Australian Journal of Parapsychology
2007, Volume 7, Number 2, pp. 112-133

Pro Attitude and Macro-PK: A Pilot Study Using Neuro-feedback and EMG Biofeedback[1]

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ABSTRACT: Using the *ProComp+* neuro-feedback apparatus, intermittent feedback was given to eight participants as they performed an alternating bimodal (i.e., normal and paranormal) task, switched at irregular intervals. During normal modes, participants were required to keep EEG alpha rhythm above threshold, and/or EMG amplitude below threshold, in order to elicit positive feedback of a 'Spinning Man' animation. The man spun only when one or both threshold contingencies were met. During paranormal modes, regardless of alpha and/or EMG amplitudes, the participants were required to keep the man spinning, but they were blind to the fact that their attempts could only elicit micro-PK changes (i.e., 'anomalous perturbations') on a single frame taken from the Spinning Man animation sequence. If psi was elicited during this mode, anomalies were expected as a result of participants' focussed attention. It was hypothesised that (i) video anomalies might occur during the paranormal modes, and (ii) EEG alpha amplitude might be higher, and/or integrated EMG amplitude might be lower, during paranormal modes. Stills of the video frame caught during paranormal modes were later analysed. No evidence was found for (i) or (ii). Three un-hypothesised 'anomalous' effects occurred during the running of the experiment but, on parsimonious grounds, these were attributed to software flaws. It is argued that lack of biofeedback during paranormal modes may have been psi-inhibitive. Previous meditation and biofeedback experience had no effect on EEG alpha amplitude or EMG. Some participants showed evidence of waveform training. Transliminality correlated with alpha and EMG in the directions hypothesised, but only approached significance in the Transliminality/alpha correlation.

[1] Preparation of this article was supported by a grant from the Bial Foundation.

Research into the processes of human brain function has now reached the point where some mental states can be defined by corresponding electroencephalograph (EEG) readings. EEG waveforms are even said to correlate with mental states such as alertness, calmness, and so on (Michael Thompson, personal communication, January, 2000), and EEG output charts can be used to diagnose categories of mental dysfunction such as Attention Deficit Disorder (ADD). Some clinicians claim that these dysfunctions can be treated successfully by neuro-biofeedback techniques that train EEG waveforms (Thompson & Thompson, 1998). Thompson and Thompson (1998) define neuro-biofeedback as "a form of biofeedback in which the subject trains to control attributes of brain wave activity" (p. 247).

Apparatus such as *ProComp+* can be used to facilitate this training.[2] *ProComp+* is a "highly flexible, multi-modality, 8-channel, artifact-free system for sophisticated monitoring of EMG, EEG, temperature, heart rate, blood volume pulse, skin conductance, EKG and respiration" (Behavioural Medicine Institute of Australia, 2002). As is the case in clinical use, experimentation with *ProComp+* would be a fairly non-invasive method of measuring, training, utilizing, and applying brainwaves and other physiological measures to various ends. The four traditional EEG waveforms that can be routinely measured and quantified using *ProComp+* are:

1. *Delta waves*: large, slow waves most prominent in infants (1-2Hz).

2. *Theta waves*: slow waves produced in deep meditation (4-7Hz).

3. *Alpha waves*: relatively slow, high amplitude waves produced when we are still awake, but relaxed (8-12Hz).

4. *Beta waves*: the normal, low amplitude, regular and fast waves produced by the brain when we are alert (15-30Hz).

Since these waveforms are present at different amplitudes during many human activities and states of consciousness, it has been theorised that paranormal functioning may also involve mental states that characteristically correspond with specific EEG waveforms. Healy (1986), for example, argued that there was a link between paranormal (psi) functioning and EEG theta rhythm (which is 'high' during deep meditation),

[2] *ProComp+* is a registered trademark of Thought Technology Limited (Canada).

though evidence was inconclusive at that time. Honorton (1969; Honorton & Carbone, 1971) got mixed results with EEG alpha rhythm and psi ('high' *and* 'low' alpha were associated with ESP-task performance). Honorton considered his alpha training sessions to be too rigorous and later opted for a less intense regime. Honorton, Davidson, and Bindler (1971) then conducted a well-designed and highly-regarded study (see Stanford, 1993) in which participants were only accepted into the experiment for psi-testing if they could initially produce alpha that was 10% above the baseline. These same participants were then given more alpha training. Participants were tested in two ESP conditions—'alpha generation' and 'alpha suppression'. The experimenters found that alpha generation was significantly higher than alpha suppression during ESP testing, and ESP performance was better in the alpha generation condition.

Relevant to EEG alpha-psi research is the finding of Stanford and Stevenson (1972) that low-frequency alpha (slow-wave alpha) "tended to accompany higher ESP scores" (p. 364). Generally, Palmer's (1978) review reports a consistent relationship between ESP and alpha rhythm, and the later review by Irwin (2004) came to a similar conclusion.

