New developments in Presentiment Research or The nature of Time[1]

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Human physiology changes in predictable ways in anticipation of and after exposure to emotional visual stimuli. In a series of experiments reported by Radin (1997), it was found that even when stimuli were adequately randomized, so that the upcoming stimuli could not be inferred, that anticipatory responses (as measured by changes in skin conductance) before exposure to emotional pictures were significantly larger than before exposure to calm pictures. In three subsequent experiments, the first and third close replications and the second a conceptual replication of Radin's studies, Bierman confirmed this so called "presentiment" or pre-feeling effect. Bierman subsequently decided to see whether these anomalies observed in physiological baseline measurements could also be found in data from studies published previously in the main stream literature. Two datasets were found and reanalyzed. The first dataset was from a study on the speed with which fear arises in animal phobic participants vs. controls by the German group of Hamm. The second study was concerned with the difference in anticipatory responses prior to choosing cards from risky vs. non-risky decks of cards in a gambling task by the US group of Damasio. The combined result showed a significant anomalous difference similar to the effects found in the original studies by Radin and Bierman.
A new development in presentiment research is the measurement of brain images rather than skin conductance preceding the presentation of randomized neutral and emotional stimuli. Preliminary results suggest that the anomaly can be located in the brain. This would allow for more detailed inspection of differences between different types of emotional stimuli like violent and erotic.

Keywords: Skin Conductance baselines, Emotion, Presentiment, Intuition, fMRI, time

[1] Parts of this article appeared in earlier publications. The new data presented here are the brain imaging data. To be published in: *Frontier Science*, CTEC (Center for Transdisciplinary Studies on Consciousness), Joaquim Fernandes (Ed.), Universidade Fernando Pessoa Press, Porto, 2002.

1. Introduction

During the sep. 11 terrorist attacks on the WTC and Pentagon buildings three airplanes crashed. Some commentators have noted that the number of travelers on the planes seemed unusual low. It has been suggested that some of the potential travelers decided to postpone their travel due to some uneasy feelings or hunches. We call this *pre-sentiment*. Indeed stories abound of people who in the last minute canceled their trip. However in order to evaluate this hypothesis in a scientific way, hard data about last minute cancellations and bookings on comparable days should be used rather than anecdotal reports. Airline companies are not willing to provide these data. However the idea that intuitive processes use some form of non conscious knowledge of the future can also be explored in the laboratory by a simple procedure.
A participant sits in a comfortable chair in a dimly lit room. The index and middle finger of the left hand are connected to a skin conductance measurement device. Skin conductance is known to correlate with the arousal of the subject. In the instructions, the experimenter emphasizes that the subject should try to experience each trial anew. After the instructions and one or more demonstration trials, the experimenter leaves the room and the participant starts the first trial at will by pressing a key on the keyboard. After 5 – 7 seconds[2], a period that we call the *fore-period*, a randomly chosen picture, either calm or highly emotional, is displayed for a specific exposure time. Before, during and after stimulation skin conductance is measured. A typical plot of the average skin conductance for the two types of stimuli is shown in the figure 1. (Bierman & Radin, 1997).

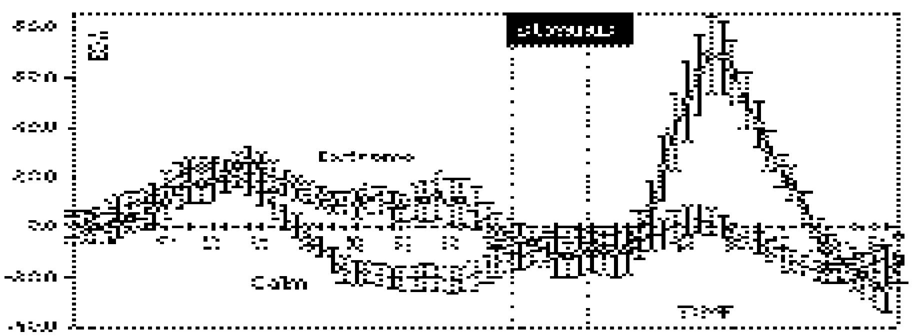

Figure 1. Typical plot of the mean skin conductance versus time, before during and after the stimulus for two types of stimuli.

