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BIBLIOGRAPHIC INFORMATION

Call Number: Lender's Holdings: 8-1990-
Title: International journal of psychophysiology : official journal of the International Organization of Psychophysiology.
ISSN: 0167-8760
Imprint: Amsterdam ; New York : Elsevier Science Publishers, [c1983-
Article: Alpers, Georg: Binocular rivalry between emotional and neutral stimuli: A validation using fear conditioning and EEG
Volume: 57
Number: 1
Date: 2005
Pages: 25-32
Verified: <TN:132570> OCLC

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Binocular rivalry between emotional and neutral stimuli: A validation using fear conditioning and EEG

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Abstract

When two incompatible pictures are projected to the two eyes, they compete for perceptual dominance. Previous research has claimed that meaningful and emotionally valenced pictures predominate over neutral pictures in this rivalry. This may be interpreted as evidence for preferential processing of emotionally significant stimuli in the visual system but it is difficult to dismiss that the physical characteristics of the different pictures or response biases influenced the results of these studies. Thus, we set out to examine the influence of emotion using methods eliminating the influence of physical characteristics and minimizing response biases. We used simple visual patterns and induced emotional valence by fear conditioning. In Experiment 1 the aversive CS+ predominated over the CS−. In Experiment 2 we extended previous findings by showing that participants’ self-reported perception is validated by corresponding steady-state visually evoked potentials in the EEG in the context of such a conditioning experiment. This was accomplished by frequency coding the rivaling stimuli with a stimulus-specific pattern reversal and extracting the corresponding frequency from the occipital lobe EEG. Taken together, these studies provide further evidence that picture valence can influence perception in binocular rivalry. This is discussed in terms of subcortical mechanisms supporting the efficient processing of threatening information.

Keywords: Binocular rivalry; Emotional pictures; Fear conditioning; EEG; Steady-state visual evoked potentials; Multistable visual perception

When two incompatible pictures are presented to the two eyes that cannot be merged to a single visual percept binocular rivalry occurs. The viewer’s perception switches back and forth between the two incompatible pictures, that is, they compete for perceptual dominance (scientific descriptions of this phenomenon date back to Wheatstone, 1838). In recent years the neural basis of binocular rivalry has been well documented (for comprehensive reviews, see Blake, 2001; Blake and Logothetis, 2001; Engel et al., 1999; Logothetis, 1998). The process underlying the alternating perception between the two stimuli is thought to be relatively independent of voluntary control and it involves several stages along the neural visual pathways of the brain including cortical areas (i.e., inferotemporal cortex). The highest correlation between perceptual shifts in dominance and neuronal activity was observed in binocular neurons in V4 (Leopold and Logothetis, 1996; Sheinberg and Logothetis, 1997).

It has been shown that visual properties of both rivalling images are processed within the visual cortex before the competition between them is decided and only one of them reaches conscious awareness (e.g., Kovacs et al., 1996; Logothetis et al., 1996; O’Shea and Crassini, 1981). More recently, it has been shown that emotional picture content can activate subcortical emotion circuits, e.g., the amygdala, even during rivalry suppression (Pasley et al., 2004; Williams et al., 2004). Based on these findings we propose that projections which have been found to link the amygdala to the visual cortex (Amaral et al., 1992) may provide for an avenue by which emotion can influence perceptual dominance of a rivaling image during visual processing in the visual cortex. The so-called “low road” of visual processing...
has been suggested to prime the visual cortex for preferential processing of emotional material, especially so if it is relevant to fear (LeDoux, 2000).