Honorton and Tremmel (1979) developed methodologies that demonstrated the connection between brain-wave states and PK effects. In two independent RNG experiments, Honorton and Tremmel (1979) found that naïve participants, oblivious to the relevance of the RNG (i.e., they thought that they were merely involved in an EEG-alpha biofeedback task) produced levels of variance in the RNG data that were above chance, but only in pre-established alpha states. In the second experiment, Honorton and Tremmel made no attempt to control EEG frequencies. Once again, significant results were obtained during the feedback periods for samples in the alpha-gated mode (i.e., performance was contingent upon reaching certain levels of alpha). The PK/alpha relationship is to be expected since alpha is associated with a relaxed and passive, but focused mind (as Honorton, 1969, had pointed out earlier), and relaxation has been correlated with psi performance (see especially, Storm & Thalbourne's, 2001a, review of the relaxation literature).

EEG alpha rhythm has also been associated with PK effects elsewhere (see Dierkens, 1978; Hasted, 1981; Varvoglis & McCarthy, 1986), and may thus prove to be advantageous to the field of parapsychology where the relationships between EEG (particularly alpha rhythm) and psi (particularly PK) are of interest. The aim of the present study was to consolidate these ostensible relationships. Other than testing hypothesised physiological predictors of paranormal (psi) effects, it would be useful to parapsychology to test two hypothesised psychological

predictors of psi—'pro attitude' and 'transliminality'. These are now introduced.

Pro Attitude

It is possible that a person's 'pro attitude', apart from its hypothesised relationship with paranormal performance, may be instrumental in the training of EEG waveforms. Thalbourne (2004) states that "a person may be said to have a pro attitude towards state ***S*** when they would prefer ***S*** rather than ***–S*** [not ***S***] if those two alternatives were to be brought to their attention" (p. 65). The pro attitude concept is a crucial component of Thalbourne's (2004) theory of psychopraxia, which was developed to clear up the conceptual muddle over the nature of psi. 'Psychopraxia' is a neologism based on two Greek words: *psyche*, which means 'soul', 'mind' or 'self', and *praxia*, from which we get the word 'practice' (derived from *prattein*, which means 'to accomplish' or 'bring about'—see Thalbourne, 2004, pp. 73-76). Thus psychopraxia is the self at work effecting, or bringing about, a goal, which can be seen, by convention, as either normal or paranormal.

The so-called pro attitude covers conscious goals and motivational states not currently in awareness (i.e., unconscious). To test this latter kind of pro attitude it would be necessary to set up a blind experimental condition so that the participant does not know that a pro attitude is required (i.e., such a pro attitude would be unconscious).[3] In the present study, the relationship between pro attitudes (conscious and unconscious) and two physiological measures (EEG alpha rhythm and EMG amplitude) will be tested in two modes—normal and paranormal.

Transliminality

Transliminality is defined as the "hypothesised tendency for psychological material to cross (*trans*) thresholds (*limines*) into or out of consciousness" (Thalbourne & Houran, 2000, p. 853). Thalbourne and Delin (1994) suggested that transliminality might correlate with paranormal effects on the basis that it was a process that drew on the unconscious, amongst other things.

Previous studies have also shown a tentative relationship between transliminality and paranormal outcomes, though results have been

[3] The theoretical similarity between Thalbourne's (2004) 'pro attitude' and Stanford's (1974) 'intention' (see his PMIR model; Stanford, 1990) have been contrasted by Storm (in press) and the distinction is drawn that Thalbourne's *pro attitude* covers intentions of the ego/self-system (which may be unconscious) whereas Stanford's *intention* is confined to conscious (egoic) needs or wishes, etc.

inconsistent (Storm & Thalbourne, 1998-1999; 2001b,c; Thalbourne, 2000; Thalbourne & Storm, in press), or not shown a psi relationship at all (e.g., Parker, 2000).

Rather than just testing the relationship between transliminality and psi, the present study also tested the hypothesis that there is a relationship between transliminality and the two physiological measures (i.e., EEG alpha and EMG).

Rationale for the Procomp Experiment

In the present study, a two-mode (normal/paranormal) procedure was implemented so that a computer-generated animation of a so-called 'Spinning Man' (see Figure 1) would run (i.e., the man would spin) in the normal mode, given alpha amplitudes sufficiently above threshold, and/or EMG amplitudes sufficiently below threshold, both automatically adjusted to provide feedback, and averaged to 50% of the time. Given the psi hypothesis, we might expect to see some kind of macro-PK effect otherwise referred to as an 'anomalous perturbation' (i.e., ostensible paranormal change or distortion) in a single 'Spinning Man' image (a single 'bitmap' image) presented on a CRT screen if the pro attitude was at a sufficient level—assuming all other necessary conditions are present during the experiment, thus establishing the overall condition sufficient in bringing about psi, otherwise known as 'exosomatic psychopraxia'.