The two mean responses after the stimulus differ for the two conditions as expected. As can be seen however, the mean skin conductance preceding the exposure of an extreme picture also significantly differs from the mean skin conductance preceding a calm picture.

Several hypotheses for this anomaly have been explored. For example, the composition of a sequence of calm and extreme pictures preceding a particular stimulus may have an effect on the skin conductance preceding that particular stimulus. However with the proper randomization with replacement that was used and when performing the

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analysis on the pooled data this would be akin to the gambler's fallacy and indeed computer simulations show that the effect cannot be accounted for by any strategy of the subject. Exploratory analyses where done in which for each extreme picture a calm picture was selected that matched this extreme pictures with regard to sequential position. The results were similar to those obtained without this correction. This finding argues against the effect being due to a first order difference in compositions of stimulus sequences (Bierman & Radin, 1998) .

2. Anomalous effect in main stream research

Whatever the cause for this anomalous effect, the effect is clearly relevant for paradigms that use measurements preceding the stimulus as a proper (stimulus-condition independent) baseline. In main stream psychophysiological research on emotions, subjects are typically randomly presented with emotional or calm stimuli while psychophysiological measures are continuously monitored. This is a procedure identical to the one followed to assess the idea of pre-sentiment. Therefore the same kind of anomalies should also be present in these main stream studies.

The dependent variable in studies of this kind is generally the post-stimulus response to the aforementioned stimuli. Here we will restrict ourselves to skin-conductance measures as the dependent variable of interest. The response value of this variable can be operationalized in many ways. One could use the peak value obtained in a specified time period following the stimulus, or the integral over the signal during this period, etc. (Boucsein, 1992). In the majority of studies a baseline value, usually derived from the signal just before presentation of the stimulus, is subtracted. The reason for this baseline correction is to reduce variance in the signal that is not related to the stimulus *per se*, but to previous exposures or to habituation to the target sequence.

The questions we therefore asked ourselves was: Are these apparently anomalous baseline effects also present in paradigms that are not specifically designed to measure them.

To answer this questions we reanalyzed data from two previously published psychophysiological experiments by researchers who were unaware of this anomaly, and with completely different research goals in mind. The advantage of using these independent datasets is that they can shed light directly on the prevalence and magnitude of the effect in generally accepted research paradigms where randomization procedures are used to prevent the subject from out-guessing the category of the upcoming stimuli. The disadvantage is that the experiments were not intended to exclude all normal explanations of a possible anomalous baseline effect, including inappropriate randomization. As a consequence, we cannot draw generalized conclusions about the reality of the anomaly, but we can identify whether these anomalous baseline differences appear in "unsuspected" data. Thus, if the effect is found, it may stimulate other researchers to investigate this issue, and in the process either find a normal explanation or establish a true anomaly.

2. 1 Global description of datasets used in the reanalysis.

Two datasets from two different paradigms in psychophysiological emotion research were found that fulfilled the criteria for reanalysis. The necessary data was retrieved for each of these two experiments, all of which used strong emotional stimuli and skin conductance as the dependent measure.

The first dataset was obtained by request from Prof. Alfons Hamm (of the University of Greifswald, Germany). The data were skin conductance samples from an experiment exploring the speed with which fear arises in animal-phobic subjects after a picture with the fear-inducing animal is shown. The data for the control group were also made available. The experiment was reported by members of Hamm's research group (Globisch et al, 1999). The setup and especially the timing of the stimuli were close to the experimental setup used in the original studies suggesting the anomalous baseline effect (Radin, 1997; Bierman & Radin, 1997). We refer to this study as the “animal-fear study.”

