant, we instead calculated SNR as the peak frequency minus the average of all frequencies ± 2 and ± 3 Hz from the peak (e.g., to compute SNR for 24 Hz, we subtracted the mean power at 21, 22, 26, and 27 Hz). Although overall SNR was much higher across all conditions using this metric, the pattern across experimental conditions was unchanged (i.e., we found no significant attention effects).

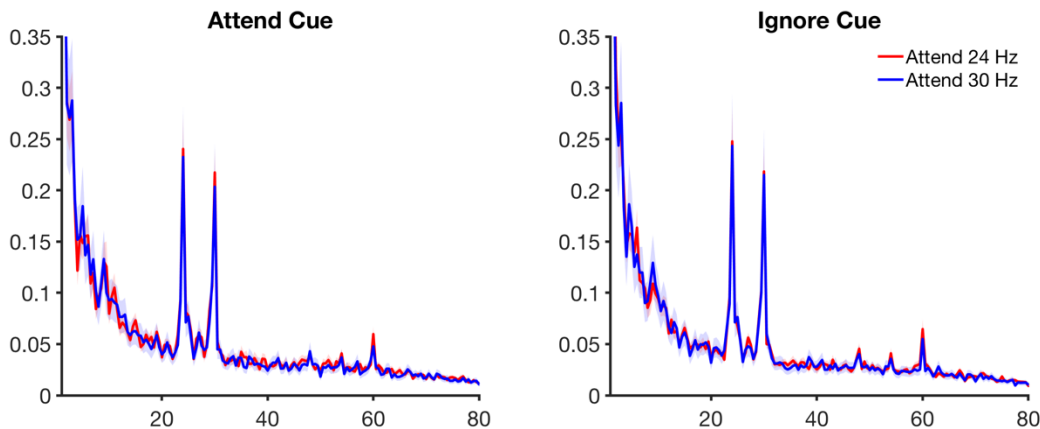


Figure S9. FFT analysis with a wider x-axis to show both the fundamental and second harmonic frequencies. (Left) FFT for the 'attend cue' condition. (Right) FFT for the 'ignore cue' condition. X-axis values are frequency (Hz); Y-axis values are amplitude (microvolts).

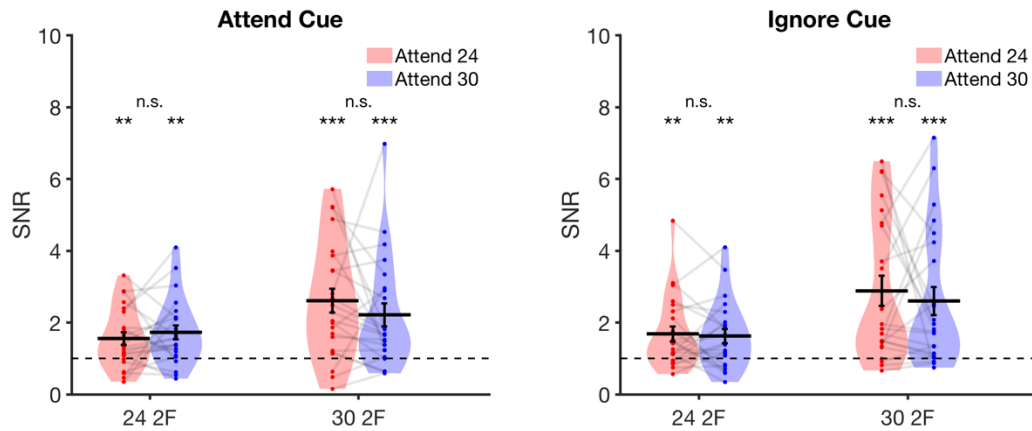


Figure S10. Violin plot of the second harmonic frequencies 48 Hz and 60 Hz from the FFT analysis. (Left) Violin plot of SNR for the second harmonic frequencies in the 'attend cue' condition; SNR for both harmonics was greater than 1, but there were no attention effects. (B) Violin plot of SNR for the second harmonic frequencies in the 'ignore cue' condition; SNR for both harmonics was greater than 1, but there were no attention effects.

