Chapter 3

Empirical evidence of retrocausality

Antonella Vannini[1]

3.1 Introduction

Empirical evidence of anticipation and retrocausality in psychology will be discussed in this chapter and one experiment will be reproduced.

1. The first experiment is relative to pre-stimuli heart-rate increases shown by Tressoldi and colleagues (University of Padua, Italy).
2. The second experiment is relative to pre-stimuli skin-conductance increases proved by Bierman and Radin in association with emotional stimuli and reproduced by the *Cognitive Science Laboratory*, which performed a series of controls searching for artifacts and alternative explanations such as cueing, expectation, stimulus generator, programming errors, data collection, computer anomalies, and participant or experimenter fraud.
3. The third experiments is relative to the anomalous mind/machine interactions demonstrated by Robert Jahn, Dean of the School of Engineering and Applied Sciences of the University of Princeton, using REG (Random Events Generator) systems. In 1979 these experiments lead to the establishment of the PEAR laboratory (*Princeton Engineering Anomalies Research*) which, thanks to an impressive number of experiments, proved the existence of retrocausal effects on REG distributions which had been produced before the expression of the intentionality of the subject.

[1] antonella.vannini@gmail.com

3.2 Pre-stimuli heart rate responses: Tressoldi's experiments.

In the article "Heart Rate Differences between Targets and Nontargets in Intuitive Tasks", Tressoldi (2005) describes two experiments, the first exploratory and the second confirmatory which show that the heart rate increases in advance to the presentation of stimuli (p=0.015 in the first experiment, p=0.001 in the second experiment).

Experiment 1

The first experiment involved 12 subjects, 5 males and 7 females with an average age of 25.5 years (range between 24 and 45 years), mainly university students. These subjects were asked to participate in a computerized trial which was based on the ability of guessing. The participants were asked to sit on a comfortable chair in front of a computer monitor; on their left hand was applied a device connected to an apparatus which detected the heart rate. All the subjects had been previously informed of the progression of events, and that the sequence of the pictures which would be shown was random. Their task was to guess which picture would be selected by the computer as a target. Each trial consisted in the presentation of 4 emotionally neutral pictures (landscapes, animals, monuments) for about 10 seconds, the time necessary to collect the heart rate data; followed by the simultaneous presentation of all four pictures. At this point the subject had to guess the target picture; also during this phase the heart rate was registered. As soon as the choice of the subject was made the computer performed its choice, using a random algorithm, and selected one of the four pictures and showed it on the monitor. Pictures were different at each trial and were emotionally neutral. The degree of emotionality of these pictures had been evaluated by a committee which gave values between 0 (no emotion) and 10 (high emotion). The average value of emotionality of the pictures used in this experiment was 1,5, with a standard deviation of 0,5.
Data acquisition and the correct functioning of the heart rate measuring apparatus was monitored by a research assistant with his or her back to the participant. Owing to the automation of the target selection, the assistant could not suggest anything to the subject. The experiment ended after 20 trials.

Target pictures are those which are selected (using a random procedure) by the computer after the expression of the choice of the subject. Nontarget pictured are those which are not selected by the computer. The results of this first experiment show a statistically significant difference among the heart rate associated with the choice of target and nontargets images. Before interpreting the results, the authors wanted to repeat the experiment on 12 other subjects, in order to exclude that the results of this first experiment could be a consequence of statistical artifacts.

Experiment 2

The second experiment involved 12 subjects, 5 males and 7 females, average age 25,3 (range 23-48 years). Also this second experiment, identical to the first one, shows a statistically significant difference in the heart rate when target and nontargets pictures are chosen.

Discussion of the results

Figure 1a and 1b compare the heart rate frequencies measured in the two different experiments when choosing the target and nontargets pictures.

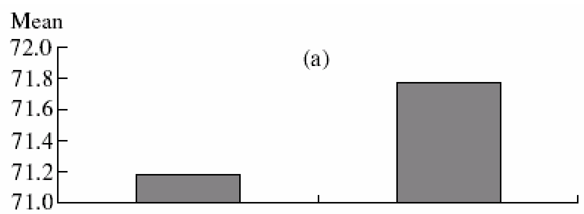


Fig. 1a - First experiment; p=0.015

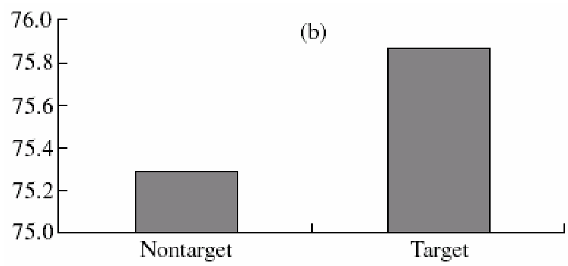


Fig. 1b – Second experiment; p=0.001

The results obtained in the second experiment confirm the heart rate differences between

target and nontargets pictures, which had been observed in the first experiment. The probability that the observed results may be a consequence of statistical artifacts, even if always present, may be considered low because of the concordant findings of the exploratory and the confirmatory experiments, and the use of the bootstrap procedure which forms new groups of 12 subjects, combining 6 subjects of the first experiment with 6 subjects of the second experiment, and which has always produced statistically significant results.
Tressoldi concluded that with this simple procedure it has been possible to see a slight, but significant, anticipatory change in the heart rate, depending on the nature of stimuli (target or nontarget), even though the choice performed by the subjects was totally random. In both the experiments, the number of guessed targets was equal to the quota expected by pure chance: 5 targets every 20 trials. Even though the sample is limited (altogether 24 subjects), 20 trials were carried out for each subject, enabling to underline even small differences between targets and nontargets.
In a different presentation of the same experiments, Tressoldi and colleagues (Sartori, 2004) underlined that physiological reactions are still considered by most contemporary theories to take place only after stimulation has occurred. Yet recent studies have suggested that the autonomic nervous system can act as a reliable predictor of a future experience. Tressoldi's experiments show that the heart rate can anticipate stimuli giving support to the hypothesis that the autonomic nervous system anticipates stimuli. Tressoldi recalls the studies performed by Damasio with somatic markers (SM) in gambling, and states that SM could be based on anticipatory effects. In 1994 Damasio defined somatic markers (SM) as special instances of feelings which have been connected by learning to predicted future outcomes of certain scenarios. When a negative SM is juxtaposed to a particular future outcome, the combination functions as an alarm bell. When a positive SM is juxtaposed instead, it becomes a beacon of incentive (Damasio, 1994).

3.3 Pre-stimuli skin-conductance increases

The *Cognitive Science Laboratory* (CSL) was established in the 1990s in California as an evolution of SRI (Stanford Research Institute) activities which had demonstrated the existence of quantum properties of the brain, and had been conducted under the direction of Harold Puthoff (quantum physicist) with the financial support of CIA and DIA (Defence Intelligence Agency). CSL research activity continues within the frame of US intelligence agencies but, differently from Puthoff's activities, the procedures are published and the experiments are therefore replicable.