The second dataset was obtained from graphs published by Prof. Antonio Damasio's group from the University of Iowa Medical School, in *Cognition* and *Cerebral Cortex* (Bechara et al, 1994, 1996). These data concerned the skin conductance of brain-damaged and normal subjects while they participated in a gambling task. Specifically, skin conductance was measured just before subjects took a winning or losing card from one of four randomized decks of cards. These decks were designed to be more or less advantageous in the long run. The goal of the study was to investigate if subjects’ physiology reflected learned, unconscious knowledge about the decks before the subjects were consciously aware that the decks were biased. This study differed considerably from the studies originally suggesting the anomalous baseline differences. Most notably, the emotional event was not induced by a well timed pictorial stimulus but by a less well-controlled feedback of the sum of money that was won or lost. We refer to this experiment as the “gambling study.”

For both studies the global hypothesis was that the baseline (anticipatory skin conductance) preceding emotional events would be greater than baselines preceding non- or less-emotional events. For details of the studies that are not relevant for the understanding and evaluation of our reanalysis, refer to the original publications.

2.2. The animal fear study [3]

2.2.1 Participants

Eighty six participants (54 women; 32 men; ages 18-41) were selected from a student population. Subjects were included in the high animal fear group if they scored above the 85^{th} percentile of the distribution in their gender group on either a spider or a snake fear

[3] The description of this experiment closely follows the description in the original publication.

questionnaire. Volunteers were assigned to the control group if their scores fell below the 50th percentile on either of these questionnaires.

2.2..2 Procedure & materials

Each participant viewed 60 color slides, in part selected from the International Affective Picture system (IAPS, Center for Study of Emotion and Attention, 1995). From these 60 slides, twenty were snakes or spiders, depending on the scores on the animal fear questionnaires, 8 were erotic pictures, and 32 were calm pictures like mushrooms, household, animals or flowers. For 38 subjects (14 animal fearful) the pictures were presented for 150 msec preceded by a fore-period of 7 seconds during which a fixation point was shown (see Figure 1).

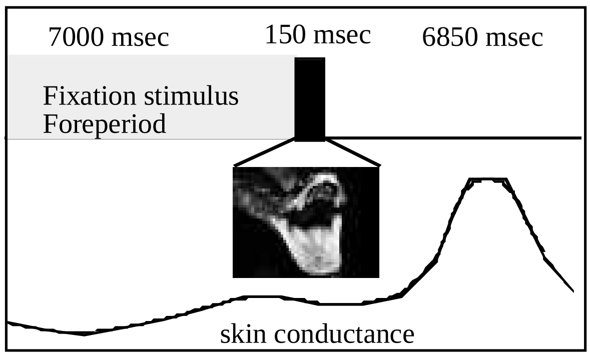

Fig. 1. Timing of stimuli in Animal Fear Study

For the remaining 48 subjects the presentation time of the stimulus was 6 seconds, but in order to keep the total measuring time similar, the fore-period was reduced to 2 seconds. The data of these subjects could not be used for the analysis of the baseline effects because the fore-period was too short to investigate differences. (However, we will consider these data when explaining the importance of having a longer fore-period when establishing true baselines in the results section.) Skin conductance was sampled with a sampling rate of 10 Hz and a resolution of 0.001 microSiemens.

2.2.3 Data reduction

To prevent potential bias from selective analysis of a specific period before stimulus onset, we deliberately defined the "baseline conductance" as the average of the conductance over the **whole** fore-period of 7 seconds. Thus all 70 samples before stimulus onset were reduced to a single value (by averaging) as opposed to using a optimal period based upon visual inspection of the graphs. For each subject, we compared these average values for the erotic pictures with the values for the calm pictures, and then calculated a z-score using the random permutation method (Blair & Kaminski, 1993)[4]. This was also done for the difference between the baseline preceding the snake/spider stimuli and the calm stimuli.

