Pre-stimuli heart rate differences

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Abstract

In this paper the results of an exploratory experiment on heart rate pre-stimuli reactions are presented. The 4 basic colours (blue, green, red and yellow) were presented as full-screen images on the computer (*presentation phase*), for a period of 4 seconds each. During this phase the heart rate was measured at fix intervals of 1 second, for a total of 5 measurements for each colour. After the presentation phase, the 4 colours were presented together, as colour bars in one image, and the task of the subject was that of guessing the colour which the computer would have chosen using a random process (*choice phase*). After the choice was performed by the subject, the computer selected one of the colours randomly and presented it full-screen (*presentation of the target*).

Results show that even though the subjects guess randomly (their guess is right 25% of the times), a strong pre-stimuli difference in the heart rate is observed during the presentation of the colour later selected by the computer (*target*). For the blue and green colours this average difference is 2 heart beats per minute. To be more precise, when the blue colour is the target an increase of more than 2 heart beats per minute is observed during the presentation phase of the blue image, while when the green colour is the target, an anticipated decrease of 2 beats per minute is observed during the presentation phase. These differences obtain high statistical significance.

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1. Introduction

Anticipatory pre-stimuli reactions are neurophysiologic responses activated before the stimulus takes place. These anticipatory reactions are activated before the subject can receive indications or cues about the stimulus. In scientific literature, various experiments show evidence of the existence of anticipatory effects, for example:

- *Pre-stimuli heart rate differences.* In his article "*Heart Rate Differences between Targets and Nontargests in Intuitive Tasks*" (Tressoldi and coll., 2005), Tressoldi and coll. report the results of two experiments, aimed at investigating pre-stimuli heart rate changes. These results support the hypothesis that the heart rate reacts before the stimulus takes place (anticipatory effects).
- *Anticipatory reaction of skin conductance.* In 2003 Spottiswoode and May of the Cognitive Science Laboratory replicated Bierman and Radin (1997) experiments which show an increase in skin conductance 2-3 seconds before emotional stimuli are presented. Spottiswoode and May replicated these results obtaining a statistical significance (error risk) of p=0.0005, and performed controls in order to exclude all possible artefacts and alternative explanations. These results support the hypothesis that the autonomic nervous system reacts in advance of stimuli (Spottiswoode and May, 2003).

It is also possible to find studies which show the existence of retrocausal effects, for example:

- In 1979 the PEAR (Princeton Engineering Anomalies Research) laboratory was established under the direction of Robert Jahn, Dean of the University's School of Engineering and Applied Sciences. The purpose of this laboratory was to replicate and study results which showed anomalous mind/machine interactions. PEAR and a consortium of other universities have replicated these results when using REG systems. The anomalous mind/machine interaction which is observed is very simple: REG systems produce ultra-precise gaussian distributions, but when a subject tries to distort these distributions only by the expression of his intentionality, statistically significant deviations are observed. Even more fascinating is the fact that those distributions which have been produced before the subjects' expression of intentionality show an amplified effect. The statistical significance of these "retrocausal" amplifications is $p<0,000000001$ (Jahn, 2005).

2. Heart rate frequency device

The experiment was first planned to use standard laboratory devices for neurophysiologic measurements. During the evaluation stage of these devices several problems arose. These devices employ software which does not allow to synchronize precisely the heart rate measurements with the presentation of the images on the computer screen. In order to overcome the problem the experimenters contacted the distributors of these devices who refused to provide the software keys which would have allowed to develop software capable of synchronizing the heart measurements with the image presentations. The evaluation was therefore extended to devices used outside the experimental laboratories. High quality heart rate devices were found in sports training. These devices can be linked to the PC and synchronized perfectly (to the 1/1000 of second) with the images shown on the computer screen.

After a careful evaluation the home training system produced by SUUNTO (www.suunto.com) was chosen. This system includes a thorax belt for measuring heart rate parameters, and a USB interface (PC-POD) which receives these measurements by radio, using digital coded signals, which eliminate any possibility of interference. The choice of this device lead the experimenters to opt for an experiment which, in many ways, is similar to Tressoldi's experiment.