A number of studies on binocular rivalry tested if the meaning of stimuli influences stimulus predominance but few examined the effects of emotionally relevant stimulus material. One of the first accounts of the relative predominance of meaningful pictures was the finding that upright portraits, which are a more familiar sight then inverted faces, predominated over the latter (Engel, 1956). In a similar vein, familiarity seems to influence which picture is perceived as dominant over the other when pictures of familiar scenes in one culture are paired with pictures familiar in another culture and presented to natives of each culture (Bogby, 1957). However, early positive findings have been criticized on methodological accounts, e.g., very brief presentation of the stimuli, unclear definition of dominance, and unclear reporting (see the review by Walker, 1978). One well-controlled study with negative findings which is frequently referred to in the literature used a dichoptic reading task (Blakem, 1988). However, here the sentences and random strings appeared successively and reading was therefore impaired. In more basic and holistic processing of pictorial stimuli predominance of meaningful stimuli is more likely. Indeed, in a series of well-controlled experiments, Yu and Blake (1992) demonstrated elegantly that images which are readily and unambiguously organized predominate more in binocular rivalry than pictures which have the same luminance and contrast but are lacking a coherent organization. This is strong evidence for the influence of the meaning of pictures in binocular rivalry but does not allow us to conclude that emotional content can influence rivalry in a pair of two meaningful pictures.

Although presenting pictures with emotional content is a well-established procedure in emotion research only one recent study presented pictures of faces with different expressions dichoptically (Coren and Russell, 1992). Here, faces expressing pleasant or unpleasant emotions were reported to have dominated pictures with less valenced emotions. However, participants reported their visual perception after the brief binocular presentation was terminated and was therefore prone to be influenced by memory and reporting biases.

In a previous study (Alpers and Pauli, submitted for publication) we tested whether emotional pictures from the International Affective Picture System (Lang et al., 1999) are more dominant in binocular rivalry than neutral pictures. Twenty pairs of emotional and neutral pictures were presented to 45 healthy participants. They reported concurrently whether they perceived an emotional, a neutral picture, or a mixture of both which was coded by the researcher. Emotional pictures were significantly more often reported to appear as the first unambiguous percept and they were significantly more dominant compared to neutral ones across the whole trial. We concluded from that study that the relative predominance of certain pictures have over others may provide a clue to the influence of automatic emotional processing on the neural networks involved in visual processing.

There were two main limitations to this earlier study. First, the physical characteristics were not constant across picture categories. Because dominance is strongly influenced by characteristics such as colour, contour, and brightness, these factors could have influenced dominance and suppression. Second, the stimulus material had to be rather large in order to be recognizable which can cause a percept mixed from parts of both stimuli ("piecemeal rivalry"). Finally, verbalizing picture content may have introduced a response bias favouring the reporting of emotional percepts.

In two studies reported here we attempted to validate our initial findings. In both studies we used simple geometric patterns in order to perfectly control for physical characteristics. The focus of Experiment 1 was to induce emotional relevance in one of the two stimuli by fear conditioning (Davis, 1992). Stimuli which obtained their emotional significance in aversive conditioning have been shown to modulate the startle reflex similar to naturally aversive pictures (Grillon and Davis, 1997; Hamm and Vaill, 1996) and draw attention in a dot-probe paradigm (Armony and Dolan, 2002).

This aversive conditioning paradigm had several advantages: First, the geometric patterns were simple and could be easily recognized at very small visual angles minimizing the probability of piecemeal rivalry. Second, because similar patterns have frequently been used in earlier psychophysical studies our results are better comparable with them. Third, perfectly controlling the physical characteristics of the competing stimuli was possible making sure that the predominance of one stimulus class over the other is not due to physical characteristics (Blake, 2001; Blake and Logothetis, 2001; Logothetis, 1998). This was further controlled by permutations of which stimulus was selected as CS+ or CS−. Moreover, possible response biases were reduced because the participants' task was not to code whether they perceived an emotional or neutral picture, but rather whether they perceived horizontal or vertical patterns.

Experiment 2 was designed in order to replicate and extend on Experiment 1. The focus of Experiment 2 was to validate self-reported perception with an EEG measures concurrently recorded from visual areas of the occipital lobe. We presented similar geometric patterns but with a fixed frequency flicker which was different between the two pictures. We used the fact that the temporal frequency of a flickering or quickly alternating stimulus causes frequency locked potentials in the EEG which are called steady-state visually evoked potentials (SSVEP, Regan, 1989). Brown and Norcia (1997) demonstrated that frequency coded visual stimuli cause a waxing and waning of the corresponding SSVEP power in synchrony with the perception alternating between the two rivaling percepts. These findings were further supported with fMRI signals which were stronger
when a high contrast stimulus was perceived and weaker, when the rivaling low contrast stimulus was dominant (Polonsky et al., 2000).