[4] The RPA method, also known as bootstrap analysis, makes no assumptions about the distribution or the interdependence of the data because it uses the empirical distribution derived from the actual data of each subject. Two procedures may be used to calculate a z-score using this RPA method. In the first method, the empirical mean and standard deviation obtained by repeated simulation of the experiment are used. In the

2.2.4 Data analysis

The hypothesis was tested by comparing the z-scores obtained from each subject with the expected mean z-score of 0 using a simple one-sample t-test.

2.2.5 Results

Figure 2 shows skin-conductance as a function of sample number in a superposed epoch analysis graph for all subjects combined.

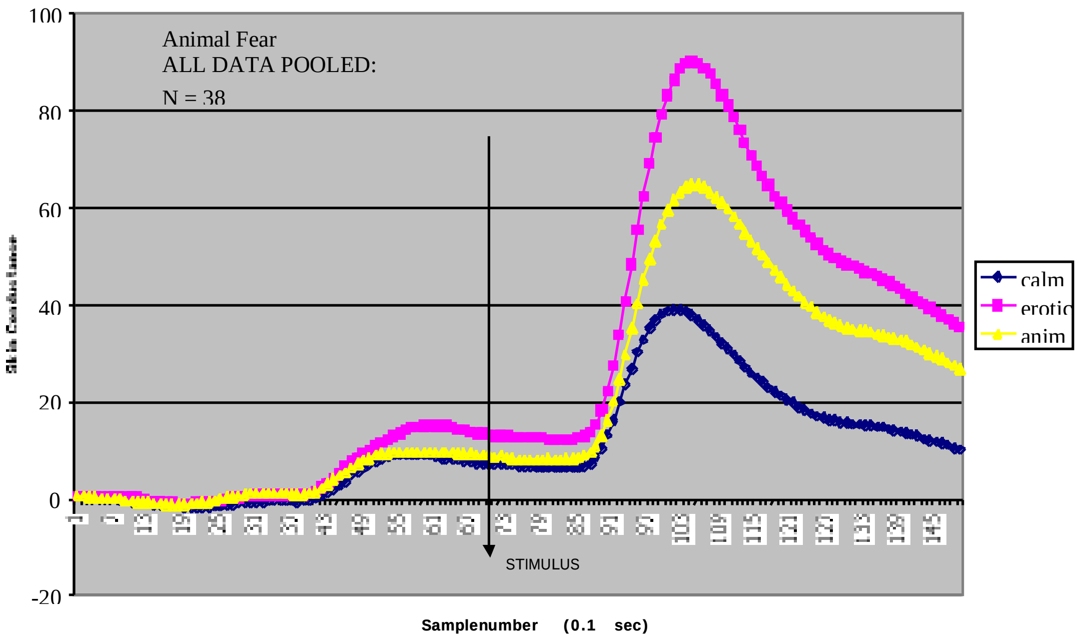

Fig. 2. Average skin conductance for the three type of stimuli.

As can be seen from Fig. 2 it appears as though skin conductance preceding the erotic pictures was larger than skin conductance preceding the snake/spider pictures as well as the level preceding the calm pictures. The skin conductance data were clamped at “-7” seconds (7 seconds before stimulus onset or sample number 1).

erotic versus calm baselines

Out of the 38 subjects, 3 did not show any response at all. They were removed from the statistical analysis. Table 1 shows the calm vs. erotic results. To illustrate the possible impact of person-variables on the anomalous baseline differences, the results are split for male and female.

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second method, the z-score is calculated from the p-value that arises through counting the number of times the same or a higher score arises in the simulations. We used the latter method because the former method assumes normality. The two methods applied to our data yield z-scores that correlate with a correlation coefficient of ~ 0.99 and thus will produce over-all results which are almost identical.

