PHYSIOLOGICAL CORRELATES OF ESP: HEART RATE DIFFERENCES BETWEEN TARGETS AND NONTARGETS

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ABSTRACT: Physiological reactions to incoming stimuli can occur without perceptual and cognitive encoding. This paper reports the results of two experiments aimed at investigating heart rate differences in participants on viewing targets and nontargets in classical clairvoyance and precognition forced-choice tasks. We opted for very easy decision-making tasks instead of using violent/erotic pictures in order to find a scientific paradigm that may also be extended to children. The task consisted of a serial presentation of 4 calm pictures; participants had to guess which picture would be randomly selected as a target. The target was selected automatically by a pseudorandom algorithm. In the clairvoyance condition, targets were selected before participants did the trials; in the precognition one, targets were determined right after participants had made their choice. For each picture presentation, a sample of 10 heart rate data points was collected. The experiments involved 12 participants who together contributed 240 trials. Results were significant in both experiments: heart rate associated with targets increased at a statistically significant level compared to nontargets. The present results lend support to the hypothesis that heart rate may be a reliable physiological variable to detect ESP cognitive information even if overt target identification is at chance.

Can ESP information be detected physiologically? This is a plausible question assuming that ESP information differs from non-ESP information only in how it is obtained and not how it is processed. Different authors have demonstrated that information not detected at an overt conscious level produces physiologically specific modification (Bechara, Damasio, Tranel, & Damasio, 1997; Bechara, Tranel, Damasio, & Damasio, 1996; Dimberg, Thunberg, & Elmehed, 2000; Kubota, Sato, Murai, Toichi, Ikeda, & Sengoku, 2000; Mayer, Merckelbach, deJong, & Leeuw, 1999).

The Search for a Physiological Index

In the field of ESP research the search for a physiological index is not a new interest. Beloff (1974) more than 25 years ago reviewed the studies related to this topic and Palmer (1978) reviewed all the studies using autonomic responses like blood flood by the use of the plethysmograph or skin resistance in a different version of an agent-recipient design. Two recent meta-analyses (Schmidt, Schneider, Utts, & Walach, 2004), on the "Direct Mental Interaction in Living Systems" and on "Remote Staring" phenomena, respectively, found a small but significant effect sufficient to continue to explore these lines of investigation.

Another line of investigation has explored if and how the nervous system reacts *before* the appearance of future emotional stimuli. Recently, Bierman and Radin (2000) and Radin (2004) reported a replication of their finding that blood volume, heart rate, and in particular, skin conductance level change according to the emotional category of future pictures. This so-called presentiment effect has also been replicated by Bierman and Scholte (2002) using fMRI data.

Moreover, further evidence supports the possibility that similar physiological effects may be observed in tasks without emotional content. McDonough, Don, and Warren (2002) detected EEG activity in the gamma band correlated to a forced-choice guessing task, confirming previous findings of the same authors (Don, McDonough, & Warren, 1998) regarding event-related brain potentials. In this study we used a task very similar to that used by McDonough et al. (2002) but by recording heart rate instead of EEG activity.

Experimental Hypothesis

The purpose was to investigate whether this procedure produced different results between a clairvoyance or a precognitive condition, and we devised two identical experiments except for changing the moment of the target choice. In the clairvoyance experiment the target was chosen before presentation of the first picture, whereas in the precognitive experiment it was selected after the participant's choice of the target. Our hypothesis was that heart rate could change according to the categories of pictures, targets versus nontargets. The direction of this difference was not predictable in advance because, to our knowledge, there are no comparable studies in the literature.

Method

Twelve volunteers, 8 females and 4 males, were tested. They were recruited from the undergraduate students attending Padova University by an informal request to participate in an experiment on the physiological correlates of intuition. Mean age was 26.5 years (range 24-45). They were paid €3. Stimuli were 80 pictures representing real-life, low emotional, coloured images, such as landscapes, plants, flowers, and portraits. Participants were seated one by one in a comfortable chair in a soundproof laboratory facing a monitor. They were instructed not to move their left index finger, which was connected to the apparatus detecting their heart rate. They were also instructed to relax when an acoustic signal was heard and to concentrate on the picture that would be shown for 10 s on the monitor (depending on the time necessary to collect 10 heart rate data points based on interbeat intervals) until it disappeared. This sequence was repeated 4 times with different pictures that were subsequently presented simultaneously on the monitor for the guess of the target picture. After the presentation of the 4 pictures, the participants were invited to choose the target by clicking the selected picture with the computer mouse. After the choice, the real target was highlighted to inform the participant about the accuracy of his/her choice. The experiment ended after 20 trials, always using different pictures. The sequence of events for each trial is illustrated in Figure 1.