Taken together both experiments were designed to replicate and extend our previous findings of emotional predominance in binocular rivalry. By using fear conditioning in both experiments, physical characteristics were perfectly controlled and response biases were minimized. Experiment 2 was designed to further include an EEG measure to validate our participants' coding. If fear conditioning induced predominance in binocular rivalry, this would be strong evidence for the influence of subcortical influences on further processing in the visual system.

1. Experiment 1

1.1. Method

1.1.1. Participants

Among students of the University of Würzburg, 33 healthy participants were recruited. They had normal or corrected to normal vision (14 had contact lenses). Wearing glasses to correct for far-sightedness was an exclusion criterion because this would have interfered with the stereoscope. Two participants were later excluded, one because he failed to code the stimuli correctly during baseline, one because she repeatedly failed to press any response key during experimental trials. Of the remaining 31 participants, 71% were female (n = 22). Their mean age was 22.3 years (range: 19–28). They received course credit for their participation.

Scores on the Positive Affect Negative Affect Scale (PANAS) were in the normal range for positive affect (M = 25.74, S.D. = 4.55) and slightly lower for negative affect (M = 13.77, S.D. = 3.18) (Krohne et al., 1996). On the other hand, the State-Trait Anxiety Inventory, trait version, (STAI-T) scores were slightly higher than the norms (Laux et al., 1981) but comparable to scores we usually find in this population (women: M = 42.09, S.D. = 7.38; men: M = 43.11, S.D. = 6.60).

1.1.2. Material and apparatus

The presentation of instructions and stimuli and the timing of the electrical pulses were controlled by a high-precision software (Experimental Runtime System, ERTS 3.32, Berisoft, Germany) running on an Intel Celeron Processor (500 MHz). A 15-in. monitor with a resolution of 800 × 600 was used. The stimulus material was two simple geometric patterns (see Fig. 1). Viewed through the stereoscope they subtended 1.31° × 1.31° of visual angle which was big enough for a clear percept due to the simple stimulus characteristics and at the same time optimal in terms of eliminating pictorial rivalry (see Blake et al., 1992).

The aversive UCS was an electric current presented to the forearm of the participants’ non-dominant hand for 100 ms. The current was the output of a stimulator capable of generating pulses between 0.1 mA and 10 mA similar to those used in other experiments (Hamm and Vaitl, 1996; Lachnit et al., 2002). The stimulator was battery operated and galvanically isolated from the mains. The pulses were delivered laterally to the forearm through two integrated gold-plated electrodes 32 mm apart and 9 mm diameter each ( Nicolet Biomedical Inc.).

1.1.3. Procedure

First, written informed consent was obtained. Participants were told that they would receive “painful electrical pulses” which were, however, not deleterious to their health. The experimental procedure was reviewed and approved by the ethics committee of the German Psychological Association (DGPs).

Then, pain thresholds were determined by a method of limits test in which a range of pulses was delivered in ascending order (3–6 times). The intensity was rated by each participant on a scale from 0 (“not noticeable”) to 12 (“very painful”). The individual pain threshold was defined as the setting at which the participant indicated that the stimulus was “painful” (a rating of 6) on three consecutive trials. We decided for this definition to have a clearly aversive stimulus even for repeated stimulations. The average intensities resulting from this were 3.96 mA (S.D. = 2.25) and thus similar to other experiments with painful stimuli (Finn et al., 2001).

Participants were then instructed to look through the mirror stereoscope. At first we presented two fusible pictures (left “+”, right “<->”) to homologue areas of the two retinas which helped us to adapt the distance between two stimuli to each participant’s eye-distance (5 alternative settings). For all further instructions we projected identical material to both eyes. We asked the participants to rate the geometric patterns on valence (−3 to +3, anchored as “negative” and “positive”) and arousal (0 to 9, anchored as “not at all” and “very much”).