The mission of CSL is to use the tools of modern behavioral, psychological, and physical sciences to:

- determine which phenomena can be validated under strict laboratory conditions;
- understand their mechanisms;
- examine the degree to which they might contribute to practical applications.

In 1997 Bierman and Radin observed anticipated responses of the autonomic nervous system 2-3 seconds before the presentation of emotional stimuli (figure 2).

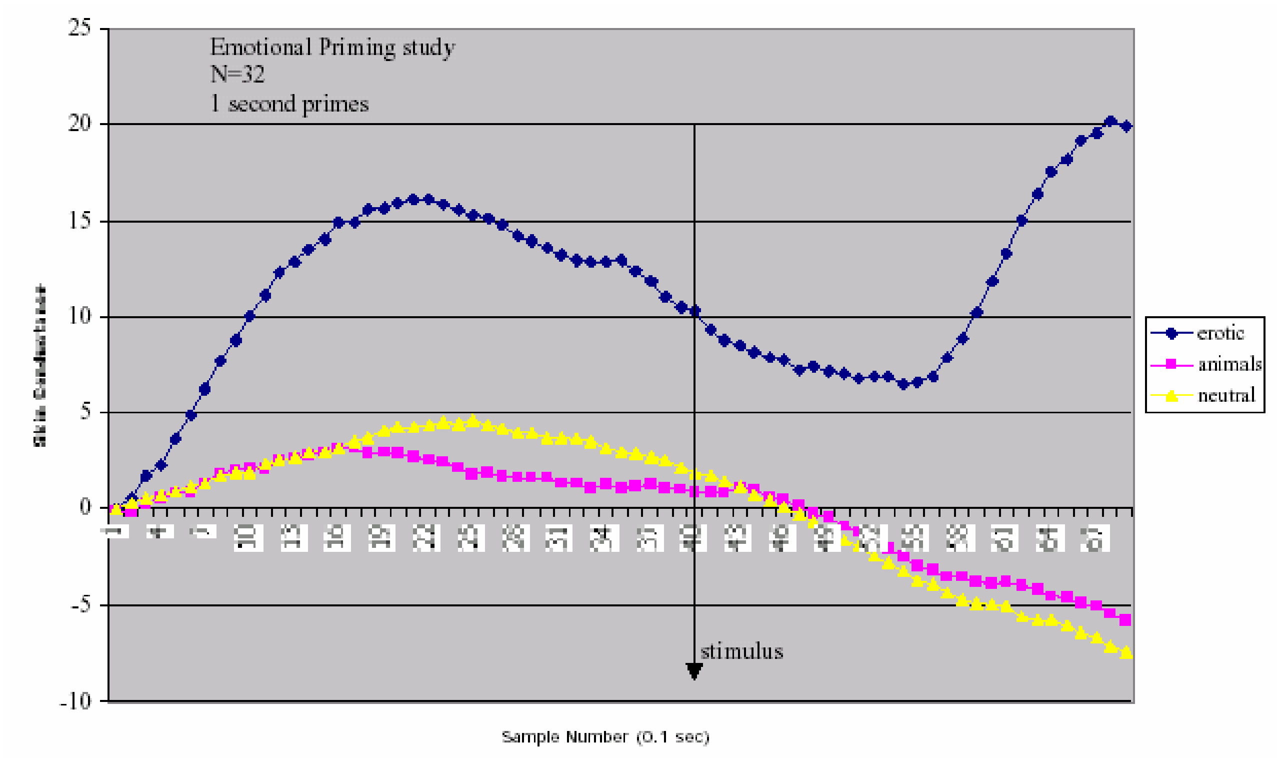


Fig. 2 – Average of skin conductance for 3 types of stimuli

Anticipation of events can play a fundamental role in intelligence activities. For this reason in 2003 Spottiswoode and May of CSL replicated Bierman and Radin experiments with the aim of controlling all possible artifacts (cueing, expectation, stimulus generator, programming errors, data collection and computer anomalies, participant or experimenter fraud). The experiment was modified in several ways, for example, instead of comparing erotic, neutral and animal images, the comparison of an acoustical stimulus generated by the computer with a “non-stimulus” (silence) was chosen. The subject used headphones which isolated him from other sounds. The intervals between stimuli were variable, reducing in this way the arousal effect. All possible forms of cueing were controlled and eliminated. The goal of this experiment was that of checking if the anticipated arousal of the autonomic nervous system (in the form of higher skin conductance) was significantly higher when neutral stimuli were used.

The experiment involved 125 subjects who had never participated before in similar experiments. A Contact Precision Instruments device was used to detect the skin conductance, with an accuracy of ±0,1 μSiemens. The presentation of stimuli depended on an automatic generator, and subjects had no way of predicting the incoming stimulus. Stimuli were arranged in a continuous random loop and did not provide any sort of cue about the timing and type of stimulus. The intervals among stimuli could vary between 40 and 80 seconds and included the following sub-intervals: 5 seconds of recording of skin conductance before stimuli, 1 second during stimuli, 24 seconds after stimuli. Each session consisted of 20 trials (stimuli). As an average 10 stimuli were audio (identical 97-dB computer generated audio stimuli) and 10 stimuli were silent (control); the selection between audio and silent stimuli was performed after skin conductance was recorded in the 5 seconds period preceding the stimulus. Audio control stimuli (silence) were used to evaluate the arousal effect. Each session lasted approximately 25 minutes, at the end of which an audio message informed about the end of the experiment.

Data analysis shows a statistically significant difference of skin conductance, between stimuli and non stimuli (silence), 2-3 seconds before stimuli, reaching a probability level of $p=0{,}00054$. Skin arousal which anticipates control stimuli is markedly lower than pre-stimuli skin conductance and disappears while reaching the stimulus (figure 3).