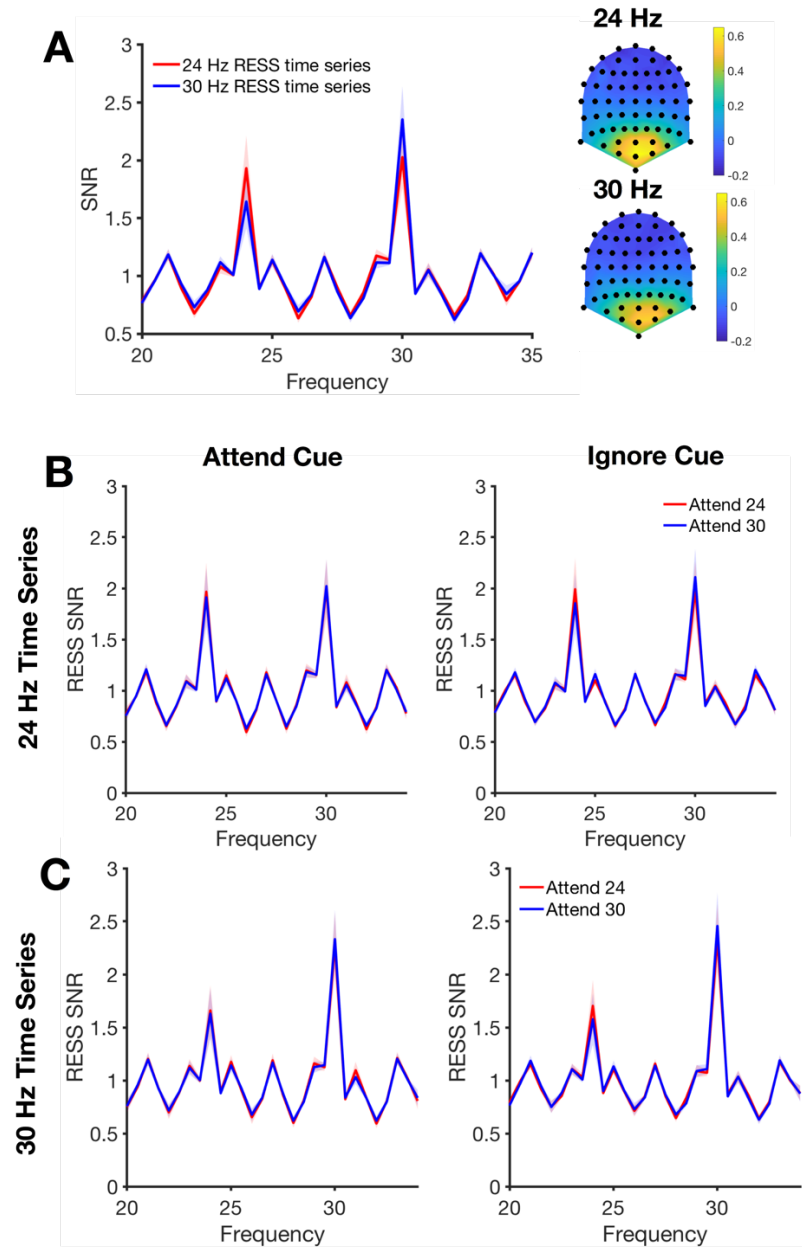


Figure S11. Rhythmic Entrainment Source Separation (RESS) analysis likewise shows null attention effects. Following code associated with [1], we performed rhythmic entrainment source separation (RESS) on our data to ensure that our a priori choice of electrodes did not impede our ability to find an attention effect. We decided to stick very closely to the default settings for RESS code developed by others in order to take some ‘researcher degrees of freedom’ out of the equation. We obtained a highly consistent pattern of results despite using a data-driven, single-trial approach that differs substantially from our pre-registered trial-averaged approach. We also note that the SNR values from the RESS approach are lower than the trial-averaged FFT we present in the main analysis, but that RESS does still provide an SNR advantage when compared to a single-trial FFT approach, as in [1]. We first calculated the spatial filters using data from all trials and the full trial length (-1000 ms to 2000 ms). We then applied the spatial filters