After the coding of the percept was explained, there were 35 practice trials with pairs of identical pictures (i.e., the gratings had the same orientation) in order to familiar-
ize the participant with the coding using two keys on the computer keyboard (the association of pattern and left or right cursor key was permuted). Participants were then instructed to indicate throughout the ensuing trials with these keys any change in their percept (see Alais and Blake, 2002). The timing between two key-presses was accurately registered in ERTS and later used to calculate the duration of a unambiguous dominant perception during rivalry test trials.

During the baseline and the following conditioning blocks, two rivalling patterns (i.e., one horizontal, one vertical) were presented which competed in binocular rivalry, leading to a perception alternating between both percepts. These trials lasted for 8 s which is best suited to maximize alternation during rivalry (Andrews and Purves, 1997). Participants coded their perception continuously by key presses. First there was a baseline assessment of predominance of the picture which was later associated with the aversive stimulation and the other picture. During the baseline assessment of perceptual dominance, the two unconditioned stimuli were presented in 14 trials.

The baseline was followed by three experimental blocks each consisting 20 trials in which one of the geometric patterns was paired with the electrical pulse for fear conditioning (Dawson et al., 1986). In each block there were 5 CS+ trials with identical pictures (for 50% of the participants this was the horizontal, for 50% the vertical pattern), 5 CS− trials with identical pictures (the pattern with grating opposite to the CS+ pattern), and 10 test trials with rivalling pictures in order to measure relative predominance (during half of them the CS+ was on the left, during half it was on the right). During 80% of the CS+ trials with identical pictures at least one aversive electrical pulse (UCS) was presented to the forearm in order to induce a negative valence, the pulse never occurred during the presentation of the CS−. During one CS+ trial with identical pictures the electrical pulses could occur at least once but up to 3 times, 1.5, 4.5, or 7.5 s after picture onset so that their timing was not predictable. We presented several pulses during some of the 8-s trials to keep up participants' attention. In order to increase participants' awareness of the contingency, they were informed that "certain patterns better predict the occurrence of an electrical pulse" but that their response with the key presses was unrelated to this. All in all each participant received 21 electrical pulses. After all 74 trials, the participants were asked for the valence and arousal ratings again.

1.1.4. Data reduction

We used two measure of predominance of the emotional picture. First we calculated an emotional predominance ratio for the number of trials on which the CS+ was the initial percept, that is the CS+ was the first reported percept in a trial with rivalling pictures (predominance=number of CS+ minus number of CS− divided by number of CS+ plus number of CS−). Second, the analogous ratio was calculated for the cumulative duration of times when the CS+ was dominant during the complete trial (predominance=duration of CS+ minus duration of CS− divided by duration of CS+ plus duration of CS−).

1.1.5. Data analyses

Our main test was defined as a t-test comparing predominance during baseline and during the last block. In addition, we ran an explorative Friedman test for the initial percept data (ordinal) and a repeated measures ANOVA for the cumulative predominance data (interval) with the blocks as a within subject factor. T-tests were defined as significant at an alpha level of 5% (one-tailed).

2. Results

2.1. Valence ratings

At baseline there was no difference between the valence of both visual stimuli (later CS+ and CS−). The manipulation check showed that the CS+ (valence pre=0.03, post=−1.55) which was rated as neutral before the experiment started was rated significantly more negative than the CS− (valence pre=−0.32, post=1.06) after the three blocks of conditioning ($t=−6.27; p<.001$).