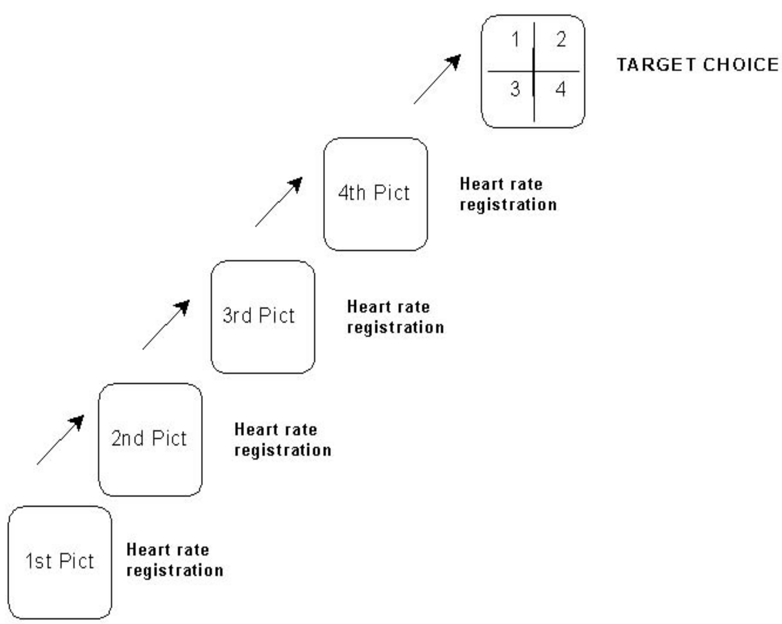

Figure 1. Scheme of the sequence of events for each trial

The interval between pictures varied randomly from 2 to 4 s. In the final presentation, for the target choice, the first picture was presented in the upper left quadrant of the screen, the second picture in the upper right quadrant, and so on.

The software for picture presentation and heart rate data acquisition was original and devised for these experiments (Massaccesi, 2001).

The target picture was chosen from the 4 by an automatic randomisation procedure. The randomisation procedure, written in C++ using the RNG algorithm of the Delphi™ library, returned a random number within the range 1- 4 (corresponding to the 4 pictures) after an initialisation with a random value obtained from the system clock of the computer. In the clairvoyance experiment the randomisation procedure was implemented at the outset of each of the 20 trials, whereas during the precognition experiment the procedure was automatically activated after the participant's target choice in each trial. The uniformity of the distribution of the pseudorandom picture target indices was tested with a chi-square test and shown not to be statistically significant.

Data acquisition and apparatus function were continuously monitored by a research assistant placed behind the participant. Owing to the automatization of the procedure, the research assistant could not have suggested anything to the participant because the target identification appeared only in the feedback phase, that is, after the participant's choice. If some artifacts were noticed (for example, anomalous heart rate registrations or apparatus malfunctioning), the task was interrupted and restarted. These situations occurred rarely, 3 times during the first experiment and 4 times during the second one.

Six participants performed the clairvoyance experiment first; the other 6 participants started with the precognition one.

For each picture 10 heart rate samples were obtained through a connection between the cardiofrequencimeter and the computer that lasted approximately 10 s, with minor variations according to the participant's heart rate. The cardiofrequencimeter consists of an opto-electronic sensor photoplethysmographic measurement using infrared light applied to the left index finger. The signal was conveyed to a cardiofrequencimeter Pulse Monitor-701 and to a digital multimeter Metex 3850 D and subsequently fed to a PC for online data acquisition. These data were obtained from the parallel port, from which the analog signal was converted in digital form.