to calculate SNR for each condition of interest (e.g., “Attend 24 Hz, Attend Cue Condition”, 24 Hz RESS time series; 500 ms to 2000 ms). For the analysis, we used a frequency resolution of 0.5 Hz, a full-width half maximum (FWHM) of 0.5 Hz for the center frequency, a FWHM of 1 Hz for the neighboring baseline frequencies ± 2 Hz from the peak frequency. SNR was calculated as the ratio between each frequency of interest and the frequencies ± 2 Hz away. (A) Normalized SNR by frequency and topography of the RESS time series optimized for 24 Hz (red) and 30 Hz (blue), collapsed across all conditions. (B) SSVEP response (computed as normalized SNR) for the 24 Hz-optimized RESS time series in the attend cue condition and ignore cue condition. (C) SSVEP response (computed as normalized SNR) for the 30 Hz-optimized RESS time series in the attend cue condition and ignore cue condition. We again found no significant effects of attention for either SSVEP frequency.

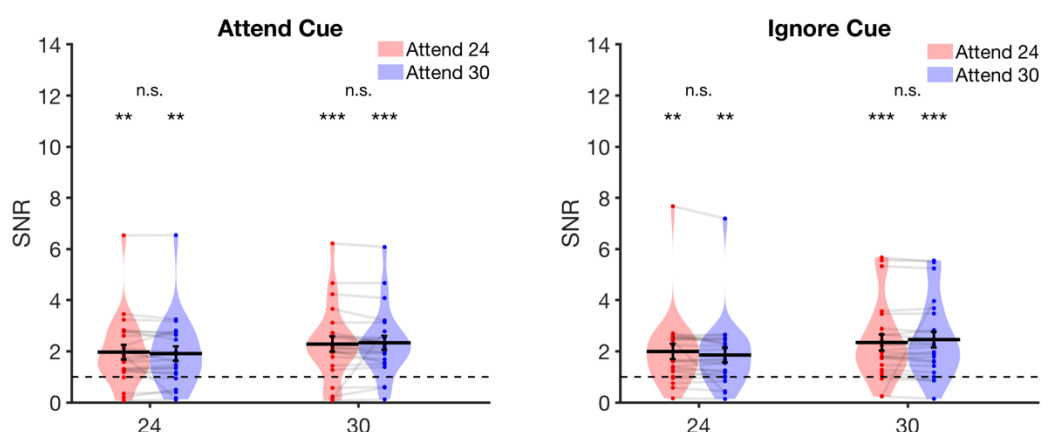


Figure S12. Violin plots of values obtained from the Rhythmic Entrainment Source Separation (RESS) analysis. We found no effect of attention on RESS values in either the Attend Cue condition (left panel) or the Ignore Cue condition (right panel).