![Graph](image)

Fig. 2. The emotional predominance ratio for the initial percept of each trial (left panel). The emotional predominance ratio for the cumulative predominance duration of CS+ over CS− during each trial (right panel). Higher values indicate more predominance.
2.2. Initial percept

In accordance with the increased negative valence of the CS+, there was an increasing predominance of the CS+ with respect to the initial percept of each trial. Across the conditioning blocks the number of trials at which the initial percept was the CS+ increased (see Fig. 2, left panel). This is reflected in a larger predominance ratio for the last block (block 3) compared to the baseline ($\chi^2 = 6.78$, $p = .009$, one-tailed) but the overall Friedman test was only marginally significant ($\chi^2 = 6.78$, $p = .079$).

2.3. Cumulative predominance

The same pattern of predominance was observed with respect to CS+ predominance over the simultaneously presented CS− when the cumulative dominance during trials was used as an index of predominance (see Fig. 2, right panel). The $t$-test between baseline and block 3 predominance ratios was significant ($t = -1.83$, $p = .038$, one-tailed). However, the repeated measures ANOVA did not indicate a significant overall effect ($F(1,90) = 1.50$, $p = .233$). Although this effect is smaller it goes in the same direction as the effect of the initial percept.

3. Experiment 2

3.1. Method

3.1.1. Participants

Among students of our university 35 healthy participants were recruited (none had participated in Experiment 1). 63% (22) were female. Their mean age was 22 years (range: 19–47). They had normal or corrected to normal vision (10 had contact lenses). Wearing glasses to correct for farsightedness was an exclusion criterion. Because participation in the experiment was rather taxing, not all data from all participants was reliable. We excluded one subject because it later turned out that he did not fully understand the instructions due to a language barrier, one because he indicated afterwards that he did not experience the electrical pulse as aversive but rather as pleasant, one because she closed her eyes repeatedly and almost fell asleep, two more because they indicated after the experiment that they became too tired in the EEG chamber to fully comply with the coding. The remaining sample consisted of 30 participants (10 male).

Relevant characteristics of mood (PANAS) and state anxiety (STAI) were comparable to the sample of Experiment 1. PANAS scores for positive affect were in the normal range ($M = 26.5, S.D. = 5.72$) but those for negative affect were slightly lower than the German norms ($M = 12.87, S.D. = 4.55$) (Kröhne et al., 1996). On the other hand, STAI-T scores were slightly higher than the norms (Laux et al., 1981) but comparable to scores we usually find in this population ($M = 40.7, S.D. = 9.44$).

3.1.2. Material and apparatus

The experiment was controlled by a highly accurately timed Presentation™ (Neurobehavioral Systems®, Inc.) script which ran on an Intel® Pentium™ (1.8 GHz) computer. The distance between the two stimuli was adjusted for eye-distance (between ±200 and ±300 pixel). Participants’ responses were assessed by key presses which were precisely registered by the Presentation™ software (Neurobehavioral Systems®).

Similar geometric patterns were shown as in Experiment 1. Here, they were round, with black and white strips of 2 cycles/deg at 80% contrast, and presented through a mirror stereoscope (see Fig. 3). The stimuli were larger than in Experiment 1 in order to elicit a stronger occipital lobe EEG response (3° of visual angle). These stimuli were shown in front of a black background on a 19-in. computer monitor (1152 × 864 resolution).

The stimuli were frequency coded with two different pattern reversal rates (180° phase shifts) because moving stimuli or truly flickering images (flashed) may prevent rivalry (Cobb et al., 1967; O’Shea and Crassini, 1984). The pattern reversal rates were 2.75 Hz and 3.3 Hz (in a series of preliminary tests we found the best signal to noise ratio for these frequencies) which were perfectly synchronized with the screen refresh rate (60 Hz). The two frequencies were permuted with the orientation and conditioning (CS+, CS−) conditions.

This frequency code was reflected in the EEG steady-state visually evoked potentials (SSVEP) at the first harmonic of each frequency (3.5 Hz and 6.6 Hz) (Brown and Norcia, 1997). We measured the EEG with a Brain-Vision™ recorder (Version 1.01b) and a Brain-Vision professional BrainAmp™ integrated amplifier system (Brain Products GmbH, Germany). Data were sampled at 500 Hz from O2 (3 cm above O2) because signal-to-noise ratio was best at this location, stored on an Intel® computer.