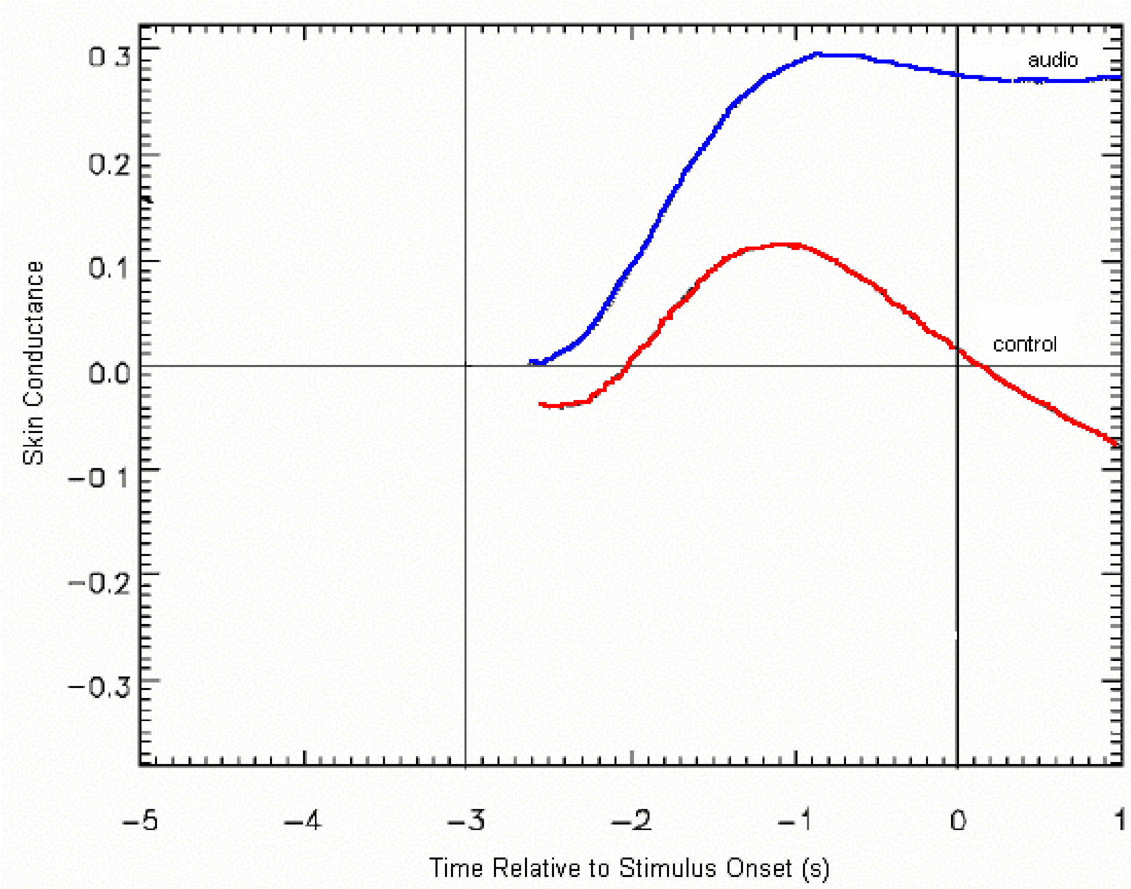


Fig. 3 – Prestimulus response of skin conductance; p=0,00054.

Spottiswoode and May performed controls for the following artifacts:

- *Cueing*. Both the experimenter and the participant were blind to the upcoming stimulus type. The choice of the audio stimulus was determined by the computer using random procedures and after the prestimulus skin conductance was measured.
- *Expectations*. The arousal effect was controlled using different pre-stimulus intervals, which were determined randomly by the computer.
- *Independence of stimuli*. The correlation among stimuli resulted as equal to zero; the absence of correlations proves that it was impossible for the subjects to predict the nature of the next stimulus on the basis of the previous stimulus.
- *Independent data analysis*. Data were simultaneously sent to the two experimenters who

produced data analyses independently.

- *Data gathering*. In order to check for artifacts the entire experiment was replicated using a skin conductance simulator, the behavior of which was known.
- *Fraud*. Two different types of fraud were analyzed. In order to avoid the possibility that subjects could manipulate data, all data was stored in a binary 128 bit format which could not be read by commercial software. The computer was not linked to internet or accessible to subjects. The possibility of fraud by the experimenter was controlled by independent data analysis; fraud would have required the agreement of both the experimenters. The replication of these results by other research institutes is the proof of the absence of this last type of fraud.

3.4 Anomalous mind/machine interactions

The PEAR (*Princeton Engineering Anomalies Research*) laboratory was founded in 1979 by Robert Jahn, Dean of the School of Engineering and Applied Sciences of the University of Princeton, as a consequence of a thesis of a student who, using a REG (*Random Events Generator*) system, showed that the intentionality of the mind could interfere with the production of REG distributions, moving mean values towards higher or lower values according to the expression of the intentionality of the mind ($p<0.000001$).

Jahn and Dunne summarized the history of the PEAR laboratory in the paper "*Consciousness and Anomalous Physical Phenomena*" (Dunne, 1995). Millions of trials were performed and the capability of the mind to interfere with the generation of REG distributions was continuously proved. This capability was tested in different modalities and it was shown that it can be obtained also when the subject was separated from the REG generator (remote modality), and when the REG distribution was produced before the expression of the intentionality of the subject (off-time modality). The strategy of PEAR is similar to that used in the modern laboratories of physics, where the modification of highly precise physical processes are studied. In REG experiments the behavior of the gaussian distribution is well known and highly precise.