Results

The initial 800 data points relating to each participant (10 s x 4 pictures x 20 trials) were reduced to 400 data points (10 s x 20 trials = 200 data points related to targets and 200 related to nontargets), by averaging the data related to nontargets within each trial. In order to have a statistical power above .80 with the expectation of a small difference between targets and nontargets, the 400 data points relating to each participant were used instead of their means. A simple paired *t* test on the total 2,400 (200 data points x 12 participants) was used to compare heart rates related to targets and nontargets. For this first experiment we kept a two-sided probability, because of its exploratory nature.

Clairvoyance Experiment

The overall comparison between targets and nontargets yielded a statistically significant difference of 0.56 pulses per minute (C.I. 95% ± 0.33): paired *t* test: $t(2{,}399) = 3.4$, $p = .0007$, two-tailed; Effect Size (d) = 0.054 (Dunlap, Cortina, Valow, & Burke, 1996). To control the reliability of this result and the possible contribution of the data autocorrelation, we implemented a bootstrap analysis (Blair & Karniski, 1993; May & Spottiswoode, 2001[1]) with Simstat™ software (Péladeau & Lacoutre, 1993) using 1,000 resamples. The result was t $(2399) = 3.38$, $p = .008$, two-tailed (C.I. 95 ± 1.98).

The mean of correct hits was close to the chance level, $M = 6.08$; $SD = 1.37$; $MCE = 5$ hits.

Precognition Experiment

The overall heart rate raw difference between target and nontarget of 0.39 (C.I. 95 ± .36) was statistically significant at $t(2{,}399) = -2.16$; $p = .03$, two-tailed; Effect Size (d) = 0.039. This result was confirmed using the bootstrap procedure with 1,000 resamples, $t(2399) = -2.19$, $p = .029$, two-tailed (C.I. 95% ± 2.03).

As in the clairvoyance experiment, the mean of hits was at chance level, $M = 5.6$; $SD = 2.05$; $MCE = 5$ hits.

Experiment Comparison

The differences between targets and nontargets in the two experiments are illustrated in Figure 2.

Meta-Analysis Using Single Data

Given the large number of data points for each participant, it was also possible to analyze the reliability of the differences between the targets and nontargets heart rate variation in the two experiments by calculating a Stouffer z from the 12 $t(199)$ values obtained from each participant. The individual *t* test and the corresponding Stouffer z values for the clairvoyance and the precognition experiments are presented in Table 1.

