High spatial frequencies drive the early posterior negativity in response to snake pictures

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Introduction

As snakes were probably the first predators of mammals, they may have been important agents of evolutionary changes in the primate visual system allowing fast visual detection of fearful stimuli (Isbell, 2006). Many EEG studies have established larger early posterior negativity (EPN) in response to snake stimuli when compared to other animal stimuli (e.g., Van Strien et al., 2014). The EPN is an event-related potential that reflects early selective visual processing of emotionally significant information. A recent study (Van Strien & Isbell, 2017) has emphasized the importance of the typical scales and scale patterns of the snake skin for the enhanced EPN in response to snake pictures. In the present research, we examined whether the EPN snake effect still exists when these scales are made less visible by blurring snake pictures, that is, we examined the influence of spatial frequency on the EPN snake effect.

Method

Thirty participants (15m/15f, mean age = 20.1 years, range 18-24) watched the rapid serial presentation of 600 snake, 600 spider, and 600 bird pictures (10 pictures per condition; 60 repetitions per picture). In half of the presentations, these pictures were blurred. Blurred and non-blurred presentations were blocked and counterbalanced. Within each block, the pictures were randomly presented at a rate of 3 pictures per second (see Figure 1).

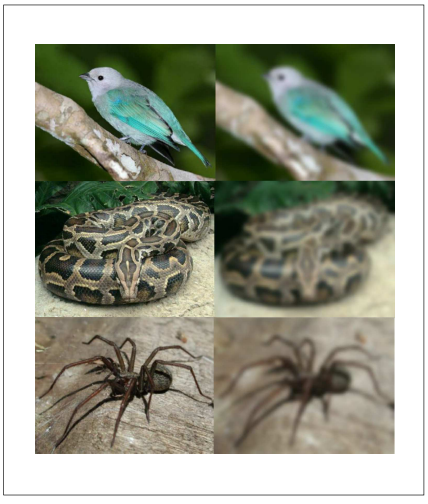

Fig.1. *Examples of non-blurred (left column) and blurred (right column) bird, snake, and spider pictures.*

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The EEG was recorded from 32 active electrodes (Biosemi ActiveTwo). EEG data were sampled at 512 Hz and band pass filtered at .10 – 30 Hz (24 dB/oct). The data were analyzed after conversion to an average reference. ERP averages were calculated with 50 ms prestimulus baseline correction (380 ms epochs).

The EPN was scored as the mean activity at occipital electrodes (PO3, O1, Oz, PO4, O2) in the 225–300 ms time window after picture onset.

Results

For the 225–300-ms EPN amplitudes, we found a significant category effect, $F(2,58) = 63.77$, $\varepsilon = .961$, $p < .001$. Snake pictures elicited larger EPN amplitudes than spider and bird pictures (both p-values < .001), whereas spider and bird pictures elicited comparable EPN amplitudes ($p = 1.000$). The ANOVA also revealed a significant condition effect, $F(1,29) = 38.92$, $p < .001$, with larger EPN for non-blurred than blurred pictures.

These main effects were qualified by a significant category × condition interaction, $F(2, 58) = 38.93$, $\varepsilon = .930$, $p < .001$. As can be seen in Figure 2, the largest EPN amplitude is found for non-blurred snake pictures.

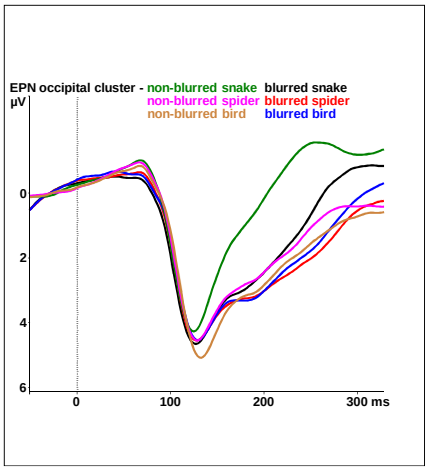

Fig.2. *The early posterior negativity (EPN) in response to non-blurred and blurred snake, spider, and bird pictures.*

There were also significant electrode × category and electrode × condition interactions (both p-values <.001). Figure 3 displays sample topographies for snake pictures.

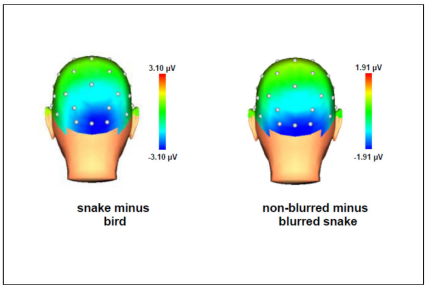

Fig.3. *Topographic maps of the differences in EPN mean amplitudes (225-300 ms) between snake vs. bird pictures (left) and between non-blurred vs. blurred snake pictures (right).*

The spectral compositions of the pictures that were used in the present research, were measured by employing a discrete wavelet analysis on each picture, using the Matlab routines *freqspat.m* and *freqspat_gui.m* (Delplanque, N'diaye, Scherer,& Grandjean, 2007). We found an excess of high spatial frequencies in non-blurred spider pictures (see Figure 4).

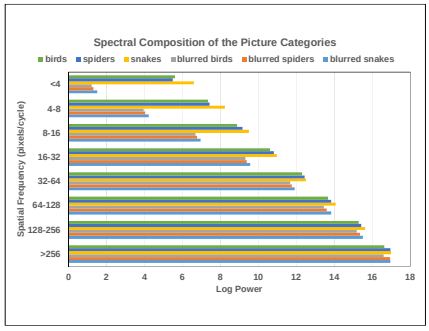

Fig.4. *Mean energy for each frequency band as a function of picture category. High spatial frequencies are on top.*

Conclusion

For non-blurred pictures, the EPN was significantly larger for snake pictures than for spider and bird pictures. The EPN snake effect was clearly attenuated for blurred pictures.

Spectral analysis revealed an excess of high spatial frequencies in non-blurred spider pictures.

The results demonstrate the importance of high spatial frequencies for the typically enhanced EPN in response to snake pictures.

References

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Further Information

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