Table 1:Mean normalized differential (erotic vs. calm) baseline values split for gender

	Mean z-score	df	t	p[5]
Female	0.320	21	1.903	0.0354
Male	0.062	12	0.215	0.4168
Total	0.225	34	1.497	0.0718

Animals (spider/snake) versus calm baselines
Table 2 gives the calm versus spider/snake results split for male and female.

Table 2: Mean normalized differential (spider/snake vs. calm) baseline values split for gender

	Mean z-score	df	t	p
Female	-0.020	21	-0.135	0.553
Male	0.188	12	0.779	0.226
Total	0.058	34	0.455	0.326

2.3 The gambling study

2.3.1 Participants

Seven of the participants (4 male, 3 female) were patients with a normal IQ but with bilateral damage to the ventromedial prefrontal cortices. Twelve 5 male and 7 female were normal control subjects.

2.3.2 Procedure[6]

In a gambling task simulating real-life decision-making in the way it factors uncertainty, rewards, and penalties, the players (participants) are given four decks of cards, a loan of $2,000 facsimile U.S. bills, and asked to play so that they would lose the least amount of money and win the most. Turning each card carries an immediate reward ($100 in decks A and B and $50 in decks C and D). Unpredictably, however, the turning of some cards also carries a penalty (which is large in decks A and B and small in decks C and D). Playing mostly from the disadvantageous decks (A and B) would lead to an overall loss. Playing from the advantageous decks (C and D) would lead to an overall gain. The players have no way of predicting when a penalty would arise in a given deck, no way to calculate with precision the net gain or loss from each deck, and no knowledge of how many cards they would have to turn to end the game (the game was stopped after 100

5 All p-values are one-tailed because a direction of the expected effect was specified.
6 The description given here is a verbatim copy of the description given by the original authors (Bechara et al, 1997).

card selections). After encountering a few losses, normal participants begin to generate skin conductance responses before selecting a card from the bad decks, and they also begin to avoid the decks with large losses. Patients with stable focal lesions as described above do neither.

2.3.3 Data extraction and analysis

The data we are interested in are identical to the data used in Bechara's (1997) analyses. This data led to the conclusion that normal participants began to generate anticipatory responses prior to taking a card from one of the disadvantageous decks. From our perspective this anticipatory response is the “baseline” for the response that will follow upon feedback of the actual amount that the participant wins or loses. Rather than evaluating these data as a function of how risky the deck was, as was the original goal of the study, we are interested in these baselines as a function of the forthcoming winning or losing card. The baseline effect found by Bechara et al can be explained in a normal causal way under the assumption of implicit learning of how risky the decks are. However if different baselines are found preceding good or bad cards this would be another example of an anomalous baseline effect. As Bechara et al state explicitly, “*the players have no way of predicting when a penalty will arise…*” (Bechara et al, 1997).

The relevant data of the 12 healthy subjects were extracted (using a graphics pointing device which gives the precise values of the coordinates) from Figure 4 in an article in *Cerebral Cortex* (Bechara et al, 1996), which describes their results. Although this figure gives the values only as a function of sequential order of the card within the deck, we could reconstruct the win/loss amount for each of these cards by using Figure 1 from the article in *Cognition* (Bechara et al, 1994). The data extraction was done by a person blind to the hypothesis. Since the original analyses used parametric tests, we employed a simple t-test to evaluate our hypothesis that baseline levels preceding the losing cards would be higher than those preceding the winning cards.

2.3.4 Results

Only the data for the normal subjects were used because the brain damaged patients typically did not develop anticipatory responses. Table 3 gives the results of the t-test comparing the baseline skin conductance before winning and before losing cards. The results are also given for each individual deck.

Table 3: Differences between baseline preceding winning and losing cards

Deck	**Mean Diff**	**df**	**t**	**P-value**
Deck A	0.176	20	1.214	0.1195
Deck B	-0.017	25	-0.102	0.5400
Deck C	0.016	33	0.256	0.3996
Deck D	0.028	33	0.571	0.2860
All Decks	0.085	117	1.634	0.0525

In 3 of the 4 decks the differences are in the expected direction and the decks pooled give a marginally significant difference in the expected direction.