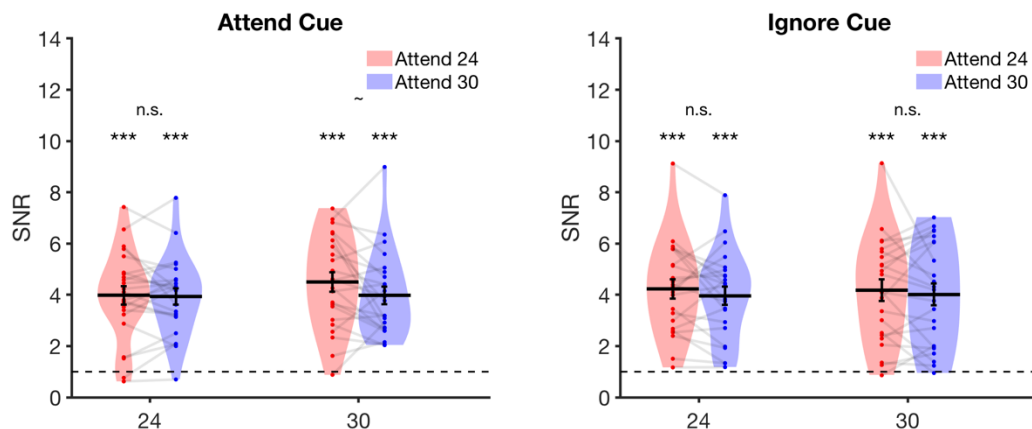


Figure S13. Violin plots of SNR values for each frequency, calculated from an FFT analysis on accurate trials only. Performing an FFT analysis on accurate trials only likewise yields null attention effects both in the attend cue condition (left panel) and the ignore cue condition (right panel).