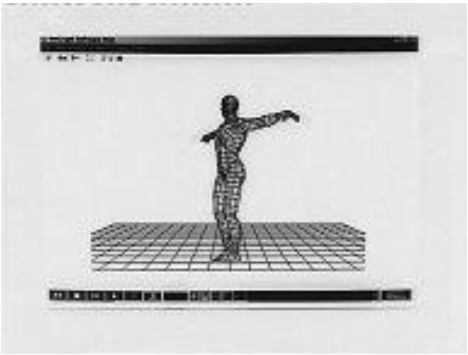

Figure 1. Still frame of the spinning man.

It was the aim of the Procomp experiment to explore whether (a) the psi process (in the form of a macro-PK effect) is related to high EEG alpha amplitude and/or low EMG amplitude; (b) the pro attitude is related to

the psi process, high EEG alpha amplitude, and low EMG amplitude; and (c) transliminality is related to the psi process, high EEG alpha amplitude, and low EMG amplitude. The relationships between the physiological measures and (i) meditation-experience and (ii) previous experience with biofeedback, were also tested.

Hypotheses

The above aims are formally stated in the following hypotheses:

Hypothesis 1: There are anomalous video effects during paranormal modes (i) between-seconds (i.e., in real-time and/or in slow motion); and/or (ii) between-frames of the animation; and/or (iii) within-frames of the animation.

Hypothesis 2: Pro attitude and transliminality predict any psi effects described in Hypothesis 1.

Hypothesis 3: Compared to normal modes, mean EEG alpha amplitude is higher in paranormal modes, and mean integrated (combined) EMG amplitude is lower in paranormal modes.

Hypothesis 4: There is a positive relationship between answers to the question "Have you been previously tested in a biofeedback experiment?" and EEG alpha amplitude, and a negative relationship between answers to the same question and integrated EMG amplitude.

Hypothesis 5: There is a positive relationship between answers to the question "Do you, or have you ever, practised meditation?" and EEG alpha amplitude, and a negative relationship between answers to the same question and integrated EMG amplitude.

Hypothesis 6: There is a positive relationship between pro attitude and EEG alpha amplitude, and a negative relationship between pro attitude and integrated EMG amplitude.

Hypothesis 7: There is a positive relationship between transliminality and EEG alpha amplitude, and a positive relationship between transliminality and integrated EMG amplitude.

Hypothesis 8: EEG alpha amplitude increases (i.e., can be 'trained up') across trials, and integrated EMG amplitude decreases (i.e., can be 'trained down') across trials.

METHOD

Participants

Nine participants in the sample of 200 participants in Thalbourne and Storm's (in press) *I Ching* experiment got two successful hits (a first hexagram hit *and* a second hexagram hit), both hexagrams of which were correctly pre-selected in advance of their generation using the coin-throwing method, p = (16/64 x 15/63) = .059. These nine double-hitters were invited to participate in the ProComp experiment. Eight of them accepted the invitation.[4] The average age of these eight participants was 31 years (*SD* = 14 years). There were four males and four females. One other participant (not a double-hitter) helped in the testing stages of the protocol and running time of the experiment.

Apparatus

(1) The *ProComp+* system consists of an isolated 8-channel encoder unit, which is used for real-time physiological monitoring; data are digitised and up to eight sensors can be recorded simultaneously (only two channels were used in the present study, one for EEG, and one for EMG). The sensor information is sampled and digitised, the resulting information is sent to a PC via a fibre-optic cable. Training stimuli consists of various graphic representations of EEG and EMG output, as well as animation video (e.g., the 'Spinning Man') which uses sequences of bitmap images that appear at a rate of 25 frames per second (fps); (2) electrodes; (3) conducting gels ('Ten20-CONDUCTIVE' and 'Signa-gel'); (4) *Biograph* operating software (Version 2.0, Thought Technology Ltd, 1999) for *ProComp+*; (5) 19-minute experimental 'Protocol' software (written by second author, NRB); (6) PC computer with 17" CRT monitor (refresh rate set to 100Hz); (7) *Sony* 'Digital 8' video camera (Model DCR-TRV140E); (8) 3 x 60-minute 'Hi8' videotapes; (9) hardware for analogue video image capture and conversion to 'AVI' files (card: miroVIDEO DC20 plus); (10) *VidCap* software for frame-grabbing; (11) *FadeToBlack* (Version 2.3) software to split digitised AVI footage into individual (25Hz) 'jpeg' frames; (12) *IrfanView* (Version 3.91) software to view jpeg images on the CRT monitor; (13) tripod to mount video camera; and (14) recliner chair.

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[4] By chance alone, there should be almost 12 double-hitters in Thalbourne and Storm's (in press) study. However, the criterion for selection in the present study is based on the possibility that the nine double-hitters might have psychic ability. This criterion was adopted because Storm (2006) showed that double-hitting, though a difficult feat by chance alone (P_{MCE} = 24.4%) was nevertheless a near-significant, above-chance effect, $P_{obs.}$ = 26.9% (p = .057).