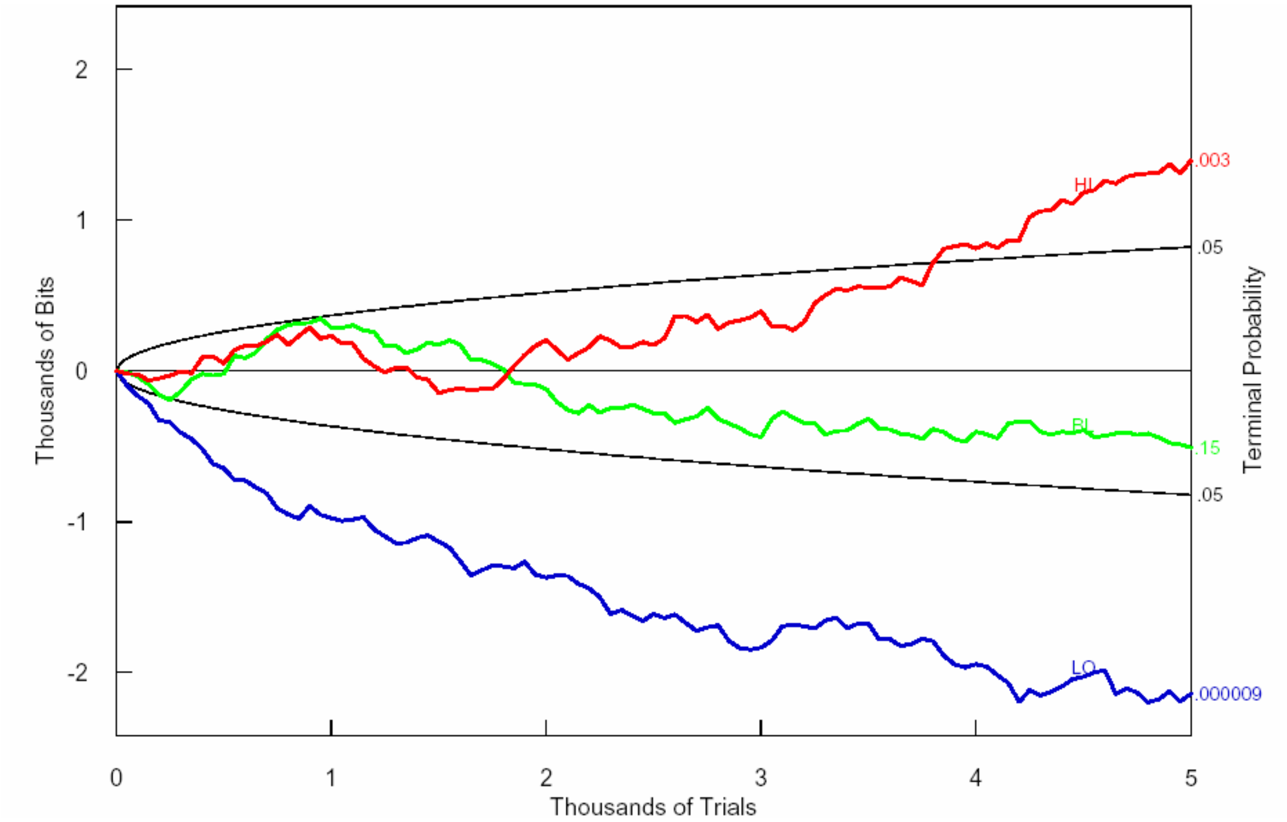


Fig. 4 – Cumulative deviations from the gaussian mean value: operator n.10, first 5.000 trials.

PEAR laboratory has engaged in its experiments a total of 140 subjects who, starting from 1979, have conducted several million trials. The independent variable was the intentionality of the subject: subjects were asked to distort the REG distributions towards high or low mean values just using the intentionality of the mind.

REG is a random events generator based on the flipping of electronic coins which are perfectly balanced; PEAR used sequences in which these electronic coins were tossed 200 times, producing in this way average values of 100 heads and tails. In figure 4, distributions are divided in high (HI), baseline (BL) and low (LO) intentionality; the average value (100) was normalized to 0. Hi and Low distributions diverge from the expected gaussian distribution with values of $p<0.000009$, for LO, and $p<0.003$ for HI.

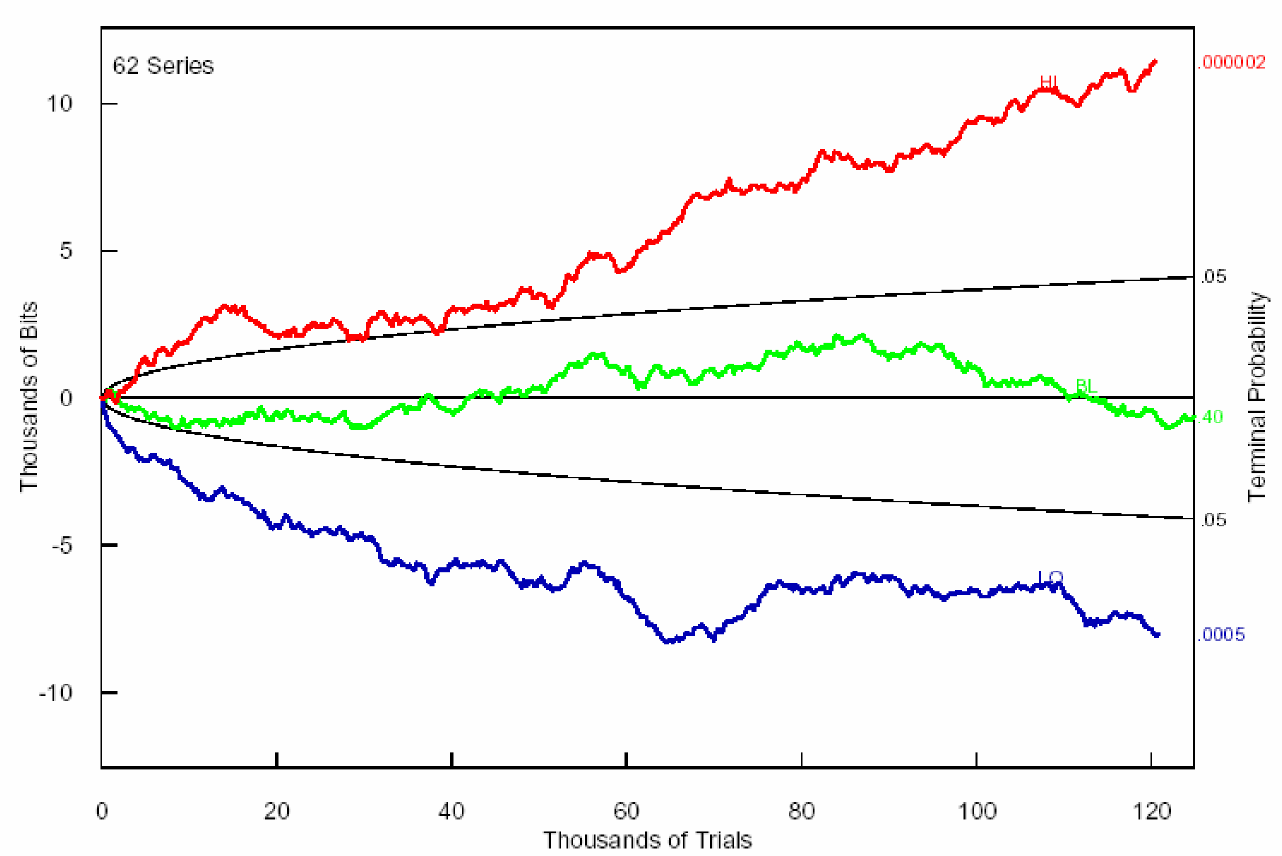


Fig. 5 – Cumulative deviations from the gaussian mean of all the trials performed by subject n. 10.

Figure 5 shows the sum of all the sequences produced by one subject in a period of 12 years.

Non local effects in space and time

PEAR non local experiments (remote and off-time) are described in the article "*Consciousness and Anomalous Physical Phenomena*" (Dunne, 1995). Remote experiments in which the REG system was spatially separated up to a distance of 5,000 Km involved 91 subjects and 396,000 trials were performed; the REG system was started at precise timing without knowledge of the intentionality which the subject was expressing. The size of the effects have been extensively reproduced and confirmed; these results are similar to those which have been produced in the local modality, where REG system and subject intentionality shared the same room and the same moment in time.

During the second group of experiments, 87,000 and 27 subjects, the REG system was activated before the expression of the intentionality of the subject. Figure 6 compares the different modalities local, remote, on time and off-time (retrocausal) and shows a significant increase in the size of the effect in the off-time modality.