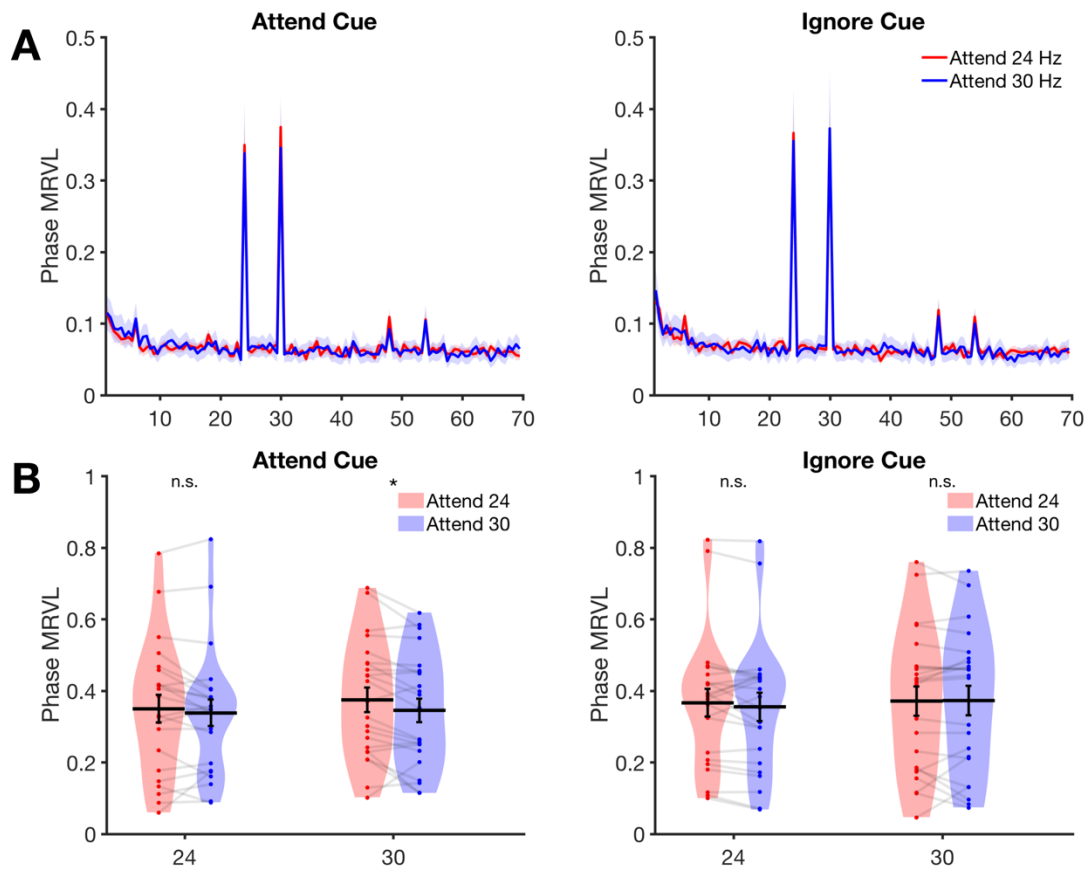


Figure S14. Results of the phase-locking index (PLI) analysis. We performed an FFT on single trials rather than on condition-averaged waveforms (time window: 333 ms – 2000 ms), and we extracted single-trial phase values (*'angle.m'*). We calculated a phase-locking index by computing mean-resultant vector length on histograms of single-trial phase values (separate histograms for each condition, electrode, and frequency). Mean-resultant vector length ranges from 0 (fully random values) to 1 (perfectly identical values), for reference, see: Zar (2010). **(A)** Phase locking index (PLI) as indexed by mean-resultant vector length, averaged across electrodes O1, O2, and Oz. Replicating prior work, we found robust PLI values at the two SSVEP frequencies (24 and 30 Hz). **(B)** However, we found no evidence that PLI values were modulated by attention in the expected direction.

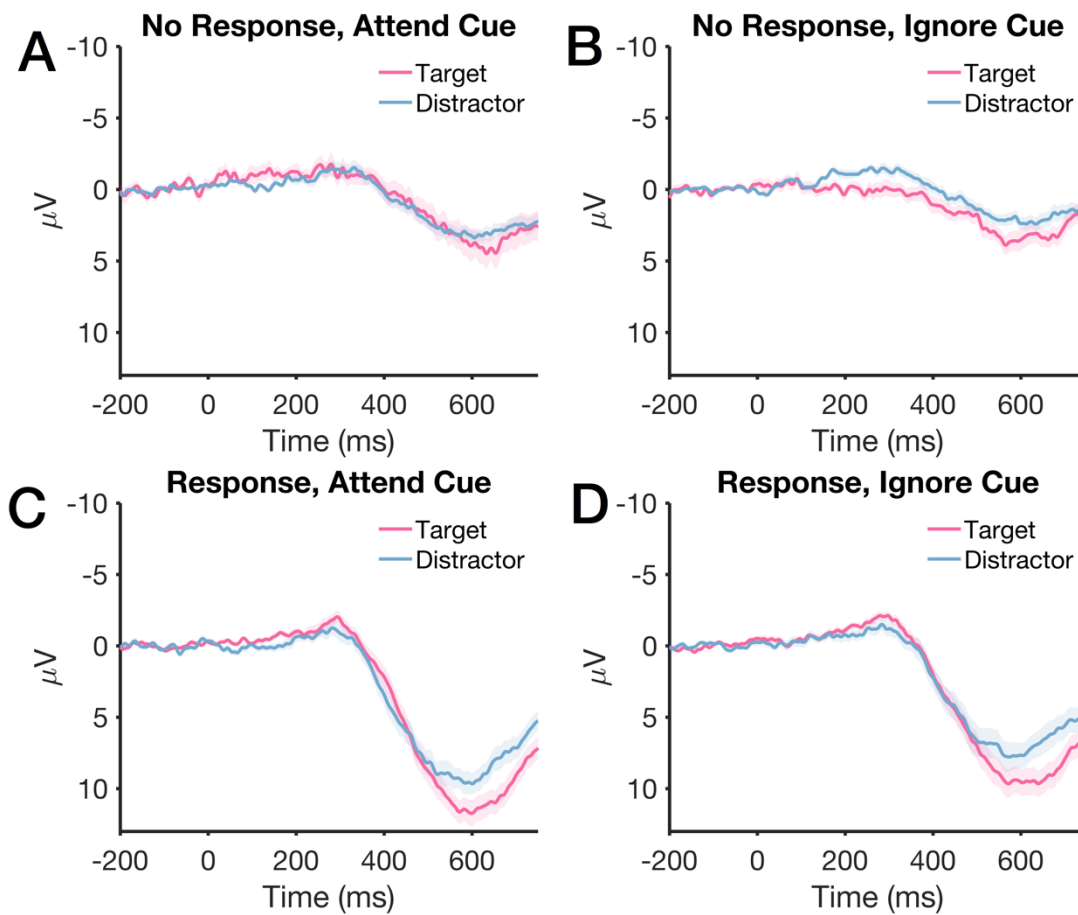


Figure S14. P3 component at electrodes Pz and POz, split by whether or not a response was made. (A) No response made, “attend cue” condition. (B) No response made, “ignore cue” condition. (C) Response made, “attend cue” condition. (D) Response made, “ignore cue” condition. Shaded error bars represent standard error of the mean.