Materials

(1) Thalbourne's (1998) Transliminality Scale, which contains 29 items taken from various scales, 14% of which refer to paranormal phenomena. The participant answers "true" or "false" to each item. Rasch scaling was then applied to eliminate age and gender bias, resulting in a 17-item Revised Transliminality Scale (RTS), with a KR20 reliability coefficient of 0.82 (see Lange, Thalbourne, Houran, & Storm, 2000); (2) Thalbourne and Storm's Pro Attitude Scale (PAS; see also Storm, 2002, 2003), incorporating six Likert scales (see Appendix A)—Cronbach's $\alpha = 0.70$ (based on $N = 200$); (3) a one-item measure: "Have you been previously tested in a biofeedback experiment?" Participants answer "Yes" or "No"; and (4) a one-item measure: "Do you, or have you ever, practiced meditation?" Participants answer "Yes" or "No."

Procedure

Each participant completed the four measures listed above; they were then prepared for physiological recording. Biofeedback information was produced using the ProComp+/Biograph system. Biograph software was run on a PC which was connected to a battery operated SB-PRO interface unit through a fibre optic cable. The sensors attached to the participant were connected to the SB-PRO interface unit.

First, the scalp and earlobes were prepared by swabbing with alcohol and gently abrading with OmniPrep. An electrode (Ag-AgCl, 10mm in diameter) was then attached at site Cz (International 10/20 System) using electrode cream; a reference electrode was attached to the left earlobe and a ground electrode to the right earlobe. Second, skin over the right trapezius muscle was swabbed with alcohol and a stick-on type electrode montage was attached so that the active electrodes were in a line parallel to the direction of the muscle.

EEG was sampled at 256Hz and EMG was sampled at 32Hz. The EEG signal was digitally filtered such that the alpha band (8-12Hz) was isolated and recorded separately. The EMG was integrated and the amplitude recorded.

Four trials were run for each participant. (Prior to the running of the four trials, a pre-trial of a few minutes duration was run to familiarise the participant with the task requirements.) Depending on the trial, participants were instructed to raise alpha above a threshold and keep it there, and/or lower EMG below a threshold and keep it there, in order to make the Spinning Man spin. Trials were between 2:15 and 4:20 minutes duration only (see Table 1), to avoid fatigue effects in participants. Also, the pseudo-random variations in trial-lengths minimise the possibility of participants guessing when sequences were to change.

Table 1
The ProComp Experiment: Trials and Times for Normal and Paranormal Modes

TRIAL	MODE 1	MODE 2	MODE 3	MODE 4	MODE 5	TIME
REST PERIOD (1:10 min.)						
1: (Alpha feedback only)	Normal (0:30)	Paranormal (0:05)	Normal (0:30)	Paranormal (0:10)	Normal (1:00)	2:15
REST PERIOD (1:05)						
2: (Alpha feedback only)	Normal (1:00)	Paranormal (0:10)	Normal (1:30)	Paranormal (0:10)	Normal (1:30)	4:20
REST PERIOD (1:05)						
3: (EMG feedback only)	Normal (1:30)	Paranormal (0:10)	Normal (0:30)	Paranormal (0:10)	Normal (1:00)	3:20
REST PERIOD (1:05)						
4: (EMG + Alpha feedback)	Normal (1:00)	Paranormal (0:10)	Normal (1:30)	Paranormal (0:10)	Normal (1:00)	3:50
TIME	4:00	0:35	4:00	0:40	4:30	13:45

Notes: Total time (trials only) = 13:45 minutes; total session time approx. 20:00 minutes (including rest periods of total time 4:25 and final prompts)

There was a rest period of 1:10 minutes before the experiment began, and three rest periods of 1:05 minutes after the first, second, and third trial. After the fourth trial, the electrodes were removed and the participant was debriefed and thanked.

The task was bimodal—that is, there was switching between normal and paranormal modes using a protocol written by NRB. The bimodal protocol modifies the conditions under which biofeedback was provided to the participant. Each participant viewed a so-called 'Spinning Man' on the 17" CRT. During normal modes (Modes 1, 3 and 5), the objective of the participant was to make the Man spin. This was achieved by the participant generating and maintaining 'high'-EEG alpha rhythm (Trials 1 and 2), 'low'-integrated EMG amplitude (Trial 3), and 'high'-alpha/'low'-EMG (Trial 4). During normal modes the protocol provided positive feedback on average 50% of the time. This was achieved by adjusting the threshold amplitude at which feedback would be provided according to the level of alpha or EMG currently being recorded. Such adjustment

encourages the participant 'to work' to increase alpha output, or decrease EMG amplitude, by providing an adequate level of reinforcement.

During paranormal modes (Modes 2 and 4), participants continued to believe their objective was to make the Man spin by maintaining appropriate physiological levels. In fact, the experimenters expected that there would only be some measure of deviation or distortion in a single frame of the Man, the result of an hypothesised paranormal influence from the participant based on their pro attitude towards keeping the Man spinning in accordance with the task requirement. Any deviations from the norm of the Man would be regarded as anomalous and ostensibly paranormal, since alpha or EMG could not produce them. These effects would be interpreted as attempts to make the Man spin.