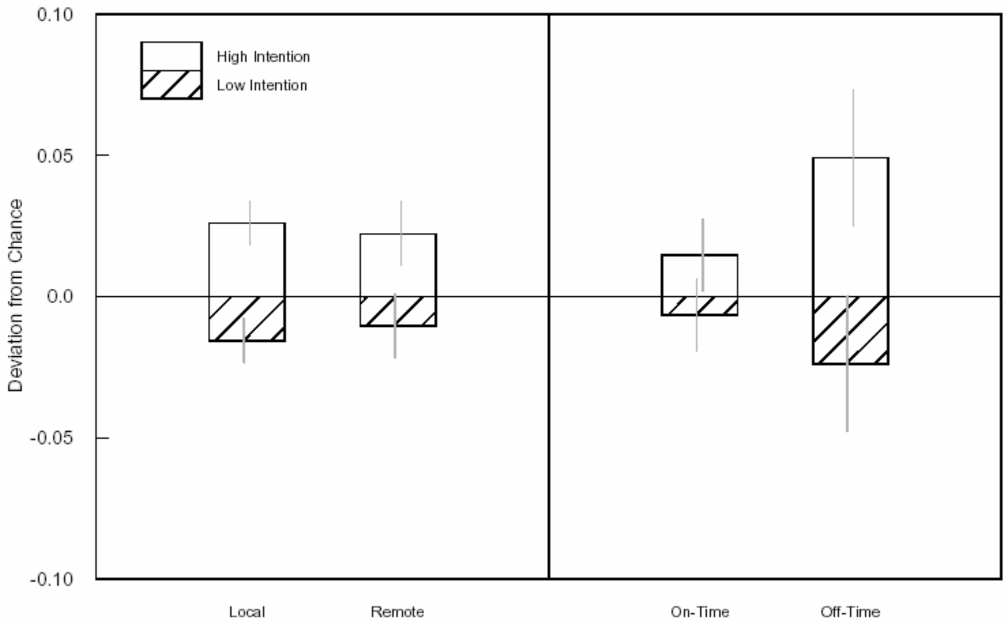


Fig. 6 – Comparison between local and remote experiments, and between on-time (sum of local and remote) and off-time (retrocausal). The height of the bar shows the mean value of the trials, while the vertical line the limits of the probability beyond which values become statistically different (for example, on-time and off time trials are significantly different).

FieldREG, retrocausality and emotions

In the paper "*The PEAR proposition*" (Jahn, 2005) Jahn and Dunne underline that, thanks to modern PC it is now possible to use REG systems which are extremely precise and which allow to perform REG experiments in the most different environments (even at home). These experiments are named *FieldREG* and have shown that the mind/machine interaction is amplified when it takes place in emotionally "resonant" environments, whereas the effects diminish when they take place in anonymous settings. The differences observed among resonant and non-resonant settings show a statistical significance of $p<3,2x10^{10}$ ($p<0.00000000032$). The FieldREG experiments demonstrate that emotions play an important role in the anomalous mind/machine interaction.

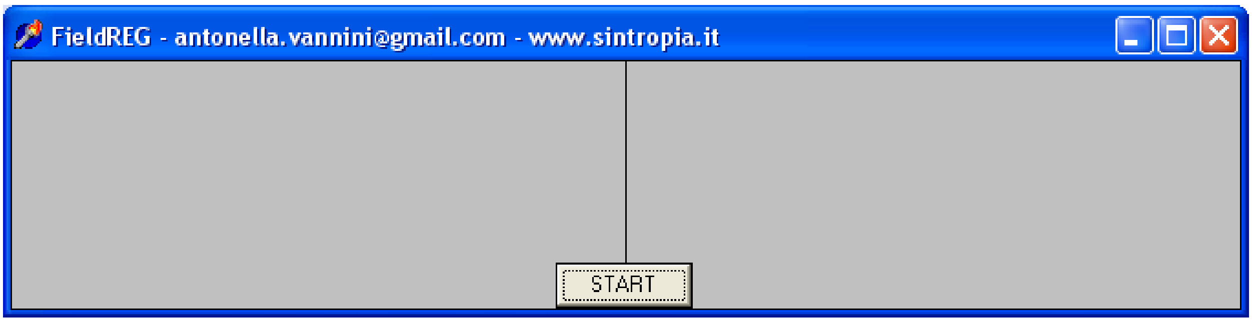
3.5 Replication of the REG experiments

The REG experiments performed at the Princeton University usually inflame skeptical reactions. For this reason, and in consideration of the fact that with modern PC it is now possible to reproduce REG experiments quite easily, it was decided to replicate these experiments in the local and retrocausal modality.

- In the local modality 16 subjects, who had never participated before in REG experiments, were involved. The results show the importance of a training period and of the motivation factor.
- In the retrocausal modality the best subject was engaged after a period of 2 weeks training.

Software

A REG software, written in Delphi 4, was developed. This software shows the REG results on a graph which is divided in two sides. The central line coincides with the gaussian theoretical mean value, the left side is relative to Low values, while the right side is relative to High values:



When the START button is pressed the computer chooses, according to a random procedure, on which side to start the trials:

Pressing the grey button under the triangle, the subject starts the REG sequence and, at the same time, expresses his/her intentionality.

When the button is pressed the computer produces 1 million sequences of 50 flips of the electronic coin. The mean value of these sequences determines the point which will be reached by the line. The lines which are drawn on the graph unite the mean values which have been obtained in successive trials.

Subjects received the instruction to express their intentionality when they pressed the button, the intentionality was to deviate the line towards the triangle. The pressure of the button is used to start the REG procedure (which lasts approximately 1 second), and to start the expression of the intentionality of the subject.

Each cycle was composed of 33 trials on the left and 33 on the right. When the trials on the first side ended (in this example the right trials) they automatically started on the opposite side.

Considering the perfection of the REG systems, and the fact that the deviation from the theoretical mean is very limited (for example: 25.004300, 24.998691, 25.008605), in order to visualize the resulting line on the graph, the space around the mean value was zoomed by a factor of 1x1.000.

Experiment performed on 16 subjects who had never participated before in REG experiments: the importance of training and motivations

This first experiment had the aim to evaluate the effect of intentionality on subjects who had never participated before in REG experiments. Subjects were enrolled using two different modalities:

- 8 subjects offered to participate during a seminar held in Tuscania (Italy) on the 21 May 2006;
- 8 subjects were contacted via e-mail, and performed the experiments at home using their own computer.

As a whole 10 females and 6 males took part in these experiments, the mean age was 38, with a range falling between 23 and 74 years.
In the trials performed in Tuscania the participants were asked to take part in 3 different

sessions, each one lasting 5 minutes, in three different moments of the day: morning, noon and afternoon. Subjects conducted the experiment alone, in a room away from noises and sources of distraction.

The first reaction of the participants was that the experiment is very demanding, it requires a lot of attention and causes loss of concentration rapidly. After the first session the instruction was added to end the experiment as soon as the concentration level diminished.

Each subject was informed that the software used a generator of random events, which produces a perfectly balanced distribution, and that the goal was to unbalance the distribution to the left when the triangle was at the left, and to the right, when the triangle was at the right, simply using their intentionality of the mind. In the next pages the results of 11 subjects will be discussed. It is important to note that the statistical unit (n) is relative to trials (and not to subjects): for example subject 1 performed 2.244 trials (each trial consists in 50million flips of the electronic coin); statistical significance is calculated within each subject comparing the High and Low distributions.