Exp.	Paper	Ref.	N	Total Trials	Trials Per Cond.	Stim. Dur. (s)	Freq. (Hz)	Sig.
1	Chen et al. 2003	[2]	11	16	8	100	7.41, 8.33	.5*
2	Wang et al. 2007 (Exp 1)	[3]	12	16	8	120	7.14, 8.33	0
3	Wang et al. 2007 (Exp 2)	[3]	12	16	8	120	7.69, 7.14, 8.33	-1
4	Wang et al. 2007 (Exp 3)	[3]	12	16	8	120	6.67, 7.14, 7.69, 8.33	-1
5	Allison et al. 2008	[4]	14	8	4	60	10, 12	n/a**
6	Keitel & Müller 2016	[5]	13	600	75	3.5	3.14, 3.62, 14.2, 17	.5***

Table S1. Study overview for studies employing a variant of the “competing gratings” task. From left to right, columns indicate: “Exp.” = Experiment number out of those reviewed, “Paper” = short-hand reference for paper, “Ref” = reference number for the full reference below, “N” = number of subjects in the experiment, “Total Trials” = total number of trials completed by the participant, “Trials Per Cond.” = The number of trials that could be analyzed per condition (i.e., after excluding target and distractor onsets), “Stimulus Duration” = the duration, in seconds, that participants attended the stimulus, “Freq.” = Frequency, in Hertz (Hz), that the stimuli flickered at, “Sig” = Qualitative code for the overall presence of a basic attention effects (when expected); 1 = attended > ignored, -1 = attended < ignored, 0.5 = mixed effects across conditions, 0 = null, n/a = statistical values for the basic attention effect not reported directly. Notes: * Statistics were performed for individuals but not across subjects; standard attention effect in one condition, reversed effect in the other. **Group level statistics not reported. ***No attention effect for the main flicker frequencies (14.2, 17 Hz), but attention effect for the slow oscillating changes to the Gabor’s features (3.14, 3.62 Hz).

Exp.	Paper	Ref.	N	Total Trials	Trials Per Cond.	Stim. Dur. (s)	Freq. (Hz)	Sig.
7	Pei et al. 2002	[6]	11	20	20	8	2.4, 3	n/a*
8	Müller et al. 2006	[7]	11	450	153	4.114	7, 11.67	1
9	Andersen et al. 2008	[8]	15	600	90	3.092	10,12,15, 17.14	1
10	Andersen et al. 2009	[9]	15	432	72	3.042	10, 12	1
11	Andersen & Müller 2010	[10]	16	480	240	2	11.98, 16.77	1
12	Quigley et al. 2010	[11]	10	440	110	2.2	8, 12	1
13	Zhang et al. 2010	[12]	18	300	300	4	10, 12	1
14	Andersen et al. 2012	[13]	16	300	60	8.5	10, 12	1
15	Quigley & Müller 2014	[14]	20	320	90	4.167	15, 17	1
16	Andersen et al. 2015	[15]	15	192	96	15	8, 10, 12, 15	1
17	Forschack et al. 2017	[16]	23	480	120	1.783	10, 12.5, 15, 17.5	1
18	Martinovic & Andersen 2018	[17]	9	768	23	6.5	10, 12	n/a**
19	Martinovic et al. 2018 (Exp 1)	[18]	11	600	70	3.14	8.57, 10, 12, 15	1
20	Martinovic et al. 2018 (Exp 2)	[18]	14	600	70	3.14	8.57, 10, 12, 15	1
21	Steinhauser & Andersen 2019	[19]	17	1600	400	1	10, 15	1

