PROGRESS REPORT

Bial project 34/04

Name: ***fMRI and photo emission study of presentiment: The role of 'coherence' in retrocausal processes.***

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Abstract

This progress report covers the pilot experiment preceding the main experiment.
Fifty two subjects, among those 30 experienced meditators, participated in this study. Their skin conductance was measured while they were stimulated at irregular intervals with either a pleasant or an unpleasant sound. The goal of the study was to compare the presentiment effect during meditation and normal wake state. The study was presented to the subjects as a study on habituation to sound stimuli since in the literature it is claimed that specific meditation traditions, most notably the concentrative and the mindfulness tradition, give different patterns of habituation.
The over-all results show no differential effects in presentiment between the meditation and the normal wake condition. There is some support for the notion that the mindfulness meditation gives stronger presentiment. The results on an individual basis are being used to select the subjects for the main experiment where, rather than sound, picture stimuli will be used to evoke presentiment and where, rather than skin conductance, brain activity as measured through fMRI will be used as the dependent variable.
The habituation results of the pilot study did not support the findings earlier reported in the literature. But there was interestingly strong interaction effect where habituation rate is largest for the type of stimulus that 'fits' best with the state of consciousness. A calming pleasant sound therefore habituates fast in the meditation state while the unpleasant sound does habituate faster in the normal wake state. There were also marked differences between the two meditation traditions and the control group.

INTRODUCTION

Presentiment is a controversial physiological response preceding a stimulus (Bierman & Radin, 1997). Anticipation of a stimulus is normal and to be expected, especially if the subject can make a reasonable guess about the timing of the stimulus. However if the anticipatory behaviour is contingent on the specific future stimulus condition, say neutral or emotional, and if the subject has no way of guessing what this condition might be, we have a real anomaly. Several authors have reported this anomaly but there haven't been formal studies into individual differences of subjects. Differences between different populations of subjects might be of great theoretical relevance.
It has been suggested (Bierman and Radin, 1998) that presentiment is basically a reflection of the basic time symmetric nature of physical reality. One of the greatest

challenges still left in physics is to explain the 'arrow of time' while the major formalisms, electromagnetism, relativity theory and quantum physics all are time symmetric[1]. If presentiment reflects a restoration of this time symmetry then the specific conditions under which this occur might help us explain why the symmetry under most conditions is violated.

One of the proposed 'explanations' for the arrow of time is the cosmological one proposed by Wheeler and Feynman (Wheeler and Feynman, 1945). According to them, the time symmetry is violated because the cosmos is not in an equilibrium state but rather far out of equilibrium. More specifically they argue that there is a huge difference in the number of multi-particle coherent systems that transmit radiation (Lasers) compared to large multi particle coherent systems that absorb radiation. While one can argue that introduction of emitors and absorbers is a hidden way to introduce an arrow of time one can also accept their reasoning and look for situations where large coherent systems absorb radiation. One could for instance use interaction between Bose-Einstein condensates and EM radiation and search for time symmetry in the interactions of those systems.

It takes a jump of faith to replace their radiation by some 'information' measure. It takes even a larger metaphorical step to replace the precise 'coherence' attribute that Wheeler and Feynman (WF) have in mind with a more fuzzy and loose description of coherence of the brain-mind system. But if one is willing to entertain this analogy for a moment one could argue that the conscious brain is such a coherent multi particle absorber and possibly interactions with the system should show time-symmetry. The notion that brains are a complex and coherent multi particle system is supported by the experiential fact that conscious experience is not fragmented. This is called 'binding' in the literature (see for instance W. Singer, 2001).

Once this step is taken a possible research question that arises is if the 'level of coherence' of this brain-mind system can be varied and if it is possible to explore potential correlating presentiment effects. This question brings us logically to the meditative states of consciousness. The manipulation of the state of consciousness as it occurs in meditation can be seen as a manipulation of 'coherence' of this system and thus might have an effect on the presentiment phenomenon where a deeper state will give rise to stronger effects. EEG studies of the meditating brain do show that several parts of the brain show collective behavior where the electrical signals show small or no phase differences (Badawi et al, 1984).