2.4. Conclusion from re-analysis main stream data

2.4.1 Is there an anomalous baseline effect in the data?

In order to answer whether there is an anomalous differential effect that is detectable *prior* to the stimulus presentation, we pooled the results of the two studies using all trials, erotic, animal fear, and calm data. Table 4 summarizes all data from the individual experiments, and gives the composite result across the three experiments, calculated by the standard Stouffer Z procedure (Rosenthal, 1978).

Table 4: Overview of 'anomalous' baseline effects in three studies

STUDY	**t (ALL emo – calm)**	**df**	**p**	**Corresponding z**
Animal-fear study	1.44	69	0.0773	1.423
Gambling study	1.634	117	0.0525	1.620
OVER-ALL			0.01	2.15

Although none of the studies reached the traditional 5% level for significance, together they seem to support the earlier findings that skin conductance baselines preceding emotional events are higher than those preceding calm events.

The question if this constitutes a genuine anomalous effect in the sense that it cannot be explained within standard scientific models, can be answered only in specifically designed research. Both experiments used a randomization method without replacement. This allows for the possibility that subjects might have implicitly learned the ratio between emotional and calm events over the course of the experiment and then they applied this knowledge later in the experiment.
An argument against this explanation is that such behavior is not observed in practice, especially not the perfectly systematic behavior required to produce slight statistical artifacts. One further argument could be found in the apparent consistent difference between the baselines preceding emotional stimuli of a different nature, like erotic and animal fear inducing stimuli.

Since it is not the primary goal of this reanalysis to demonstrate the existence of an anomaly, we will not further evaluate this question. Nevertheless, we may conclude that baseline differences prior to a stimulus do occur under generally accepted randomization procedures in psychophysiology. Thus the calculation of response values using such baselines might be in error.

3. New developments: Brain imaging presentiment

In some of the experiments above suggestive evidence was found for not only a difference between calm and emotional stimuli but also between two types of emotional stimuli. Violent stimuli seemed to produce an earlier presponse (i.e. more seconds before the event) than erotic stimuli (Bierman & Radin, 1998). This might make sense if we interpret the data in an evolutionary sense. However the power of the experiments was too low to draw firm conclusions. Differential effects within the emotional conditions would certainly strengthen the case that this is an anomalous phenomenon indeed. Therefore it was decided to explore the same paradigm using brain imaging equipment rather than skin conductance measurements.

3.1 Method

3.1.1 Subjects

Ten subjects (6 male, 4 female) with a mean age of 28.1 years (sd=12.2) volunteered to participate . The study was approved by the local ethics committee and informed written consent was obtained prior to the study.

3.1.2 Stimulus presentation

The subjects were instructed to relax while passively looking via a mirror at the pictures that were presented by a computer connected to a video projector onto a screen. They were requested to try to forget any emotional material right after exposure finished so that the next presentation would be influenced as little as possible by the previous one.
The stimulus material consisted of a picture pool of 36 emotional (18 erotic, 18 violent) and 48 neutral stimuli. The neutral and violent stimuli were from the International Affective Picture System (IAPS, REF) while the erotic material was used before in a study on sexuality (REF). For each stimulus presentation the stimulus condition was determined randomly with an a priori chance of 2 neutral versus 1 emotional. After the stimulus condition was determined the pool was shuffled and the first picture of that condition was selected. After use that picture was removed from the pool.
Each stimulus sequence started with the 4.2 seconds (2 volumes) presentation of a fixation point during which the anticipation was measured. After the exposure of the stimulus picture which lasted also 4.2 second there was a period of 8.4 seconds during which the subject was supposed to recover from the stimulus presentation.