Since EEG and EMG signals were being recorded throughout the whole session for each participant, anomalies on the CRT during paranormal modes could not be recorded on computer by the *Procomp+* software. For paranormal modes, a single bitmap of the Man was presented to participants as if it were part of the normal biofeedback session (i.e., participants were blind to paranormal modes). The 'Digital 8' video camera was mounted on a tripod above and behind each participant, and the sessions were taped. This way, any macro-PK effects would be permanently recorded, to be analysed later.

Once all sessions were completed, videotapes were removed from the camera and handed to our assistant, Ben P. Stone. The "miroVIDEO DC20 plus" capture card and associated software '*VidCap*' was used to capture and digitise the analogue video source into AVI files. A trial version of '*FadeToBlack*' software was then used to split the digitised AVI footage into individual 25Hz frames.

'*Irfanview*' software was used by the first author (LS), with assistance from colleague Michael A. Thalbourne (MAT), to view and inspect the individual jpeg frames, which were presented on computer. Both frame-inspectors viewed the frames at the same time to reach a consensus on anomalies (if any). Each of eight participants had one initial paranormal mode of five seconds duration and seven subsequent paranormal modes each of ten seconds duration—total paranormal test time was 75 seconds (see Table 1).

For the eight participants, the total time was 8 x 75 = 600 seconds. There are 25 fps, so that 15,000 frames needed to be individually inspected for anomalies. Since Trial 3 for one participant (EMG only) failed to record (i.e., 500 frames were lost), the total of number of frames for analysis was reduced to 14,500 frames.

RESULTS

All participants completed all four trials, but (as just mentioned) the video camera did not record Trial 3 (EMG only) for one participant.

The mean-score for the Revised Transliminality Scale (RTS) was 28.41 (*SD* = 3.53). Though high, this mean-score was not significantly higher than a corresponding sample mean-score of 27.14 (*SD* = 4.09) in the *I Ching* experiment (*N* = 192; this mean-score excludes the eight ProComp participants who were also in the *I Ching* experiment), $t(198) = -0.87$, $p = .387$ (two-tailed).

There was a minimum gap of 15 weeks and a maximum gap of 45 weeks between the initial administration of the RTS during the *I Ching* experiment and the second administration of the scale during the ProComp experiment. The test-retest correlation was very high, $r(6) = .83$, $p = .011$ (two-tailed).

The mean-score for the Pro Attitude Scale (PAS) was 33.13 (*SD* = 6.73), which is not significantly higher compared to the corresponding sample mean-score of 32.01 (*SD* = 5.01) in the *I Ching* experiment, $t(198) = -0.61$, $p = .544$ (two-tailed). Again, the time between first and second administrations of the PAS ranged from 15 to 45 weeks. The correlation between scores was high, $r(6) = .89$, $p = .003$ (two-tailed).

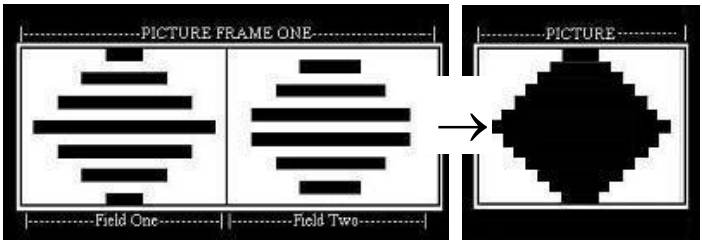
Planned Analyses

H1: There are anomalous video effects during paranormal modes (i) between-seconds (i.e., in real-time and/or in slow motion); and/or (ii) between-frames of the animation; and/or (iii) within-frames of the animation.

(i) *Between-Seconds Effect:* No between-seconds (i.e., real time or slow motion playback) anomalous effects were observed during paranormal modes.

(ii) *Between-Frames Effect:* An unusual but faint between-frames effect was observed in 5 of 62 paranormal modes, the duration of each of the five lasting between 136ms and 172ms. Specifically, its form consisted of a two-frame repeated flickering pattern, but only in small areas of the frame (on the Man only). This would hardly be detectable in real-time as it would be an 'on-off' effect flashing at 2/25Hz—not too fast for the human eye to detect in real time, but more readily detected by LS and MAT during manual frame-by-frame review. This same effect was observed in normal modes. We, therefore, do not claim the effect to be an unexplained anomaly.

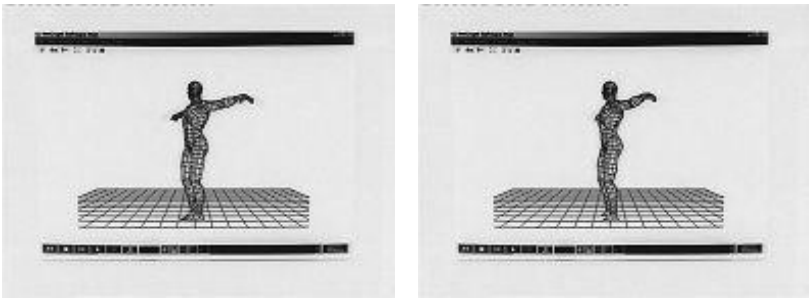
As it happens, the effect can be explained parsimoniously. Each frame is made up of two fields—half-pictures containing every other horizontal line—see Figure 2.