The current pilot study was presented to the subjects as a study into habituation to sound stimuli. Thus they remained formally uninformed about the presentiment aspect until after the study. This was done in order to prevent them to think about the possible condition of the upcoming stimuli during the experiment. The assumption being that any cognitive activity might disturb the 'coherent' meditative state. One of the controversial findings in the meditation literature is the effect of meditation on habituation (Ananad et al, 1961; Bagchi and Wenger. 1957; Becker and Shapiro, 1981). Especially the difference

[1] Time symmetry implies here that the physical formalism gives always two valid solutions, where the time variable 't' can be replaced by '-t'. This holds for the Relativity theory as well as for the Quantum theory. The second law of thermodynamics and the 'collapse' in quantum physics 'force' time asymmetry into physics but it is not well understood why this is the case.

between the habituation occurring in the concentrative meditative state and occurring in the mindfulness meditative state was first received with a lot of enthousiasm because it fitted so well with the assumed properties of these states of consciousness. In the mindful meditative state each stimulus is supposed to be fresh and new and hence no habituation is expected. In the concentrative state ALL attention is directed to a specific thought or percept and hence external stimuli are thought to provoke hardly any response.

In the pilot study we therefore formulated two sets of hypotheses. One dealing with presentiment and one dealing with habituation. More explicitly we expected larger presentiment effects in experienced meditators, especially while they were meditating. Furthermore we expected no habituation effect during mindful meditation with the response being constant while for concentrative meditation we didn't expect a strong response on the different stimuli.

METHOD

Subjects

Subjects were recruited through contacts with several Meditation Centers and during a meditation event in Amsterdam. Control subjects were recruited from freshman psychology students and among friends and family of the experimenters. The latter was necessary to obtain an age distribution in the control subjects that was comparable to the age distribution among the meditators (see table I)

Table 1: Subjects entering the study

	Male	**Female**	**N**	**Mean-age**	**SD-age**
Concentr. (CM)	6	10	16	47.7	10.4
Mindful (MM)	11	9	20	47.6	11.8
Control (Cntrl)	8	10	18	31	11.5

It can be seen that in spite of the efforts to match the age we did not quite succeed. Note also that a few of the participants claimed that their specific meditation technique shouldn't be labelled as either concentrative or mindful. In those cases we decided on the basis of informal descriptions of their technique. Among the 52 subjects there were two who were experienced in both meditation techniques. They were tested twice. Five subjects did not show skin conductance responses and were excluded from the analyses.

Materials

Two sounds were selected from a pool of 37 sounds which were judged by 25 judges on a scale from 1 to 5, 1 indicating very unpleasant and 5 indicating very pleasant. The most pleasant (3.16) and the most unpleasant (1.12) sound were selected. The most pleasant sound was that of a bas guitare. The most unpleasant one was an alarm clock sound. The sounds were randomly presented through a pair of speakers.

The interval between stimulation varied randomly from 16 to 30 seconds. The probability for the pleasant sound was always 0.666 and for the unpleasant sound always 0.333.

Skin Conductance was measured using a constant alternating current PsyLab preamplifier connected to a BioSemi 24 bit ADConverter.

Procedure

Each subject participated in two subsequent sessions. One session was the meditating session (or relaxed session for the control subjects) while the other session was the normal wake state session. Order of session was randomized. After introduction to the experiment and an intro-interview, subjects were seated in front of a computer display and a pair of two Ag-AgCl electrodes were attached at the standard sites on their non preferred hand. Isotonic paste was used to ensure stable contact. After 5 to 10 minutes adaptation time the experiment was started. The session took in total about 20 minutes during which 50 sounds were presented and the skin conductance was measured. Between the first and the second sessions subjects filled in the HIP (human information processing) questionnaire. This questionnaire measures some aspects of intuitive processing.

After the second session the subject filled in the exit-interview and there was ample time to discuss the goal and prospects of the research. Especially the meditation subjects sometimes generated new insights about the planned main experiment

RESULTS

Due to 5 non responsive subjects analyses were possible on 47 subjects (CM =13, MM= 17, Controls = 17). The male-female distribution was equal for the three groups but the age distribution differed significantly between controls and meditator groups ($F(2,44) = 18.4$; $p< 0.01$). Mean age difference was about 19 years.

During the exit interview the participants were also asked to judge the pleasantness of the sounds. They rated the alarm slightly less unpleasant (M=2) than the rating found for the general population and also their rating for the pleasant stimulus was less extreme (M=3.1). These differences might be due to the more frequent exposure resulting in some habituation to the sound. The difference in rating was however very significant ($t(46) = 9.3$, $p <0.001$) and therefore the manipulation was successful.

