AN ANOMALY OF AN ANOMALY: INVESTIGATING THE CORTICAL ELECTROPHYSIOLOGY OF REMOTE STARING DETECTION

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ABSTRACT: If there is evidence of an overall effect of remote staring detection, then theoretically there should also be evidence of electrophysiological processing of this information in the brain. A series of three experiments examining the potential electrocortical correlates of remote staring detection are presented, followed by a fourth experiment to examine a potential artifact. The first experiment provided an initial exploration of this effect, finding primarily that "remote staring detection" has no evident time-locked processing associated with it on its own but rather acts upon other processes occurring at the same time. The second experiment provided evidence that this effect is not related specifically to face processing but can impact on other forms of processing as well. The third experiment uncovered evidence of a potential artifact that could explain the "remote staring effect," which is verified in the final experiment. The overall results are discussed in light of an interesting and subtle psychophysics luminance effect that could potentially have an impact upon a wide variety of experiments that employ event-related measures of electrocortical processing.

Keywords: remote staring detection, electroencephalography, global field power, psychophysics, luminance artifact

Remote staring detection has been defined as "… the purported ability to detect when one is being watched or stared at by someone situated beyond the range of the conventional senses." (Braud, Shafer, & Andrews, 1993a, p. 391). Remote staring detection involves the measurement of behavioural or physiological reactions in *starees* when stared at by a *starer*, even though it should be impossible for the starees to know through any conventional sensory means that the starer is staring at them at any particular moment. Belief in this phenomenon as an everyday experience is considerably widespread, with incidences of belief ranging from approximately 70% to 94% of the populations sampled (Braud et al., 1993a; Braud, Shafer, & Andrews, 1993b; Coover, 1913; Cottrell, Winer, & Smith, 1996; Rosenthal, Soper, & Tabony, 1994; Sheldrake, 2003; Thalbourne & Evans, 1992). Over the past 100 years there have been several attempts to examine these anecdotal experiences and beliefs under controlled conditions. The earliest research in this area used relatively simple and direct behavioural measures that demonstrated an evolution of methodological sophistication over time as greater controls over extraneous variables were introduced (Coover, 1913; Poortman, 1959; Titchener, 1898; Williams, 1983). The introduction of the use of electrodermal activity (EDA) as a measure of autonomic nervous system (ANS) activity and as a potential indicator of a "fight-or-flight" response to being stared at remotely was a significant methodological development. This was particularly the case when the EDA method was combined with the use of CCTV systems to separate the starer and staree (Braud et al., 1993a, 1993b). Collectively referred to as the "EDA-CCTV" studies (Baker, 2005), several researchers found interesting results utilizing this method, including potential skeptic-believer experimenter effects (Schlitz & LaBerge, 1994; Schlitz, Wiseman, Watt, & Radin, 2006; Watt, Schlitz, Wiseman, & Radin, 2005; Watt, Wiseman, & Schlitz, 2002; Wiseman & Schlitz, 1997, 1999; Wiseman & Smith, 1994, 1994). A meta-analysis (Schmidt, Schneider, Utts, & Walach, 2004) of the 15 EDA-CCTV experiments that had been conducted at that time found a small but significant effect (d = .13, p = .01), suggesting evidence that requires further investigation.

This was the primary objective of the research presented in this paper. Firstly, previous EDA-CCTV methods were expanded to include central nervous system (CNS) activity. It would be expected that, if this phenomenon is genuine, then any stimulus processing or awareness of a remote stare should result in corresponding activity in the brain. Secondly, it was important to embed the potential effect within a wider theoretical framework. Assuming that remote staring detection is producing brain activity as the information is processed, does this processing follow similar systems to those that have already been identified in cognitive neuroscience; for example, the processing of faces and/or the gaze of others?