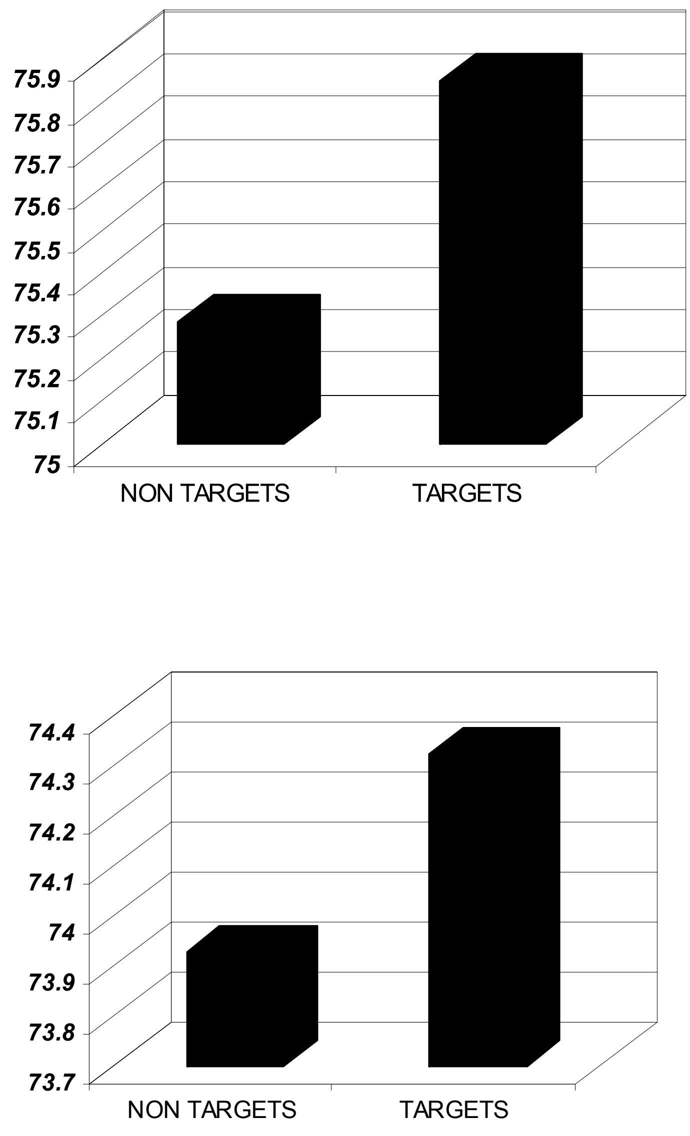

Figure 2. Heart rate means of targets and nontargets in the clairvoyance (upper) and the precognition (lower) tasks

TABLE 1
INDIVIDUAL *T* VALUES OF EACH PARTICIPANT IN THE TWO EXPERIMENTS, WITH STOUFFER *Z* VALUES

Participant	Clairvoyance	Precognition
X1	-0.99	-0.55
X2	-1.48	-0.19
X3	-1.42	0.26
X4	0.61	-1.17
X5	-0.88	0.7
X6	-3.1	-1.48
X7	-1.39	-0.2
X8	-1.49	0.78
X9	2.43	-3.4
X10	-1.63	-0.05
X11	-2.57	-2.64
X12	0.06	1.7
Stouffer *z*	-3.42	-1.8
p (two-tailed)	.0003	.036

Reliability of the Differences Between Targets and Nontargets Heart Rate Variations

For both experiments the Stouffer value is statistically significant, but not their difference, $z = 1.6$; $p = .108$, two-tailed.

The Stouffer values confirm the results obtained with all the data, adding convergent evidence of the plausibility of the hypothesis that heart rate differs between targets and nontargets before their identification by the participants.

DISCUSSION

With a simple procedure we have obtained evidence that heart rate is a physiological variable sensitive enough to differentiate two categories of information that will be known in the future. Even if the raw difference is very low, less than one heart rate pulse per second on average, and the methodological and statistical artifacts can never be excluded completely, this difference seems quite reliable as demonstrated by the results of the two experiments, a further replication of the clairvoyance experiment in our laboratory (Tressoldi, Martinelli, Massaccesi, & Sartori, submitted), and the control of the uniformity of the distribution of the target choice and of our statistics with the bootstrap method. Our data suggest a similar effect for the clairvoyance and the precognition conditions even if in the latter condition the heart rate difference between targets and nontargets seems less marked.

Our findings offer new evidence that it is possible to detect ESP information at a neuro- and psychophysiological level, adding convergent support to the EEG preknowledge paradigm investigated by McDonough et al. (2002). A critique of these "ESP physiological signals" is that not only they are so weak as to be practically undetectable by the participants (in fact in both experiments, at the overt cognitive level, the means of hits were close to chance) but also that they are extracted from a relatively high number of trials, giving a statistically high power to detect very low effect sizes. This critique is reasonable. However, if these physiological signals represent real pre-(covert) cognitive information, we can start to investigate whether it is possible to extract a "prototypical pattern" distinguishing targets from nontargets at the level of single or less numerous trials, for example using algorithms implemented in neural networks. Another possibility is to manipulate the "physiological signal," enhancing the differences at a level detectable by the participants. The theoretical contribution of Stevens (2000) about stochastic resonance (SR), a phenomenon wherein some characteristics of the signal (amplitude, signal-to-noise ratio, coherence, etc.) are, counter to intuition, actually improved by the presence of the noise, may be another useful approach for this line of investigation.

References

Bechara, A., Tranel, D., Damasio, H., & Damasio, A.R. (1996). Failure to respond to anticipated future outcomes following damage to prefrontal cortex. *Cerebral Cortex*, **6**, 215-225.

Bechara, A., Damasio, H., Tranel, D., & Damasio, A.R. (1997). Deciding advantageously before knowing the advantageous strategy. *Science,* **275**, 1293-1295.