Habituation

Four habituation coefficients were calculated based upon the peak amplitudes of the first 10 responses in subsequent trials. These habituation coefficients were the habituation to unpleasant and pleasant sounds ($H_{unpleasant}$ and $H_{pleasant}$). These were calculated for the 'meditation session' and the 'wake state session' separately. The habituation coefficient was simply the linear regression coefficient over the subsequent relevant stimuli. The more negative this coefficient, the stronger the habituation.

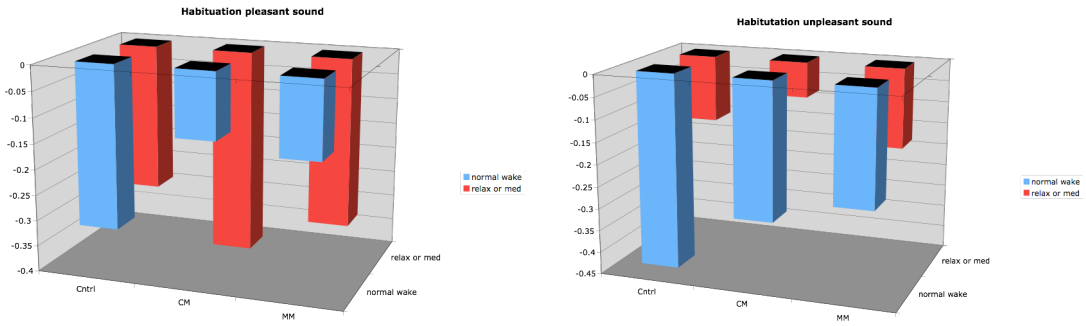
Order of sessions was balanced and differential analyses showed that the order (meditation-wake or wake-meditation) had no effect on the results.

Table II shows the results for the two states for the three groups separately. One row (MED) shows the data for both meditation groups combined.

Table I. Habituation coefficients for the two conditions and two type of stimuli.

		Meditation (relax) state		Waking State	
Group	**N**	**$H_{pleasant}$**	**$H_{unpleasant}$**	**$H_{pleasant}$**	**$H_{unpleasant}$**
CM	13	-0.40 (0.42)	-0.08 (0.46)	-0.13 (0.38)	-0.31 (0.45)
MM	17	-0.33 (0.36)	-0.18 (0.45)	-0.15 (0.40)	-0.26 (0.38)
Cntr	17	-0.29 (0.44)	-0.15 (0.40)	-0.32 (0.37)	-0.44 (0.37)
MED	30	-0.36 (0.38)	-0.13 (0.45)	-0.14 (0.39)	-0.28 (0.41)

Contrary to expectations, both mediation groups show very similar habituation coefficients though there is some indication that the concentrative meditators seem to 'block' the unpleasant sound more. However this 'blocking' should be a general feature according to the literature and it is obviously not present for the pleasant stimuli for which the CM group shows the strongest habituation. Also there is hardly any difference between the control group in a relaxed state and the meditators while meditating. However in the waking state the meditator groups do differ from the control group. Habituation is smaller especially for the pleasant stimuli. There is a strong interaction effect between state and the habituation per stimulus type. ($F(1,44) = 12.1$, $p = 0.002$). The stimulus which is mood consistent (i.e. the pleasant stimulus while relaxing or meditating and the unpleasant, arousing stimulus while in normal wake state) does habituate much faster.



This is not quite unexpected since the non state consistent stimuli can be seen as having more 'news-value' and hence habituation is slower.

Presentiment

Mean Skin Conductance plots were obtained for each of the three group of subjects for the two types of stimuli (figure 1).