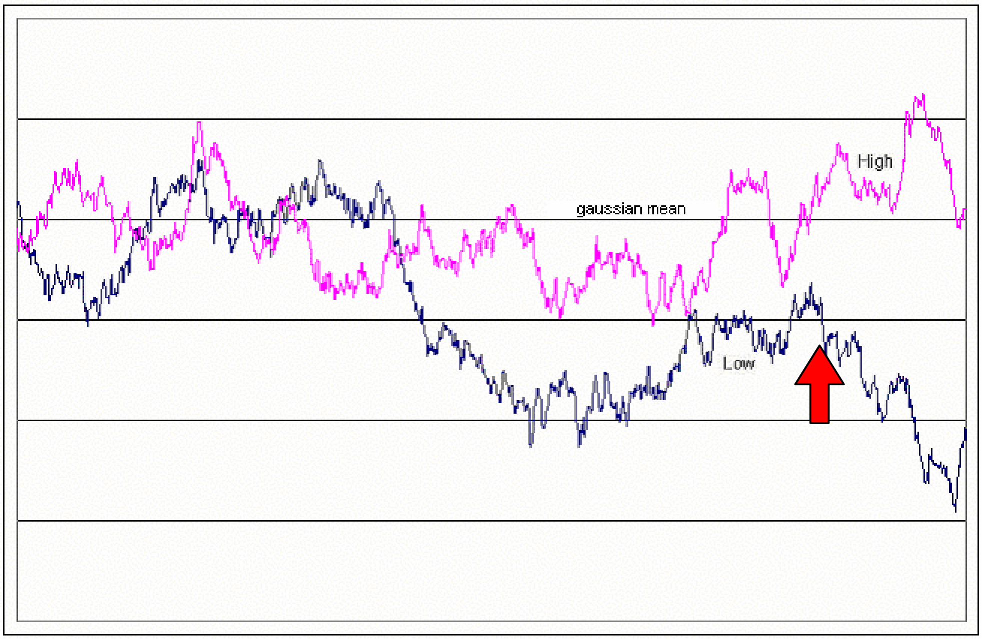


Fig. 7 – Distribution of the REG trials of subject n. 1 (F, N=2240).

Figure 7 shows the results of subject 1. It is possible to note that only at the end of the trials the two distributions start to diverge (the red arrow shows the point where the two distributions start to diverge). It is well known that an initial period of training, which varies in length for each subject, is necessary before effects start showing. This first period is characterized by High and Low distributions which do not diverge significantly from the gaussian mean value and which intersect continuously with each other.

In this first replication of REG experiments, statistical significance has been calculated including the training period, obtaining in this way values which are markedly lower than what can be obtained when excluding the training period.

It is important to remember that PEAR has been working for 25 years with a limited number of subjects (reaching a maximum of 140 subjects) and results have been examined only after the training period.

Figure 8 shows the results produced by subject n. 2, while figure 9 shows the graphical representation of the results produced by subject n.3.

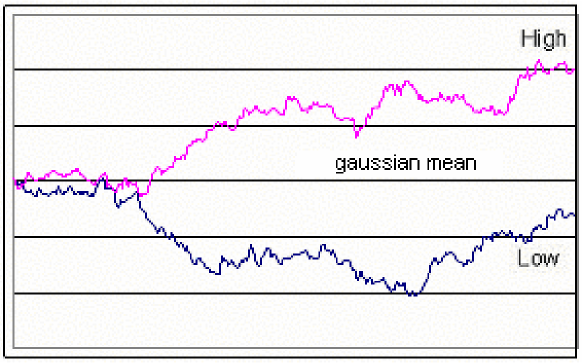


Fig. 8 - Subject 2 (F, n=596, $p<0,05$)

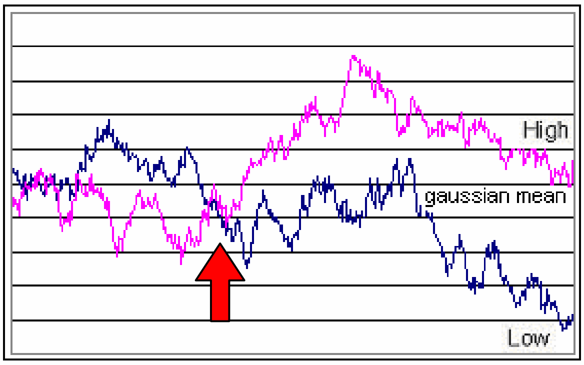


Fig. 9 – Subject 3 (M, n=1190)

Subject 2 shows a very short period of training (only 2 cycles), during which the two distributions High and Low do not diverge from the mean value and among themselves. After this training period the two distributions show a sudden tendency to diverge. Subject 2 shows that in some cases a session of just 5 minutes is sufficient in order to activate the processes which produce the anomalous effect mind/machine.

Subject 3, on the contrary, shows a long training period. It is important to say that this subject started to produce the effect only after he received detailed information about how the REG software works: how distributions are calculated, and what the line which is drawn by the computer means. Subject 3 has shown that beside a training period, which varies depending on the subject, another important element is the motivation which derives from a deeper knowledge of the hypothesis and procedures of the experiment.

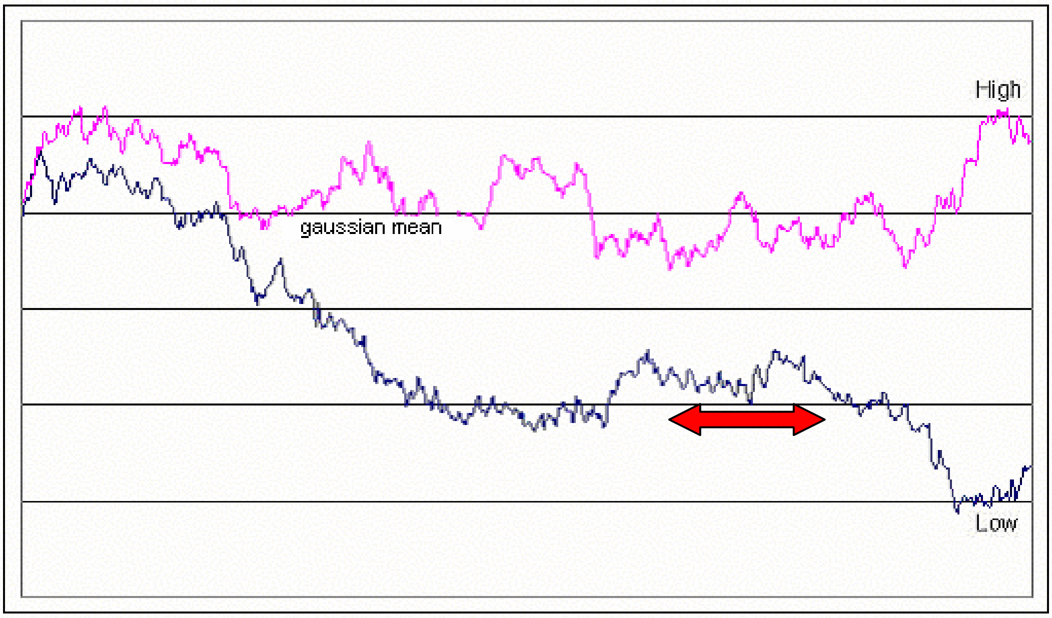


Fig. 10 - Subject 4 (F, n=1190, p<0,05)

In figure 10 the results produced by subject 4 show a good separation of the low distribution, the only exception being interval underlined with the red arrow, which was characterized by a strong headache, after which the two distribution started to diverge again. This graph supports the hypothesis that REG systems could become a new diagnostic technology.