(a) (b)

Figure 2. On the videotape, PICTURE FRAME ONE—see (a)—is comprised of two half-frames or fields (Field One and Field Two), which combine in playback to appear as one frame—see (b).

These are captured every 20 milliseconds. Fields captured at 50Hz are used because at 25Hz, the real-time video effect (i.e., 25 fps) appears jerky or strobed. In the case of the Spinning Man, the transition from one image to a different image takes place within a single frame comprised of a field from one image and a second field from another image (see Figure 3).



Frame 3a Frame 3b

Figure 3. Frame 3a is captured by the video camera as Field One, and Frame 3b is captured by the video camera as Field Two.

The two fields are combined into one image—i.e., one frame (see Figure 4). The result is a double-exposure effect, which would normally go undetected if played in real time.

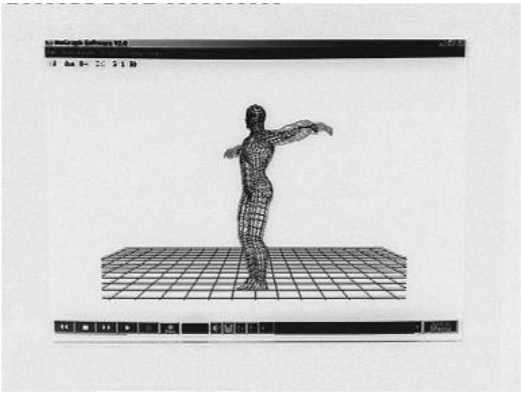


Figure 4. In playback, Field One and Field Two (Frame 3a and Frame 3b shown in Figure 3 above) combine to form a single frame of a double-exposed Spinning Man.

(iii) *The Within-Frames Effect:* No within-frames effects were observed during paranormal modes. The hypothesis was not supported.

H2: Pro attitude and transliminality predict any psi effects described in Hypothesis 1. This two-part hypothesis could not be tested. It was expected that participants who produced video anomalies would also be high scorers on one or both measures.

H3: Compared to normal modes, mean EEG alpha amplitude is higher in paranormal modes, and mean integrated EMG amplitude is lower in paranormal modes. Mean alpha was *not* higher in the paranormal mode, 8.24mV (*SD* = 3.56), compared to normal mode, 8.82mV (*SD* = 3.76). Also, mean EMG was *not* lower in the paranormal mode, 2.42mV (*SD* = 0.54) compared to the normal mode 2.38mV (*SD* = 0.53). These counter-intuitive findings may be explained by the fact that paranormal modes did not include feedback, which means the results here are possibly artifacts of lack of feedback, if not chance.

H4: There is a positive relationship between answers to the question "Have you been previously tested in a biofeedback experiment?" and EEG alpha amplitude, and a negative relationship between answers to the same question and integrated EMG amplitude. (Note that only normal feedback data are used to test this hypothesis.) Counter to the hypothesised direction, those participants who said 'Yes' to this question tended *not* to produce more alpha. However, those participants who answered 'Yes' to this

question did tend to produce less EMG, but the relationship was not significant, $r_s(6) = -.17$, $p = .345$ (one-tailed). The statistic was in the hypothesised direction, although the result can be attributed to chance.

H5: There is a positive relationship between answers to the question "Do you, or have you ever, practised meditation?" and EEG alpha amplitude, and a negative relationship between answers to the same question and integrated EMG amplitude. (Note that only normal feedback data are used to test this hypothesis.) Those participants who said 'Yes' to this question did tend to produce more alpha, but the relationship was not significant, $r_s(6) = .17$, $p = .345$ (one-tailed). Those participants who said 'Yes' to this question did tend to produce less EMG, but the relationship was not significant, $r_s(6) = -.28$, $p = .250$ (one-tailed). The statistics were in the right direction in both cases, but the results are attributable to chance.

H6: There is a positive relationship between pro attitude and EEG alpha amplitude, and a negative relationship between pro attitude and integrated EMG amplitude. (Note that only normal feedback data are used to test this hypothesis.) Pro Attitude Scale scores and alpha did correlate positively, but the relationship was not significant, $r_s(6) = .24$, $p = .284$ (one-tailed). The hypothesis was not supported. Pro Attitude Scale scores and EMG did correlate negatively, but the relationship was not significant, $r_s(6) = -.17$, $p = .346$ (one-tailed). The statistics were in the right direction in both cases, but the results are attributable to chance.