Table S2. Study overview for studies employing a variant of the “whole-field flicker” task. From left to right, columns indicate: “Exp.” = Experiment number out of those reviewed, “Paper” = short-hand reference for paper, “Ref” = reference number for the full reference below, “N” = number of subjects in the experiment, “Total Trials” = total number of trials completed by the participant, “Trials Per Cond.” = The number of trials that could be analyzed per condition (i.e., after excluding target and distractor onsets), “Stimulus Duration” = the duration, in seconds, that participants attended the stimulus, “Freq.” = Frequency, in Hertz (Hz), of the stimulus flicker, “Sig” = Qualitative code for the overall presence of a basic attention effects (when expected); 1 = attended > ignored, -1 = attended < ignored, 0.5 = mixed effects across conditions, 0 = null, n/a = statistical values for the basic attention effect not reported directly. Notes: *Analyzed harmonics (2F, 4F) but not the fundamental frequency. 2F but not 4F had a significant attention effect. ** Attention modulation scores were only compared across conditions, not to baseline; they are presumably overall significant, but this was not formally tested.

Exp.	Paper	Ref.	N	Total Trials	Trials Per Cond.	Stim. Dur. (s)	Freq. (Hz)	Sig.
22	Andersen et al. 2011	[20]	19	600	100	3.05	8.46, 11.85, 14.81, 19.75	1
23	Andersen et al. 2013 (Exp 1)	[21]	13	560	160	2.94	7.5, 8.57, 10, 12	1
24	Andersen et al. 2013 (Exp 2)	[21]	11	560	320	2.94	7, 8.57, 10, 12	1
25	Störmer & Alvarez 2014	[22]	16	640	160	2.6	7.1, 8.5, 10.7	1
26	Müller et al. 2018	[23]	23	480	120	1.783	6.5, 8.5, 11.5, 13.5	1
27	Adamian et al. 2019	[24]	16	672	128	2.94	7.5, 8.57, 10, 12	1

Table S3. Study overview for studies employing a variant of the “hemifield flicker” task. From left to right, columns indicate: “Exp.” = Experiment number out of those reviewed, “Paper” = short-hand reference for paper, “Ref” = reference number for the full reference below, “N” = number of subjects in the experiment, “Total Trials” = total number of trials completed by the participant, “Trials Per Cond.” = The number of trials that could be analyzed per condition (i.e., after excluding target and distractor onsets), “Stimulus Duration” = the duration, in seconds, that participants attended the stimulus, “Freq.” = Frequency, in Hertz (Hz), of the stimulus flicker, “Sig” = Qualitative code for the overall presence of a basic attention effects (when expected); 1 = attended > ignored, -1 = attended < ignored, 0.5 = mixed effects across conditions, 0 = null, n/a = statistical values for the basic attention effect not reported directly.

Exp.	Paper	Ref.	N	Total Trials	Trials Per Cond.	Stim. Dur. (s)	Freq. (Hz)	Sig.
29	Painter et al. 2014 (Exp 1)	[25]	20	288	144	7.2	12.5, 16.7	1
30	Painter et al. 2014 (Exp 2)	[25]	20	216	216	8.4	7.6, 13.3, 17.8	1
31	Painter et al. 2015	[26]	20	512	128	8	8, 12	0*
32	Jiang et al. 2017	[27]	23	288	144	8.4	12, 15	.5**
33	Chu & D’Zmura 2019 (Exp 1)	[28]	20	128	32	7	12.5, 18.75	1
34	Chu & D’Zmura 2019 (Exp 2)	[28]	21	128	32	9	12.5, 18.75	1