3.1.3 MRI scanning procedure

A 1.5 Tesla Siemens Sonata system was used to acquire T1 weighted high resolution structural images and echo-planar T2* weighted images with BOLD (Blood oxygenation level dependent) contrast. Functional images were acquired by continuous scanning a total of 8 volumes per stimulus sequence for a total of 384 volumes. Each volume consisted of 21 slices. The field of view was 200 mm with 64^2 matrix (3.1 mm^2) in plane resolution and a slice thickness of 5 mm. Each run began with 3 dummy volumes to allow for T1 equilibration effects; these volumes were subsequently disregarded.
Each subject got first a MPRAGE high resolution scan lasting about 20 minutes. Subsequently the subject got the task instruction outside of the scanner and after a position localizer scan of about 2 minutes the task of about 13 minutes was presented. For a few subjects further tasks followed.

3.2 Data Analysis

Data were analyzed using Brainvoyager 2000 (V4.4). Scans were aligned using the first volumes as a reference and after slicetimecorrection, spatial and temporal filtering were transformed into Talairach space. Fitting of the BOLD response to a general linear model was done using the first 2.1 seconds (the excitation part) of the hemodynamic response curve. Event related averaging was performed over neutral, erotic, and violent stimuli separately/

3.3. Results

It was decided that the analysis would comprise two phases. The first phase with 4 subjects would be exploratory and about every thinkable analysis would be performed to get a feeling for the data. On the basis of the first 4 subjects more precise hypotheses, especially in relation with the brain structures involved, would be formulated. At the time of writing of these proceedings we did analyze two subjects. The first subject did show a clear presentiment effect in most regions of the brain where the variance of the oxygenation was significantly explained by a combination of all factors (neutral and emotional). (see figure 3 and caption for explanation).