![Fig. 3. Stimuli with horizontal and vertical orientation used as rivaling binocular stimuli in Experiment 2. The two pictures with the same orientation (upper and lower row) were shown alternating in one location (pattern reversals) resulting in a frequency-code of a certain frequency.](image-url)
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Pentium™ (2 GHz) computer which received parallel port signals from the control computer for synchronization. We used a notch filter for 50 Hz and referenced the EEG from OO to OZ (making corrections for blinks and other artifacts unnecessary). EEG power at both frequencies was calculated by complex demodulation using a filter width of ±0.5 Hz for each frequency (Brain-Vision-Analyzer version 1.04, Brain Products GmbH, Germany). From this procedure we obtained the power of SSVEP for both target frequencies for every sampling point. The continuous data for each frequency was then averaged according to participants’ key presses which indicated their dominant percept.

3.1.3. Procedure

First, informed consent was obtained. In the consent form, participants were informed that they would receive “painful electrical stimuli” which were not dangerous. They were asked whether they had ever experienced seizures.

Pain thresholds were determined with the same procedure as in Experiment 1. Each experimental trial lasted 14 s and there was an inter-stimulus interval of 2 s. Extending the design of Experiment 1 we added another conditioning block in order to examine if more learning leads to more predominance. Moreover, we added two extinction blocks during which there were no further aversive stimuli. Another change was that we presented electrical impulses on 20% of the congruent CS− trials in order to prevent a positive change in CS− valence as in Experiment 1.

3.1.4. Data reduction and analysis

Data reduction followed the same rationale as in Experiment 1.

4. Results

4.1. Valence

As in Experiment 1, the aversive conditioning resulted in changes in the ratings in accordance with expectations: Both CS+ and CS− were rated neutral before conditioning, and CS+ was rated more negative than CS− after conditioning (CS+ pre = −0.13, post = −1.77; CS− pre = −0.47, post = −0.23; t = 5.21, p < .001). Moreover, the two extinction blocks led to a complete return to baseline ratings (CS+ before versus CS+ after extinction, post-exposure = −0.20: t = 0.28, p = .39, one-tailed). That we presented aversive electrical pulses on some of the congruent CS− trials prevented a change in their neutral valence.

4.2. Predominance

Different from Experiment 1 there was no change in the predominance at the level of the initial percept of each trial. In accordance with Experiment 1 there was a small but significant increase in emotional predominance from baseline to block 3 (t(29) = −1.76, p = .044, one-tailed). However, there was no evidence for a further incline of the predominance ratio with block 4 (baseline to Block 4: t(29) = −1.02, p = .16). Also, there was no evidence for a decline during the two extinction blocks (Block 4 to Block 6: t(29) = −0.27, p = .39).

4.3. EEG

As can be seen in Fig. 4 there is a correspondence between key presses and recorded EEG power of the

![Fig. 4. Mean EEG power at OO (and standard error) of the coding frequencies recorded at OO (5.5 Hz and 6.6 Hz). The solid circles depict the EEG power of the 5.5-Hz frequency, the open circles of 6.6 Hz. The left side shows the values when the congruent key was pressed indicating that the stimulus coded with this frequency was perceived and the right side depicts incongruent key presses, i.e., the picture coded with the other frequency was perceived. Both conditions depict data irrespective of permutation condition.](image-url)
SSVEP recorded at electrode OO. Depicted is the power under two conditions (perceived versus suppressed) for each stimulus frequency (5.5 Hz and 6.6 Hz) there. The EEG power can be compared between the congruent condition (i.e., the key associated with the stimulus coded with this frequency is pressed) and the incongruent condition (i.e., the key associated with the stimulus coded with the other frequency is pressed).

As expected, for both frequencies the EEG power at OO was significantly higher in the congruent condition than in the incongruent condition (significant main effect; $F(1,29)=13.30, p<.001$). There was no significant difference in power between the two frequencies and the difference was significant for both frequencies (5.5 Hz: $t_{(29)}=-3.95, p<.001$. 6.6 Hz: $t_{(29)}=-2.51, p<.009$, one-tailed). There was no significant interaction effect.