Table S4. Study overview for studies employing a variant of the “attend central, peripheral flicker” task. From left to right, columns indicate: “Exp.” = Experiment number out of those reviewed, “Paper” = short-hand reference for paper, “Ref” = reference number for the full reference below, “N” = number of subjects in the experiment, “Total Trials” = total number of trials completed by the participant, “Trials Per Cond.” = The number of trials that could be analyzed per condition (i.e., after excluding target and distractor onsets), “Stimulus Duration” = the duration, in seconds, that participants attended the stimulus, “Freq.” = Frequency, in Hertz (Hz), of the stimulus flicker, “Sig” = Qualitative code for the overall presence of a basic attention effects (when expected); 1 = attended > ignored, -1 = attended < ignored, 0.5 = mixed effects across conditions, 0 = null, n/a = statistical values for the basic attention effect not reported directly. Notes: *No attention effect at *a priori* electrode; other electrodes were examined post-hoc, but statistics were not reported for each. **Significant in 1 of 2 expected conditions.

Exp.	Paper	Ref.	Behavior	Target type	Dur. (ms)	Sig.
7	Pei et al. 2002	[6]	n/a	No Targets	n/a	n/a*
8	Müller et al. 2006	[7]	$d' = 1.95 - 2.89$	75% Coherent Motion	586	1
9	Andersen et al. 2008	[8]	$d' = 2.74 - 3.25$	70% Coherent Motion	500	1
10	Andersen et al. 2009	[9]	$d' = 2.67 - 3.23†$	20% Luminance Decrement	200	1
11	Andersen & Müller 2010	[10]	$d' = 1.83$	75% Coherent Motion	298	1
12	Quigley et al. 2010	[11]	$d' = 2.665$	85% Coherent Motion	556	1
13	Zhang et al. 2010	[12]	n/a	No Targets	n/a	1
14	Andersen et al. 2012	[13]	$d' = 2.64$	50% Coherent Motion	400	1
15	Quigley & Müller 2014	[14]	Acc = 87.5% - 98%†	40% Coherent Oblique Motion	500	1
16	Andersen et al. 2015	[15]	$d' = 1.3 - 1.75†$	70% Coherent Motion	500	1
17	Forschack et al. 2017	[16]	$d' = 2$	60% Coherent Motion	300	1
18	Martinovic & Andersen 2018	[17]	$d' = 0.8 - 3.0†$	50% Coherent Motion	400	n/a**
19	Martinovic et al. 2018 (Exp 1)	[18]	$d' = 1.05$	50% Coherent Motion	400	1
20	Martinovic et al. 2018 (Exp 2)	[18]	$d' = 1.0$	50% Coherent Motion	400	1
21	Steinhauser & Andersen 2019	[19]	Acc = 90.3%	75% Coherent Motion	500	1
22	Andersen et al. 2011	[20]	$d' = 0.95 - 2.8$	75% Coherent Motion	500	1
23	Andersen et al. 2013 (Exp 1)	[21]	$d' = 2.133 - 3.111$	20% Luminance Decrement	200	1
24	Andersen et al. 2013 (Exp 2)	[21]	$d' = 2.637$	20% Luminance Decrement	200	1
25	Störmer & Alvarez 2014	[22]	Acc = 78%	80% Coherent Motion	230	1
26	Müller et al. 2018	[23]	$d' = 1.81$	60% Coherent Motion	300	1
27	Adamian et al. 2019	[24]	$d' = 2.8†$	20% Luminance Decrement	200	1

Table S5. Accuracy and task variant for studies where participants detected a target within the flickering stimulus (whole-field and hemifield flicker tasks). To test if the difficulty of our task may have contributed to our null results, we examined behavior from studies in which participants monitored for a target in the flickering stimulus (i.e., whole-field and hemifield flicker tasks). We also noted the type of target and how long it was on the screen. Notes: †Values were not listed in the text, so some values were approximated based on the figures (e.g., hit rates or d' depicted in a bar graph). *Analyzed harmonics (2F, 4F) but not the fundamental frequency. 2F but not 4F had a significant attention effect. **Attention modulation scores were only compared across conditions, not to baseline; they were presumably significant overall, but this was not formally tested.

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