The significance of various forms of eye-based nonverbal communication in humans has been long established in the social psychology literature (e.g., Argyle & Cook, 1976; Ellsworth, Carlsmith, & Henson, 1972; Kirkland & Lewis, 1976). The human eye has the largest ratio of exposed, white sclera to dark iris compared to any other primate (Kobayashi & Kohshima, 1997; Riccardelli, Baylis, & Driver, 2000), which appears to aid humans in being particularly sensitive to the detection of gaze and its direction (Itier, Van Roon, & Alain, 2011). The impact of the gaze of another also elevates electrodermal measures of arousal (Helminen, Kaasinen, & Hietanen, 2011; Leavitt & Donovan, 1979; McBride, King, & James, 1965; Nichols & Champness, 1971; Strom & Buck, 1979), which neatly correlates with the EDA-CCTV measures of remote staring detection mentioned previously. The impact of face and gaze processing on electrical brain activity has been well-studied over the past decade and a half. Different components have been identified, but there appears to be significant activation surrounding the T_5 (or P_7) and T_6 (or P_8) electrodes, particularly a negative component in the right (i.e., T_6/P_8) hemisphere at approximately 170 ms after stimulus onset (Allison, Puce, Spencer, & McCarthy, 1999; Bentin, Allison, Puce, Perez, & McCarthy, 1996; Carmel & Bentin, 2002; McCarthy, Puce, Belger, & Allison, 1999), with the subtle differences between eyes-only and face processing as a whole being under debate (Farroni, Csibra, Simion, & Johnson, 2002; Itier, Latinus, & Taylor, 2006; Taylor, Itier, Allison, & Edmonds, 2001; Watanabe, Kensaku, & Ryusuke, 2002). It is becoming increasingly apparent that the processing of eye and gaze stimuli may represent a core substrate of social cognition (George & Conty, 2008; Itier & Batty, 2009).

A series of studies is reported here that examined the potential existence of electrocortical correlates of remote staring detection, and the potential association of such correlates with more conventional forms of eye or face perception. The method and analysis procedure for each of the four experiments was identical unless otherwise noted. A series of planned and post hoc analyses was conducted on the electroencephalographic (EEG) data from each experiment, including event-related potentials (ERPs), topographical analyses, fast Fourier transforms (FFTs), evoked and induced event-related band power (ERBP) and partial-least squares (PLS). Additionally, extensive analysis was conducted on the skin conductance (SC) data and questionnaire data. However, due to space limitations only the primary ERP analysis (as reflected by the global field power [GFP] analysis), the frequency analysis of the entire stimulus epoch for Study 2, and the analysis of skin conductance are reported here (see Baker, 2007 for more details of the other analyses).

This first study had two main objectives: (a) was there any evidence of global electrocortical processing of remote staring detection, and (b) did any such processing vary in any way when administered at the same time as more conventional face processing? Such an approach was designed to act as an initial step in a program of research to examine if remote staring detection and face/gaze processing were potentially utilizing the same brain processes.

Experiment 1

This experiment examined if remote staring detection was revealed in global electrocortial processing, and if this processing may have an interaction with more conventional forms of face processing. Accordingly, participants were exposed to four different conditions: (a) conventional face processing, (b) a remote stare, (c) both face and remote stare processing together, and (d) no stimulus as a control condition.

Method

Participants. Twenty participants (7 males and 13 females) took part in this experiment with an average age of 26.0 years (range: 21–41 years). The participants were not paid and were selected using an opportunity sampling method. The majority of the participants were right-handed (two were left-handed). This and all of the following experiments received ethical approval from the Ethics Committee of the School of Philosophy, Psychology and Language Sciences at the University of Edinburgh, and conformed to BPS and APA ethical guidelines. All participants provided informed consent.