Fig. 1 - SUUNTO Heart rate monitor consisting of a thorax belt and a USB radio receiver

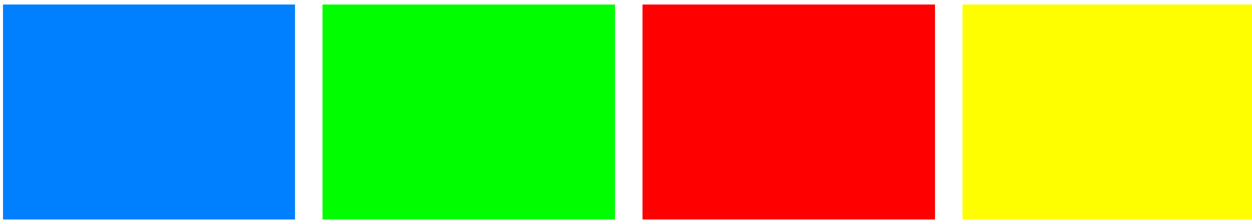
SUUNTO heart monitor measures the heart frequency every second and saves this information in a file associated with the exact time (minute, second, millisecond). A software was devised using MicroSoft Visual Basic 2005 and particular attention was given to the synchronization of the heart rate measurements and the presentation of the images on the computer screen, obtaining precision in the region of milliseconds.

3. The experiment

Each experimental trial is divided in 3 phases:

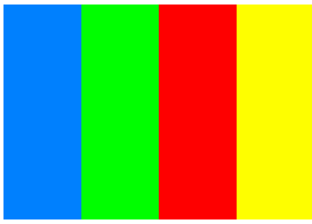
1. *Presentation phase:* 4 images are presented one after the other on the screen of the computer. The first one is blue, the second one is green, the third one is red and the fourth is yellow. Each image (colour) is shown for exactly 4 seconds. The subject is asked to look at the images, and during the presentation the heart frequency is measured at fixed intervals of 1 second. For each image 5 measurements of the heart frequency are taken: one at the beginning, 3 intermediate and one at the end. The presentation of the image is perfectly synchronized with the heart rate measurement. When necessary this synchronization is performed using a white image before the presentation of the first colour.

Image 1 Image 2 Image 3 Image 4



Tab. 1 – Images presented in a sequence as full screen. Each image is presented for exactly 4 seconds, and the heart frequency measured 5 times at a distance of 1 second each.

2. *Choice phase:* at the end of the presentation of the 4 colours, an image with 4 colour bars is shown (blue, green, red and yellow) in order to allow the subject to choose (using the mouse) the colour which he thinks the computer will select. In other words, the subject is asked to guess the colour which the computer will select.



3. *Presentation of the target:* as soon as the subject chooses a colour the computer selects the target colour, using a random process, and shows the selected colour full-screen on the computer.

The experiment consists of 20 trials and requires approximately 7 minutes. Each subject was asked to repeat the experiment 3 times.

4. The sample

The experiment was conducted on a sample of 24 subjects, with ages ranging from 15 to 75. A total of 14 females and 10 males was present in this sample. Each subject performed the experiment 3 times, for a total time of slightly more than 20 minutes. Heart rate frequency was measured 1,200 times for each subject, producing a sample of heart rate frequencies which allows to calculate statistical significances also within each subject.

5. Results

Target is the colour selected and shown by the computer after the subject performs the guess.

Taking into account all the heart rate frequencies (28,800) no significant difference is observed between target and non target images; the target images obtain an average value of the heart rate frequency of 80.94 and the non target images of 80.97. But, when the analysis is conducted within each colour, strong differences of the heart rate are observed between targets and non targets for the blue colour (target 81.99 and non target 79.84) and the green colour (target 79.60 and non target 81.45). These differences correspond to a t of Student value of 10.74 for the blue colour, and 8.81 for the green colour.