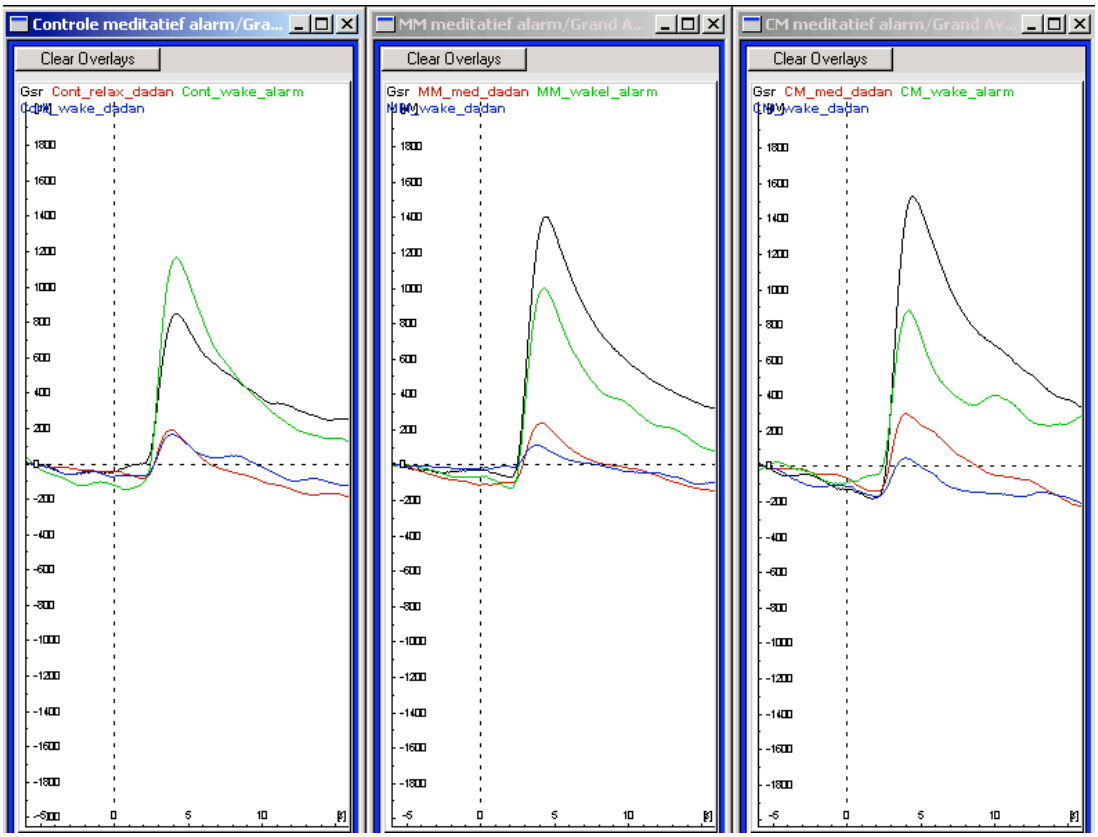


Figure 1: Mean SC scores before and after stimulus exposure for the Control Subjects (left pane), Mindfulness Meditators (middle pane), and Concentrative Meditators (right pane). Black trace: unpleasant + meditating/relax. Red: pleasant + meditating/relax, Green: Unpleasant + waking state. Blue: pleasant + waking state.

From these traces we can observe that the largest responses for both meditator groups are in the meditating condition for the unpleasant sounds while for the largest effect is in the waking state! More relevant for presentiment we already observe that the differences preceding stimulus exposure are small and not very consistent.
Presentiment scores were calculated in arbitrary units for each subject in each condition.
The presentiment score was defined as the mean skin conductance during the interval from -3 to 0 seconds minus the baseline value defined as the skin conductance at 7.5 seconds before the stimulus was generated.

Table III. Presentiment scores for the two conditions and two type of stimuli.

		Meditation (relax) state		Waking State	
Group	**N**	**$P_{pleasant}$**	**$P_{unpleasant}$**	**$P_{pleasant}$**	**$P_{unpleasant}$**
CM	11	-109 (102)	-171(186)	-116 (241)	-27 (318)
MM	18	-106 (85)	-103 (115)	-50 (117)	-86 (347)
Cntr	17	-63 (120)	-115 (96)	-59 (137)	-168 (454)
MED	30	-107 (90)	-129 (147)	-75 (174)	-64 (332)

It can be seen that globally the presentiment score preceding the unpleasant stimulus is not larger than the one preceding the pleasant stimulus. In most conditions the difference is even reversed and contrary to expectation. The hypothesis of presentiment couldn't be confirmed in this dataset[2]. However as stated earlier one of the major goal of this pilot study was to select subject who showed a promising presentiment effect. Although averaged over subjects there was no indication of presentiment some subjects did exhibit the typical patterns. Mean skin conductance for the whole epoch 5 seconds preceding and 15 seconds following upon stimulation was plotted per subject per condition (see also http://M0134.fmg.uva.nl/meditatie). From these plots the subjects with the most promising presentiment were selected for participation in the main fMRI experiment.