5. Discussion

The data presented here contribute to the growing evidence that there is an evolutionary preparedness to preferentially process emotional material in order to enable the organism to quickly and automatically initiate defensive reactions in the face of danger (Ohman, 1992). To our knowledge, these are the first experiments examining whether fear conditioning with previously neutral stimuli influences the predominance in binocular rivalry. Together with the observation that subjective report is reflected in brain potentials, this supports the previously reported dominance of emotional pictures in binocular rivalry (Alpers and Pauli, submitted for publication; Coren and Russell, 1992).

While the effect of our fear conditioning was clearly effective in our healthy participants with respect to valence ratings, the observed perceptual predominance of the emotional stimuli over the neutral ones was weak. However in Experiment 1 both indices of emotional predominance (the initial percept and the emotional predominance across time) were in accordance with the hypothesis and the effects were reliable across several experimental blocks. Moreover, in a similar second Experiment, we observed an effect in the same direction. However, the predominance of the CS+ was much weaker in both experiments than in our previous study with IAPS pictures (Alpers and Pauli, submitted for publication). First, this may have been because the stimuli we employed here had no evolutionary relevance while the IAPS pictures often depict evolutionary relevant objects or scenes (i.e., the open jaw of a predator). The neural circuits thought to underlie the phenomenon may respond much stronger to such prepared or naturally relevant stimuli. Second, the number of conditioning trials were relatively few in the present studies. Although subjective ratings changed in the expected direction, the effects were not large. The preferential processing of more aversive naturalistic stimuli (e.g., phobic material) may prompt much stronger neural responses in the underlying neural systems.

Because the coding of the percepts was easy to do ("horizontal grating" versus "vertical grating") and the stimuli were emotionally neutral before the experiment, the results are less likely than in previous studies produced by participants’ response biases. There is wide acceptance that the switching between percepts is relatively independent of voluntary control. Thus, the effects observed here do not seem to be due to controlled attentional selection. Therefore these data support the notion that emotional relevance of visual stimuli can influence information processing at early stages of processing. Although the visual competition in binocular rivalry is likely to involve several stages of primary visual cortex and even extrastriatal areas (Kovacs et al., 1996; Leopold and Logothetis, 1996; Logothetis et al., 1996; O’Shea and Crassini, 1981; Sheinberg and Logothetis, 1997), the mechanism underlying the emotional influences on visual competition in binocular rivalry may be an automatic activation of emotion circuits such as the amygdala. The amygdala which is central to emotional processing has been speculated to prime and modulate primary visual circuits (Davis and Whalen, 2001; LeDoux, 1998). This is made possible by the direct neural link between sensory pathways of the thalamus and the amygdala (Amaral and Price, 1984; Amaral et al., 1992).

That the amygdala may be activated by emotionally relevant stimuli relatively independent from the visual cortex is supported by evidence from neurologically impaired patients (Anders et al., 2004; Hamm et al., 2003). An affective response to visual stimulation does not depend on an intact visual cortex which is the route to awareness.

In Experiment 2 EEG power of the perceived stimuli’s pattern reversal frequency derived by complex demodulation varied with the self-reported perception of the participants. This replicates previous findings (Brown and Norcia, 1997) with a somewhat different methodological approach and in a fear conditioning paradigm. It therefore corroborates that participants’ self-report can be used to examine the influence of emotional pictures in binocular rivalry.

We conclude from the two studies that the predominance of emotional pictures over neutral pictures is not merely caused by differences in physical characteristics of the emotional pictures and not only due to response biases. The emotional binocular rivalry paradigm proves valid for the study of biopsychological theories of visual processing of fear stimuli.

Acknowledgements

We would like to thank Dr. Ronald F. Mucha for helpful comments on our conditioning procedure and Mr. Peter Lenz for his help with setting up the pulse generator.
References