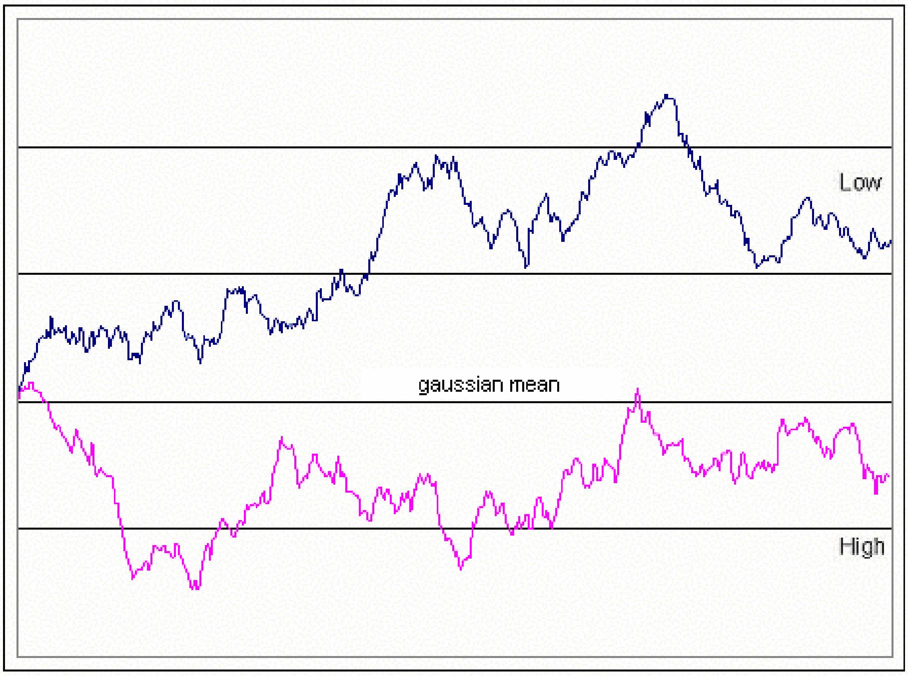


Fig. 11 – Subject 5 (M, n=792)

Subject 5 (figure 11) has shown the initial absence of the training period but with inverted a high and low effect.

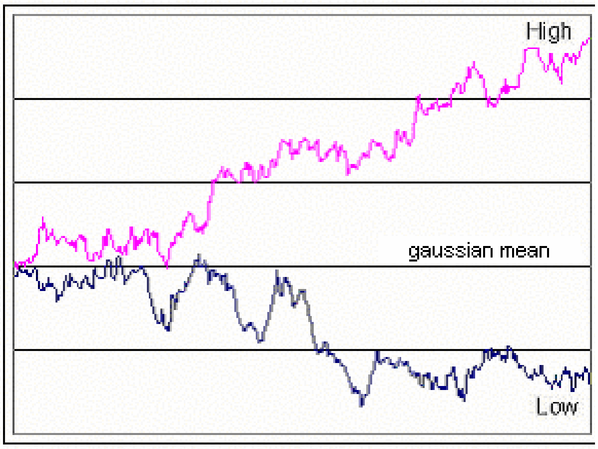


Fig. 12 - Subject 6 (F, n=462, p<0,01)

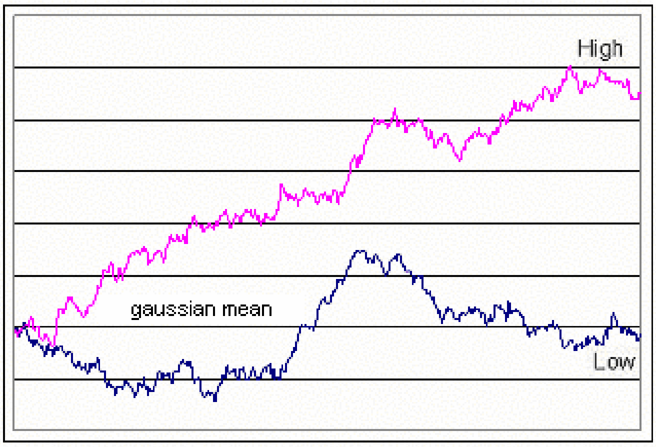


Fig. 13 – Subject 7 (F, n=1188, p<0,01)

Subject 6 (figure 12) shows from the beginning High and Low distributions diverging from the gaussian mean value, while subject 7 (figure 13) shows a steady and clear trend for the High distribution.

The other subjects who took part in this first exploratory REG experiment showed High and Low distributions which did not diverge in a statistically significant way. These results suggest that it is necessary to take into account a training period, and that data should be analyzed only afterwards. It is important to note that if these distributions were determined by pure chance, the High and Low distributions would not diverge from the mean gaussian value, and should continuously intersect each other. Instead, all subjects, even those who did not reach statistically significant values, show distributions which are deeply different, and this fact suggests that these distributions were not the result of pure chance, for example:

Fig. 14 – Confronto di alcuni soggetti le cui distribuzioni High e Low non si sono separate

It is necessary to remember that all the subjects complained about fatigue and loss of concentration. In the replication of PEAR experiments it is therefore necessary to keep in mind the following factors: training time, fatigue, motivation, and total length of the experiment (which can last also for several years).

Results obtained after a training period

In this paragraph results produced by a single subject, after a 2 weeks training period, show a statistical significance of p<0,005. The experiment consisted in 198 High trials, in which the intention of the subject was that of increasing the number of positive flips, and 198 "Low" trials in which the intention of the subject was that of increasing the number of negative flips. Each trial comprised 50 million flips of the electronic coin, reaching a total of 19,8 billion flips.