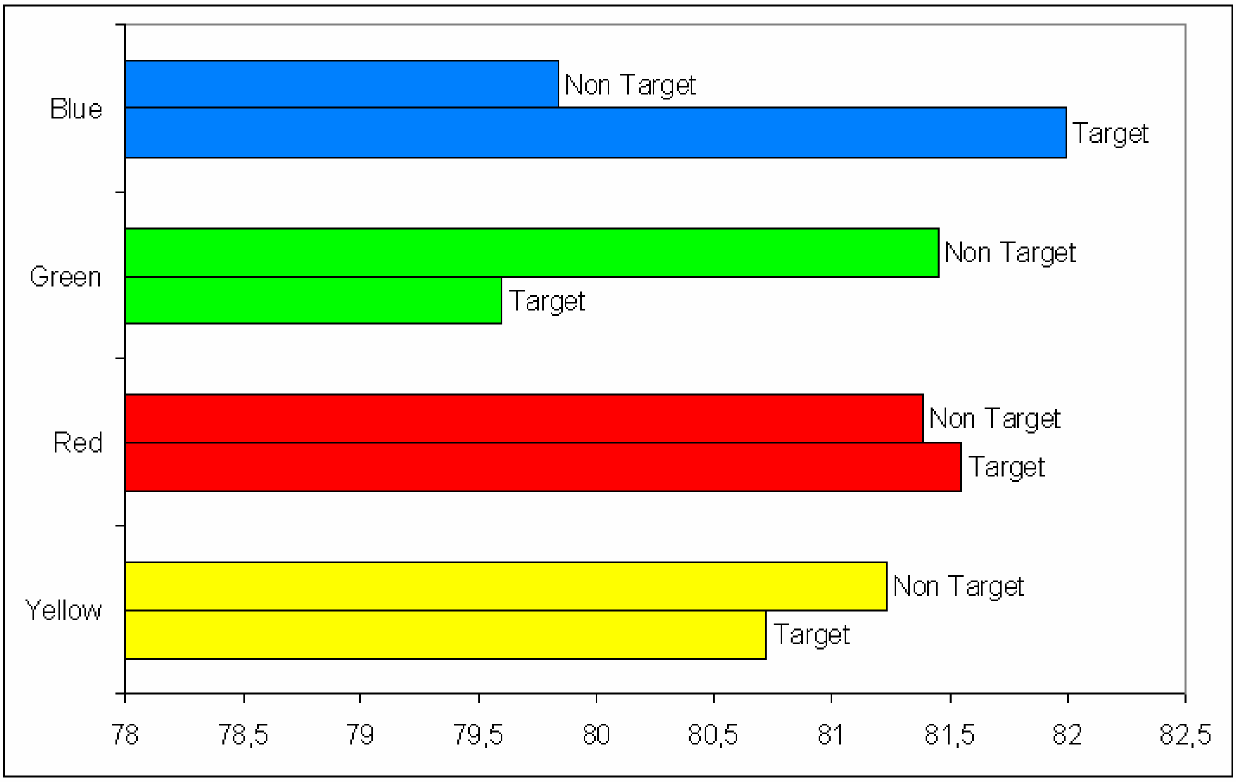


Fig. 2 – Heart rate frequencies by colour and target

A t Student value of 3.291 is statistically significant with $p<0.001$, meaning that there is less than 1 probability in 1,000 to be wrong when stating that the difference is not a product of chance. A t of Student of 8,81 (obtained in our experiment comparing the target and non target images of the green colour) tells that the probability of being wrong is practically equal to zero; it is therefore possible to state, with nearly absolute certainty, that there is a difference between target and non target images, which is not a consequence of chance, but a consequence of an anticipatory effect detected by the heart rate frequency.

A second analysis was performed using the Chi Square test. Statistical significance was calculated comparing the number of measurements which were over or under the baseline of the colour. Also in this case a strong statistical significance was observed with Chi Square values over 30 when the $p<0.001$ significance is reached with Chi Square values of 10.8.

It is important to note that even though a strong anticipated heart rate difference was observed, no ability of the subjects to guess the target was noticed. As a whole, 26.8% of the total guesses were correct, one out of 4, which is what we would expect by chance. In other words the rational conscious side seems unable to access the anticipatory information which is observed with the heart frequency measurements.

It is also important to underline that strong individual differences were observed. While, as a whole, all subjects show a tendency towards higher heart rate frequencies when shown a blue target and lower heart rate frequencies when shown a green target, two subjects showed strong results in the opposite direction. A unambiguous mark seems to be associated to each subject, and this mark seems to remain constant during all the experiment.