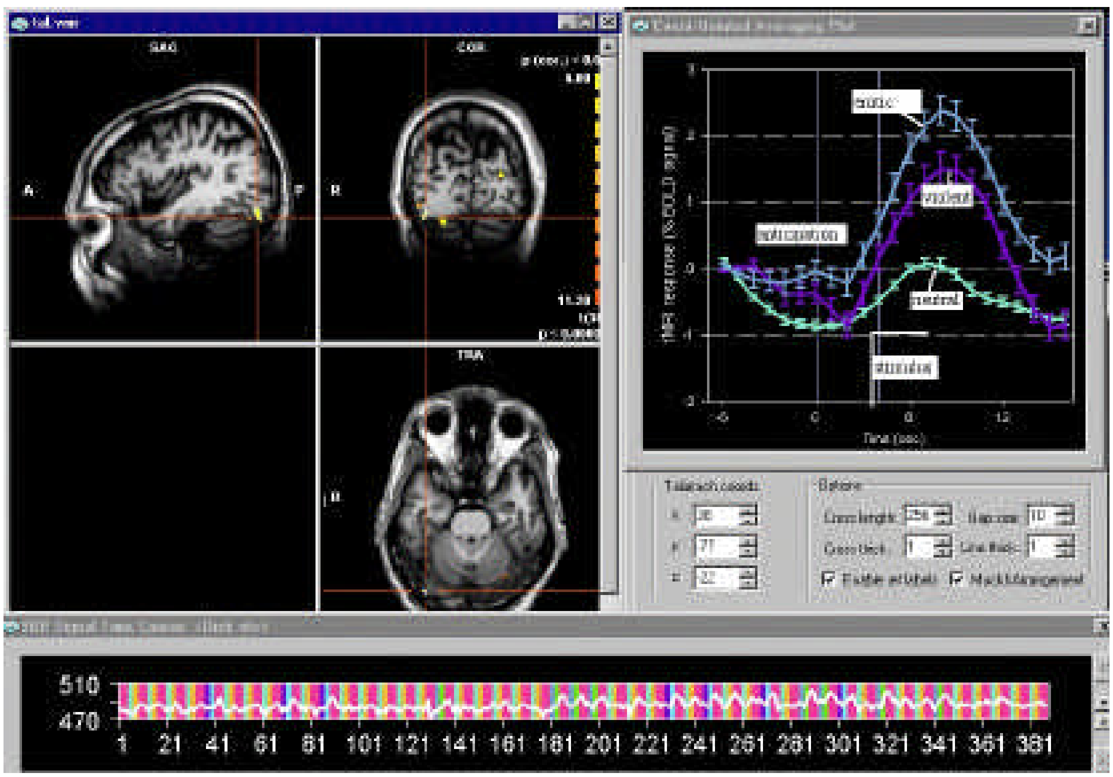

Figure 3: Screendump of the final stage of the analysis of Ss1. The upper left pane indicates the region in the brain where most variance is explained by a general linear model including all factors (neutral, violent and erotic). The lower panel gives the bold signal for the whole experiment in that specific region of the brain. The upper right panel gives the mean activity for the three conditions. Note that the emotional conditions show already higher activation preceding the stimulus.

The second subject didn't show a presentiment effect but it was interesting to note that this subject was also atypical in the sense that she didn't show a clear differential response between neutral and emotional stimuli. In a small region of the brain a reverse effect was found (i.e. there was a larger DECREASE in bold signal preceding emotional than preceding neutral stimuli) but such a result seems to be not well interpretable since even inhibition type of brain processes require increased neural activity and hence increased level of oxygenation.
The current results are encouraging but no definite conclusions can be drawn until further analysis. The crucial tests will be on the remaining 6 subjects once the brain regions of interest have been identified.

4. The nature of time: macroscopic time symmetry?
Formally the laws of physics are time-symmetric. In practical terms, this time symmetry is observed in classical mechanics but not in thermodynamics, where Boltzmann's second law forces the systems toward increasingly higher states of entropy. In a lucid book on time symmetry, Huw Price analyses this problem and concludes that the standard "explanation" based upon probabilistic arguments is incorrect (as Boltzmann himself also realized) (Price, 1996).
In an analysis of the asymmetry observed in radiation (electromagnetic theory), Price suggests that the asymmetry is caused by the spatial arrangements of absorbers and emitters. Absorbers tend to be non-coherent and transmitters tend to be coherent. According to Price this results in a destructive interference of the "advanced" waves. Thus we rarely observe back-action in nature unless we have a coherent absorbing system. We speculate that consciousness may be such a system. Price shows also that when allowing for time-symmetry in quantum physics all of the puzzling paradoxes related to the measurement problem, such as non-locality, disappear.
Price's analysis of the problem of lost time-symmetry suggests a continuation of these types of experiments using experienced meditators. On the other hand, there are some suggestions in the present data, and in data of ongoing experiments, that a *conscious* emotional experience may be required to elicit the presentiment effect. I.e. if the meditator is too experienced and succeeds in completely blocking the target picture out of his or her awareness, the presentiment effect may disappear. Interestingly, our speculation about consciousness as a coherent absorbing system fits in with folklore about the relationship between meditation and the occurrence of psi-phenomena. It is said that on the path toward control of one's consciousness, at some point psi-phenomena just naturally appear. It is also said that one should not pay attention to these phenomena, because that would only frustrate further progress in meditation performance.
Within this admittedly speculative framework, the expected point of symmetry on the time axis is *not* at the time of stimulus onset, but rather at the start of the conscious experience, which may be around 350 msec later. Therefore the peak of the presponse is not expected closer to stimulus onset than where it would be if it was a mirror image of the response with symmetry point at stimulus onset. This fits in well with the observed peaks.

Acknowledgements

I wish to express my gratitude to A. Hamm for providing me with the raw data of his experiments. A.Bechara was helpful in pointing out that the randomization used in their study was not appropriate for drawing strong conclusions about the true anomalous nature of the effects. Last, I thank my daughter Jet Bierman for the conscientious way in which she obtained the data from the gambling study.

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