CONCLUSION

There are two types of results in this pilot study. First the scientific results and secondly the practical results.

Most importantly we were unable to show a clear-cut presentiment effect. Note that we expected the meditation state to enhance the effect. The use of sounds as emotion inducing or relaxing stimuli was new and it could be that the difference in emotional value (2 versus 3.1) was rather small. On the other hand the responses that we measured on pleasant and unpleasant sounds were markedly different.

The results with respect to habituation did not confirm the expected difference between different meditation techniques. This is not quite unexpected because in the literature it has already been noted that these differences were once found but never successfully replicated. On the other hand we found a nice consistent interaction effect that makes much sense: The sound that fits well with the state the subject is in habituates the fastest. This result is new and could shed some more light on the meditation state. The fact that meditators in waking state habituate considerably faster then controls in the waking state might indicate long term effects transferring to the waking state but it could also be interpreted that the meditators form a special set of the population to begin with. I.e. that the reason that they start and continue meditating is because they need to 'become normal habituators'.

The practical results of this pilot study indicate that it is possible to work with meditators under lab conditions that are different form the normal home environment these subjects are used to. However the conditions in the main experiment will be even more different.

[2] We intend to re-analyze these data for the final report using a variance measure rather than the mean value of the SC as the dependent variable.

First the stimuli to be used will be pictures rather than sounds. This requires the subjects to keep their eyes open. In some meditation traditions this is a difficult exercise. Secondly the subjects will be lying down in the scanner. Most meditators prefer sitting or walking over lying down. Finally the subjects will experience aversive sounds produced by the scanner.
Currently we are training the subjects to adapt to these circumstances by means of a training consisting of two parts. First the selected subjects have been asked to meditate while they play a sound track of fMRI sounds at their daily practice at home. Secondly the subjects are invited to the lab where we have built a fMRI simulation chamber. Subjects will lie down and pictures will be presented to them through a mirror just like in the real fMRI experiment. They will be asked to meditate throughout. Earlier plans to ask them to switch from the meditative state to the normal waking state upon exposure have been cancelled after the subjects indicated that this task was too complicated.

CURRENT STATE OF THE MAIN EXPERIMENT (november 2005)

• We have selected the subjects with an indication of presentiment from the pilot study and who fulfilled the requirements to be exposed to MRI equipment.

• We have finished training these subjects to meditate during exposure by visual stimuli and the noise produced by a MRI scanner.

• We have finished the data acquisition in the fMRI experiment for 8 meditatin g subjects (2 sessions) and 8 control subjects. The total amount of data is ~ 6 GigaBytes.

• Analyses of the response activation with a between factor of 'meditating experience' and within factors concerning the emotional content of the exposed pictures has started.

REFERENCES

Anand, B.K., Chhina, G.S. and Singh, B. (1961) Some aspects of electroencephalographic studies in yogis. *Electroenceph. Clin. Neurophysiol*. **13**: 452–456.

Badawi, K., Wallace R.K., Orme-Johnson, D. and Rouzere, A.M. (1984)Electrophysiologic characteristics of respiratory suspension periods occurring during the practice of the Transcendental Meditation Program. *Psychosomatic Medicine*, Vol 46, Issue 3 267-276.

Bagchi, B. K., & Wenger, M. A. (1957) Electrophysiological correlates of some yogic exercises. *EEG and Clinical Neurophysiology*, Supplement 7.

Becker, D.E. and Shapiro, D. (1981) Physiological responses to clicks during zen, yoga, and TM meditation. *Psychophysiology* **18(6):** 694–69.

Bierman, D. J. & Radin, D. I. (1997). Anomalous anticipatory response on randomized future conditions. *Perceptual and Motor Skills*, **84**, 689-690

Bierman, D. J. & Radin, D. I. (1998). Conscious and anomalous non-conscious emotional processes: A reversal of the arrow of time? *Toward a Science of Consciousness, Tucson III*. MIT Press, 1999, 367-386

Bierman, D. J. & Scholte, H. S. (2002). Anomalous anticipatory brain activation preceding exposure of emotional and neutral pictures. Paper presented at Toward a Science of Consciousness, Tucson IV.

Singer W. (2001): Consciousness and the binding problem. Ann NY Acad Sci 929: 123-146

Wheeler J. A. and Feynman, R. P. (1945) Rev. Mod. Phys. 17, 157