6. Interpretation and theory

After a careful review of the quantum models of consciousness, the only model which seems to offer an explanation of the anticipatory heart rate effects is the model of the anticipated waves which is developed integrating special relativity with quantum mechanics.

What does it mean to integrate quantum mechanics with special relativity?

In special relativity the energy/momentum/mass equation:

$$E^2 = m^2c^4 + p^2c^2$$

relates the energy of an object (E) with its mass and moment (speed). This equation simplifies into the famous ***E=mc²*** when the momentum is set equal to zero (p=0).

In quantum mechanics the key equation is Schrödinger's wave equation, symbolized with $\boldsymbol{\psi}$.

In 1926 Klein and Gordon united the energy/momentum/mass relation (special relativity) with Schrödinger's wave equation (quantum mechanics) obtaining the following equation:

$$E\psi = \sqrt{p^2 + m^2}\psi$$

The solution of Klein and Gordon's equation depends on a square root which always leads to a dual solution: one positive, in which waves propagate from the past to the future, and one negative, according to which waves propagate backward in time, from the future to the past.

In the 1930s the negative solution was refused as it was considered to be impossible, even though many experimental evidences were supporting it (for example Dirac's neg-electron, Anderson's positron and the discovery of antimatter). Any attempt to integrate quantum mechanics with special relativity always opens the uncomfortable dilemma of waves which move backward in time. The refusal of the negative solution keeps special relativity separated from quantum mechanics. Lately, Cramer (physicist at the Washington State University) showed that only when advanced waves, which move backward in time, are considered to be real the mysteries of quantum mechanics (such as the dual nature of matter – waves and particles – and nonlocality) become necessary manifestations of the dual nature of waves and time (Cramer, 1988).

In 1941 the mathematician Luigi Fantappiè, working on quantum mechanics and special relativity, proposed a mathematical demonstration which shows that the positive solution, which describes waves (and particles) which propagate forward in time, is governed by the law of entropy (dissipation, disorder and death) whereas the negative solution, which describes waves (and particles) which propagate backward in time, is governed by a symmetrical law which Fantappiè named syntropy and which has the following properties:

- concentration of energy;
- differentiation;
- creation of structures;
- order.

Fantappiè noticed that the properties of the law of syntropy are similar to the properties of living systems, arriving at the conclusion that living systems are, in their essence, attracted by the future, and therefore anticipatory systems. This interpretation has always been refused as impossible, limiting biology and science only to entropic-mechanical explanations (Fantappiè, 1991).

The strong results obtained in the experiment described in this paper support the hypothesis that anticipated waves are real and that living systems are anticipatory systems, attracted by the future.

6. Conclusions

It is important to note that it appears to be impossible to test the existence of advanced waves in a laboratory of physics:

- According to Fantappiè, anticipated waves do not obey classical causation, therefore they cannot be studied with experiments which obey the classical experimental method (Fantappiè, 1942).
- According to Wheeler's and Feynman's electrodynamics, emitters coincide with retarded fields, which propagate into the future, while absorbers coincide with advanced fields, which propagate backward in time. This time-symmetric model leads to predictions identical with those of conventional electrodynamics. For this reason it is impossible to distinguish between time-symmetric results and conventional results (Wheeler and Feynman, 1949).
- In his Transactional Interpretations of Quantum Mechanics, Cramer states that "*Nature, in a very subtle way, may be engaging in backwards-in-time handshaking. But the use of this mechanism is not available to experimental investigators even at the microscopic level. The completed transaction erases all advanced effects, so that no advanced wave signalling is possible. The future can effect the past only very indirectly, by offering possibilities for transactions*" (Cramer, 1986).

On the contrary, according to Fantappiè living systems are a direct consequence of anticipated waves which move backward in time (law of syntropy), and consequently it should be possible to observe and study anticipation using living systems.

The experimental results described in this paper seem to support the hypothesis that anticipation is one of the fundamental characteristics of life and, as a consequence, of the physical and biological world.

7. Bibliography

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