Beloff, J. (1974). ESP: The search for a physiological index. *Journal of the Society for Psychical Research*, **47**, 403-420.

Bierman, D.J., & Radin, D.I. (2000). Anomalous unconscious emotional responses: Evidence for a reversal of time. In S.R. Hameroff, A.W. Kaszniak, & R.D. Chalmers (Eds.), *Tucson III: Towards a science of consciousness* (pp.367-386). Cambridge: MIT Press.

Bierman, D.J., & Scholte, H.S. (2002). A fMRI Brain Imaging study of presentiment. *Journal of ISLIS*, **20**, 380-389.

Blair, R.C., & Karniski, W. (1993). An alternative method for significance testing of waveform difference potentials. *Psychophysiology*, **30**, 518-524.

DIMBERG, U., THUNBERG, M., & ELMEHED, K. (2000). Unconscious facial reactions to emotional facial expressions. *Psychological Science*, **11**, 86-89.

DON, N.S., MCDONOUGH, B.E., & WARREN, C.A. (1998). Event-related brain potential (ERP) indicators of unconscious psi: A replication using subjects unselected for psi. *Journal of Parapsychology*, **62**, 127-145.

DUNLAP, W.P., CORTINA, J.M., VALOW, J.B., & BURKE, M.J. (1996). Meta-analysis of experiments with matched groups or repeated measures designs. *Psychological Methods*, **1,** 170-177.

KUBOTA, Y., SATO, W., MURAI, T., TOICHI, M., IKEDA, A., & SENGOKU, A. (2000). Emotional cognition without awareness after unilateral temporal lobectomy in humans. *Journal of Neuroscience*, Oct; **20**, RC97.

MASSACCESI, S. (2001). Un sistema modulare portatile per la rilevazione dell'attività elettrodermica e della frequenza cardiaca [A portable modular system for electrodermic and heart rate acquisition]. *Giornale Italiano di Psicologia,* **4**, 825-837.

MAY, E.C., SPOTTISWOODE S. J.P., & FAITH, L.V. (2001). Methodological issue in the study of correlation between psychophysiological variables. *Proceedings of Presented Papers: The Parapsychological Association 44th Annual Convention*, 166-178.

MAYER, B., MERCKELBACH, H., DEJONG, P., & LEEUW, I. (1999). Skin conductance responses of spider phobics to backwardly masked phobic cues. *Journal of Psychophysiology*, **13**, 52-159.

MCDONOUGH, B.E., DON, N.S., & WARREN, C.A. (2002). Differential event-related potentials in targets and decoys in guessing task. *Journal of Scientific Exploration*, **16**, 187-206.

PALMER, J. (1978). Extrasensory perception: Research findings. In S. Krippner (Ed.), *Advances in Parapsychological Research* 2 (pp. 59-243). New York: Plenum Press.

PÉLADEAU, N., & LACOUTRE, Y. (1993). SIMSTAT: Bootstrap computer simulation and statistical program for IBM personal computer. *Behavioral Research Methods, Instruments, & Computers*, **25**, 410-413.

RADIN, D. (2004). Electrodermal presentiment of future emotions. *Journal of Scientific Explorations*, **18**, 253-274.

SCHMIDT, S., SCHNEIDER, R., UTTS, J., & WALACH, H. (2004). Distant intentionality and the feeling of being stared at: Two meta-analyses. *British Journal of Psychology*, **95**, 235-247.

STEVENS, P. (2000). Noise, physics and psi: New ideas for research. *International Journal of Parapsychology*, **11**, 63-72.

TRESSOLDI, P.E., MARTINELLI, M., MASSACCESI, S., & SARTORI, L. (submitted). Heart rate differences between targets and nontargets in intuition tasks.

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Note

1. Bootstrap simulation is a resampling technique whereby the initial sample is treated as if it constitutes the population under study, and it is particularly useful for analyzing the autocorrelated time-series datasets generated in psychophysiological experiments By replicating these data infinite times, we then draw a large number of samples at random from that population, each one the same size as the original sample. By computing for every bootstrap sample, a statistical estimator of interest (such as a mean, a correlation or a *t* test between two variables), this resampling procedure recreates an empirical sampling distribution of this estimator.