Materials, equipment, and procedure. The experiment broadly followed the procedure outlined in previous remote staring detection and direct mental interaction with living systems (DMILS) experiments (Braud & Schlitz, 1991; Braud et al., 1993a, 1993b), with additional elements due to the use of more complex electrophysiological methods. The schematic of the setup of the experimental equipment is shown in Figure 1. Participants were initially oriented in the testing laboratory and asked to complete three questionnaires: a general demographics questionnaire, a 23-item Self Consciousness Questionnaire (Burnkrant & Page, 1984; Fenigstein, Scheier, & Buss, 1975; Mittal & Balasubramanian, 1987), and a 20-item nonclinical paranoia questionnaire (Fenigstein & Vanable, 1992). The analysis of the questionnaire data is not reported in this paper due to space limitations (see Baker, 2007, for more details). The skin conductance (SC) electrodes were then applied to the medial phalanges of digits 2 and 3 of the participant's nondominant hand (as per the guidelines set out by Fowles et al., 1981). Unfortunately, due to equipment failure the skin conductance data for Experiment 1 was corrupted and could not be analysed.The EEG cap was then fitted according to the 10-20 system (Jasper, 1958). The recording electrodes were as follows: F_{p1}, F_{p2}, F_{T9}, F_{T10}, F_7, F_8, F_3, F_4, F_z, F_{T7}, F_{T8}, F_{C3}, F_{C4}, F_{Cz}, T_7, T_8, C_3, C_4, C_z, T_{P7}, T_{P8}, C_{P3}, C_{P4}, C_{Pz}, P_7, P_8, P_3, P_4, P_z, P_1, P_2, O_1, O_2, O_z, A_1, A_2, V_{EOG+}, V_{EOG-}, H_{EOGL}, H_{EOGR}, and ground (GNR). The EEG cap was connected to the NeuroScan NuAmps Amplifier, which was connected to the EEG recording computer. Triggers for the EEG were sent via an optically isolated connection from the experimental computer. The starer and staree were physically isolated from one another in two rooms that were 25 meters apart, and the staree was in a sound-attenuated room.

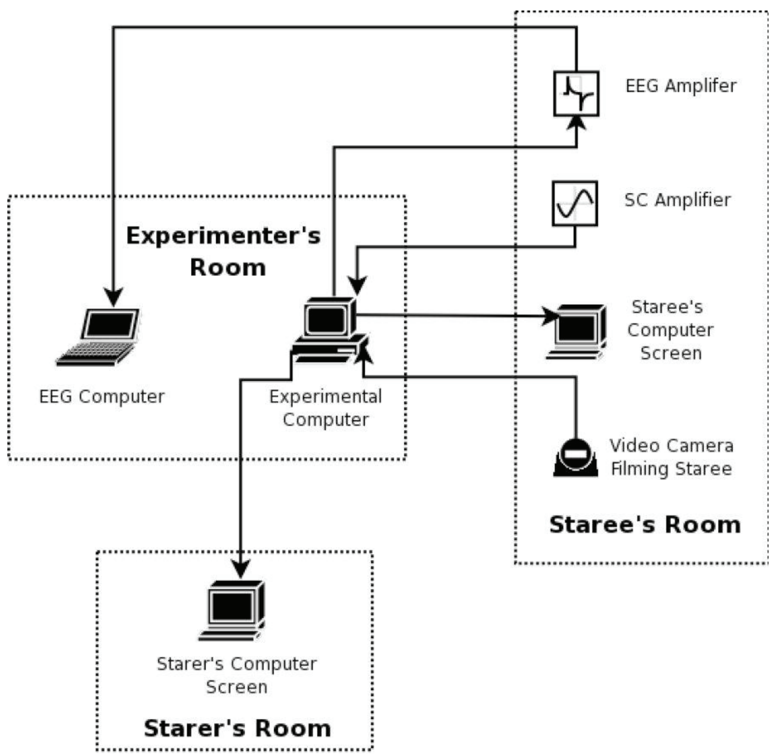

Figure 1. Schematic of the equipment setup for all three experiments.