H7: There is a positive relationship between transliminality and EEG alpha amplitude, and a positive relationship between transliminality and integrated EMG amplitude. (Note that only normal feedback data are used to test this hypothesis.) Revised Transliminality Scale (RTS) scores and alpha did correlate positively, but the relationship only approached significance, $r_s(6) = .61$, $p = .056$ (one-tailed). There was marginal support for this part of the two-part hypothesis. RTS scores and EMG did correlate negatively, but the relationship was not significant, $r_s(6) = -.10$, $p = .410$ (one-tailed). This part of the two-part hypothesis was not supported.

H8: EEG alpha amplitude increases (i.e., can be 'trained up') across trials, and integrated EMG amplitude decreases (i.e., can be 'trained down') across trials. (Note that only normal feedback data are used to test this hypothesis.) Five of the eight participants showed an increase in alpha. Based on mean values, alpha generally increased (though only slightly), rising from 8.21mV ($SD = 4.43$) to 8.22mV ($SD = 2.43$)—note especially the marked decrease in *SD*. Given the small sample ($N = 8$), and small

effect, the difference was not significant, $z = 0.42$, $p = .337$ (one-tailed). It is important to note here that in Trial 3, participants were burdened with the task of keeping EMG low while attempting to maintain high-alpha, so the comparison is hardly fair. Those five participants did exceedingly well on that basis. The statistic was in the right direction, but the result can be attributed to chance.

Raw EMG values are used (Trials 3 and 4) to test this part of the two-part hypothesis. Only three of the eight participants showed a decrease in EMG (the same three showed increases in alpha across sessions). However, based on mean values, EMG actually increased, from 2.33mV ($SD = 0.45$) to 2.44mV ($SD = 0.62$). The difference was not significant, $z = 1.19$, $p = .111$ (one-tailed). It is important to note again that in Trial 3, participants were burdened with the task of keeping alpha high while attempting to maintain low-EMG, so once again, the comparison is hardly fair. Those three participants did exceedingly well on that basis. The directional hypothesis was not supported.

Unexpected Anomalies

Three unusual events occurred during the course of the experiment:

1. As well as the expected Channel A (EEG) and Channel C (EMG) appearing in the on-screen dialog box that lists opened channels used during the running of the protocol, Channel H (Respiration) was also listed for one female participant, even though the participant was not wired up for respiration measures. In keeping with the protocol, this channel should not have been listed, but no meaningful respiration data was recorded throughout the session. Nevertheless, this same participant has a history of producing macro-PK effects with computers (Karolyi, 2003; D. Morena, personal communication, May 5, 2004).

2. The heartbeat of another female participant could not be eliminated from the EMG display despite repeated attempts to do so. Therefore, the EMG was not a clean waveform. Also, the Man did not spin during normal modes—Trial 3 (EMG only). At the time, it was thought that the heartbeat was causing the problem. However, in Trial 4 (Alpha and EMG), the Man did spin. The heartbeat artifact alone, then, could not account for the problem in Trial 3.

3. Exactly the same problem just described in (2) above occurred with a middle-aged male participant. While it is true that this participant has a history of heart problems (J. Judd, personal communication, May 7,

2004), his medical condition alone does not satisfactorily explain the twofold anomaly.

Until proved otherwise, and on purely parsimonious grounds, these 'anomalies' are attributed to program flaws ('bugs') in the *Biograph* software.

DISCUSSION

It was proposed in the present study that a greater understanding of the brain and other physiological processes involved in paranormal processes might be achieved. The *ProComp+* apparatus was used in this experiment—essentially a pilot study—as a first step towards that end. Specifically, the study was conducted to determine whether macro-PK effects (if any) on a CRT might be related to EEG alpha rhythm and/or EMG outputs from participants. It was also proposed that alpha would be higher, and EMG would be lower, during paranormal modes compared to normal modes. Pro attitude and transliminality were hypothesised to be predictors of psi, alpha, and EMG. Also, prior biofeedback experience and meditation experience were thought to yield higher levels of EEG alpha and/or lower levels of EMG.

No evidence was forthcoming to show that alpha and/or EMG were related to the psi process (at least as macro-PK effects). Since the absence of an effect (i.e., null-psi) was constant throughout the experiment, we could not test Hypothesis 2 (that pro attitude and/or transliminality might be predictors of psi).

Alpha and EMG were not, on average, at the hypothesised levels during paranormal modes, but these findings may be attributed to constraints in the experimental design during those modes, at which time participants did not get feedback. It might be argued that an improvement to the experiment would see a feedback condition implemented during paranormal modes. However, this condition cannot be achieved—if waveform-induced feedback is given, there can be no way to discern a psi effect. This problem is exacerbated by the fact that there would be no volition in participants to elicit psi anyway if the Man was already occasionally spinning (in other words, why use psi when there is no perceived need to use it, and therefore no likelihood of an unconscious pro attitude towards that end?). Therefore, while the ideal experimental design would provide ongoing feedback *and* allow participants the opportunity to use psi (without conscious volition for reasons given above), it is clear that,

far from *ProComp+* being inadequate in such a design, the dual-condition could only be operationalised with great difficulty, if at all.