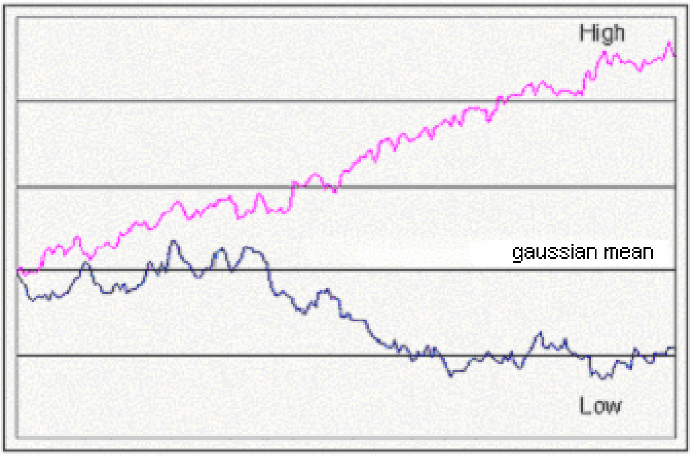


Fig. 15 – Local experiment (M, N=396, p<0,005)

The cumulative effects on the High and Low distributions show a positive contribution of the High intentionality and of the Low intentionality in the progressive deviation of the two distributions.

The statistical significance was calculated using the t Student test. The deviation between High and Low distribution reached a statistical significance of p<0,005. In the absence of interaction between REG system and intentionality of the mind the two distributions should have intersected continuously in the proximity of the gaussian mean.

Results in the retrocausal modality

The same software was used to perform the retrocausal experiment, with only one minor change: the REG sequence was not calculated on-time, but it was produced previously (2 hours before). The first two experiments were disappointing, even if the effect gradually showed up (fig. 16 and 17). The third and last experiment obtained a statistical significance of p<0,0005, even if only the High modality diverged, while the "Low" modality continued to be governed by chance (fig. 18).

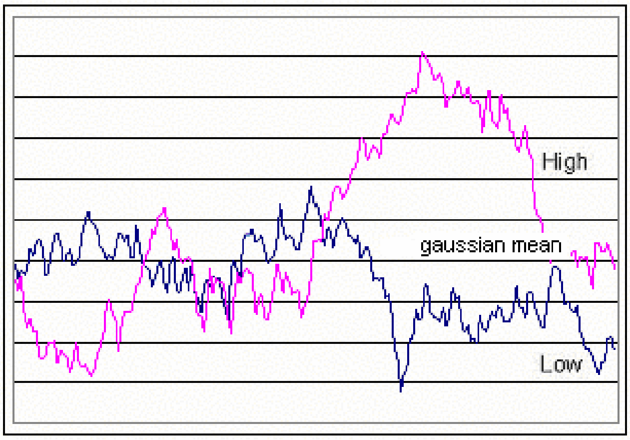


Fig. 16 – Retrocausal experiment n. 1 (M, N=396)

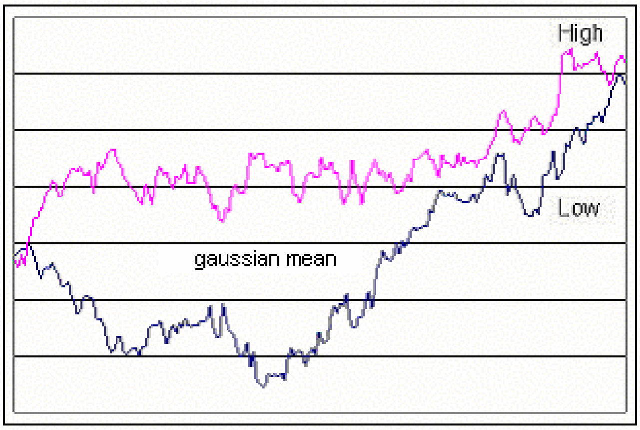


Fig. 17 –Retrocausal experiment n. 2 (M, N=396)

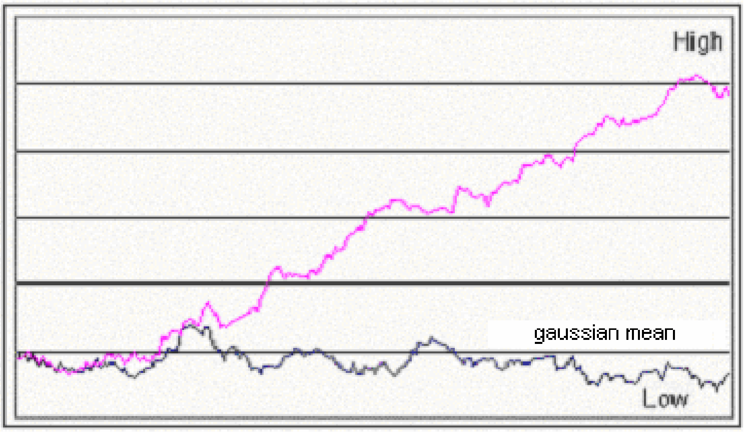


Fig. 18 – Retrocausal experiment n. 3 (M, N=396, p<0,0005)

Discussion

The need of a period of training has lead PEAR to use the same subjects (a total of 140 subjects) for a long period, up to 25 years. For this reason the results produced by PEAR are markedly more significant than those which have been replicated here.
According to the researcher of the PEAR laboratory, the anomalous interaction mind/machine, especially in the retrocausal modality, can be understood and explained only thanks to the properties of quantum mechanics. Costa de Beauregard had already pointed out that: “In quantum mechanics it is possible to carry out experiments deciding only after the

experiment is started which aspect of reality we want to observe. If, for example, two particles originate from a common point, we can decide later if we want to observe them as waves or as particles. Now, in an astrophysics laboratory, when we decide whether to see waves or particles of photons coming from distant quasars, we generate a backwards effect to the moment when photons were emitted, 4 billion years ago. What happened 4 billion years ago is determined by what we decide to see in our laboratory".

In the same way the retrocausal REG experiments show that it is possible to retro-act (with our intentionality) on processes which have already taken place. This fact supports the hypothesis that a level of reality should be characterized by a unitary time with, no distinctions between past, present and future. Nowadays this level of reality with unitary time is known to be the quantum level of the microscopic world. These results give strength to the assertion that living systems are linked to the quantum level of reality.

3.6 Final considerations

The empirical evidence which has been discussed in this chapter, show a strong interaction between emotions and retrocausality, for example:

- Tressoldi's experiments suggest a link between anticipatory effects and the autonomic nervous system in the form of heart rate increases;
- CSL experiments prove the link between anticipatory effects and the autonomic nervous system in the form of skin conductance increases;
- FieldREG experiments show that positive emotional environments increase anomalous mind/machine effects.

Tressoldi and colleagues underline that psychological theories are still based on the assumption that psychological reaction can take place only after stimuli are determined. In these pages psychological evidence of retrocausality and anticipation demonstrate that the dual energy solution acts also on the autonomic nervous systems, and that psychological reactions can therefore anticipate the determination of stimuli.

Blaise Pascal (1623-1662), one of the major scientists of the 17th century states that "*the heart knows reasons which reason cannot know*". The discovery of retrocausality and its interactions with emotions seem to support this statement.