It might also be argued that alpha activity is stronger at Pz rather than Cz, and that alpha is usually higher on the right side of the brain (cf. Hughes, 1994). However, we must not confuse time-domain and frequency-domain visualisation of the EEG signal. The time-domain EEG alpha rhythm is not identical with the frequency-domain alpha activity (somewhat arbitrarily defined as 8-13 Hz). It is the former of these where the *amplitude* of EEG alpha rhythm is higher at posterior derivations. Reasons for this may include that the generators are located occipitally or parietally; or, that the skull is less thick in these areas. Therefore, the use of Cz is justified (cf. Lubar, 1997; Thompson & Thompson, 1998).

It could also be claimed that alpha is usually reduced while the eyes are open, which was necessarily the case so that participants could get on-going visual feedback, so it is possible that the general failure to elicit high levels of alpha may be an artifact of the visual feedback condition. But as it happens, alpha is easily recorded with eyes open. Furthermore, this flaw is irrelevant when the EEG is processed in the frequency domain via the Fast Fourier Transform and alpha *power* is quantified. Moreover, many studies have shown *increases* in alpha activity under conditions of apparent increased visual attention (cf. Gevins et al., 1979). Indeed, in ADD treatment where, for example, alpha is trained up, children must have their eyes open or the therapy cannot proceed.

As regards biofeedback experience and meditation experience, it was hypothesised that both would predict alpha and EMG. There was no evidence to indicate either of those relationships, other than that the effects were in the directions hypothesised, though no statistical evidence supports these outcomes as effects other than chance. Likewise, no evidence was found that pro attitude could predict alpha or EMG, but again, results were in the directions hypothesised. Transliminality also correlated in the hypothesised directions with alpha and EMG—marginally significantly with alpha, but not significantly with EMG.

Altogether, most of the nonsignificant results may be due to low *N*, and/or small effects. However, six out of eight tests (75%, $p = .144$) were in the directions hypothesised according to theory, but again this outcome is chance-like (note that two tests—see Hypotheses 3—are not included in this count because the results for those tests are claimed to be artifacts due to lack of feedback.) Also, the use of *ProComp+* in the present study did show that alpha could be trained-up (five in eight cases). Three of those same five also produced lower EMG across the third and fourth trials—too late in the session to see any substantial lowering of EMG.

While alpha showed a general trend in the hypothesised direction (based on mean scores), the increase was not significant, once again probably due to low *N*. These results are actually very encouraging, but if the ProComp experiment is to be improved, and since we expect effects to be weak, it would be wise to test a larger *N* in replication studies. We also recommend a greater number of sessions to be conducted per participant (at least 10 sessions to train EMG, and at least 20 sessions to train alpha, with more feedback in both conditions). Time and financial constraints were limiting factors in this pilot study, but we do argue that future studies should incorporate these more rigorous procedures. It was never our attention to undertake a full clinical biofeedback protocol—we merely aimed to instantiate the conditions that apply during such a protocol. Indeed, the data show that we achieved some measure of success in that aim.

If alpha and EMG are related to psi, as is suggested by the literature, we maintain that *ProComp+* may yet prove to be a serviceable tool for (i) increasing the likelihood of finding psi-able types in the population, and (ii) training alpha and/or EMG in non-psychics so as to improve their chances of eliciting psi. Of course, the major requirement is the *elicitation* of psi (i.e., PK) in the first place—not an easily achievable aim given our knowledge of the paranormal. Furthermore, a definitive measure of psi must be developed before *ProComp+* can have applications in parapsychology. In that regard, and due to the fact that the experiment was a pilot study only (using judges' visual inspection to gauge macro PK-effects), a step towards gainful use of *ProComp+* would be to introduce a more sensitive and objective analysis that would measure micro PK-effects at macro *and* micro (i.e., pixel) levels. That next step would require use of, or development of, software that can analyse clusters and sequences of frames, and pixels within frames, from paranormal modes and detect any comparable differences from a template-frame derived from the sample during normal modes. This method would also eliminate the human error and time-cost inherent in the tedious process of visually inspecting the many thousands of individual frames.

Notwithstanding these problems, the advantage to parapsychologists will be manifested in either (a) time and resources saved that would ordinarily be spent on testing participants who are not likely to elicit psi (mainly a proof-oriented advantage), or (b) the development of *ProComp+* protocols for enhancing psi (mainly a process-oriented advantage), or both (a) and (b). Note that advantage (a) would require access to, or the establishment of, norms for alpha and EMG, in order to ascertain participant suitability.

Under the circumstances, the ProComp experiment was reasonably well set up in principle to create a psi-conducive physiological state,

although it did not elicit any psi effects (at least, that we could reasonably claim). A major limitation of the experiment may have been its lack of feedback during paranormal modes, though how that could be achieved has yet to be determined. Nevertheless, in spite of that problem, the ProComp experiment is of some worth—the possibility still exists that it could be used to show that EEG and other physiological waveforms can be trained and applied in practical ways.

ACKNOWLEDGEMENTS

We thank Henk LaDru and Ben P. Stone for their technical advice and assistance.

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