During the experiment, the participant was exposed to four separate conditions. Each condition was repeated 48 times in a pseudorandomised and counterbalanced order that was automatically changed by the computer for each participant. During certain conditions starees were presented with a static picture of the starer on the screen in front of them, at other times it was blank. In addition, during these times starees may also be stared at remotely by the starer via the computer-controlled CCTV system, depending on the condition. These four conditions are summarised in Table 1.

Table 1

2 × 2 Table of the Independent Variable Manipulation for Experiment 2

		Staree's screen	
		Face displayed	Blank screen
Action of starer	Remote Stare	Face + Remote Stare condition	Remote Stare condition
	No Remote Stare	Face condition	Control condition

The participants' EEG was recorded at 500 Hz sample rate, with a bandpass filter at 0.5 Hz (high pass) and 100 Hz (low pass) with a 50-Hz notch filter. Each condition lasted for 5,000 ms followed by a 5,000-ms rest period.

Results and Discussion

The EEG data were preprocessed to remove muscle and ocular artifacts, epoched and averaged into event-related potential (ERP) data for each condition (-100-ms to 500-ms epochs). The data from all of the electrodes were then summarised using GFP (Lehmann & Skrandies, 1980; Nunez & Srinivasan, 2006; Skrandies, 2002). GFP can be expressed as the following (from Lehmann & Skrandies, 1980):

$$GFP = \sqrt{\frac{1}{2n}\sum_{i=1}^{n}\sum_{j=1}^{n}\left(U_i - U_j\right)^2}$$

This formula represents the root-mean-square deviations between all electrodes (i.e., for each of the voltages U for an $i \times j$ array of n electrodes) for each time point (based on Skrandies, 1995). Essentially, the GFP values represent the spatial standard deviation between all electrodes over time. It is a highly robust measure that uses the data from all of the recording electrodes, and it is also independent of the reference site (Lehmann & Skrandies, 1980). It is partly due to these reasons that it is the primary method for peak identification as recommended in the Society for Psychophysiological Research recording standards and publication criteria (Picton et al., 2000). Peak detection was used as the main measure here as it is discreet and easily definable, which is vital for the a priori definition of the measurement of a phenomenon that has never been examined in this way before. As a function of the calculation, all values are positive. The GFP data for all participants and for all four conditions can be seen in Figure 2. Two primary temporal peaks were identified as being of interest: 134 ms and 222 ms, and an additional slower peak from 378–500 ms. Unlike the two earlier peaks, the 378–500-ms epoch did not have a clear and distinct peak but is of interest due to the novel nature of the stimuli. Due to the duration of this, an area-under-the-curve (as opposed to a mean) measure was used in this analysis. Shapiro-Wilk analyses revealed that the data were not normally distributed and therefore nonparametric analyses were conducted. Alpha levels were corrected using a modified Bonferroni procedure (Keppel, 1982; Russel, 1990), giving an $\alpha_{MB} = .01$ in this instance.

The analyses focused upon demonstrating a potential remote staring detection effect by comparing the Remote Stare and Control conditions, and the potential relationship between face processing and remote staring detection (by comparing the Face and the Face + Remote Stare conditions). The analysis demonstrated that there was a significant difference between the peak GFP amplitudes for the Face and the Face + Remote Stare conditions for both the 134-ms (z = -2.88, p = .004) and 222-ms peaks (z = -2.43, p = .01), but not for the 378–500-ms time period (z = -0.04, p = .97). There were no significant differences between the peak GFP amplitudes for the Remote Stare and Control conditions for the different time points (134 ms: z = -0.60, p = .55, 222 ms: z = -0.30, p = .77, 378–500 ms: z = -0.22, p = .82). In addition to the findings above, there was also a clear and highly significant effect of face processing when the Face and Control conditions were compared (134 ms: $z = -3.81$, $p < .001$, 222 ms: $z = 3.92$, $p < .001$, 378–500 ms: $z = -3.88$, $p < .001$), although these results need to be treated with caution due to the considerable difference in stimulus types.

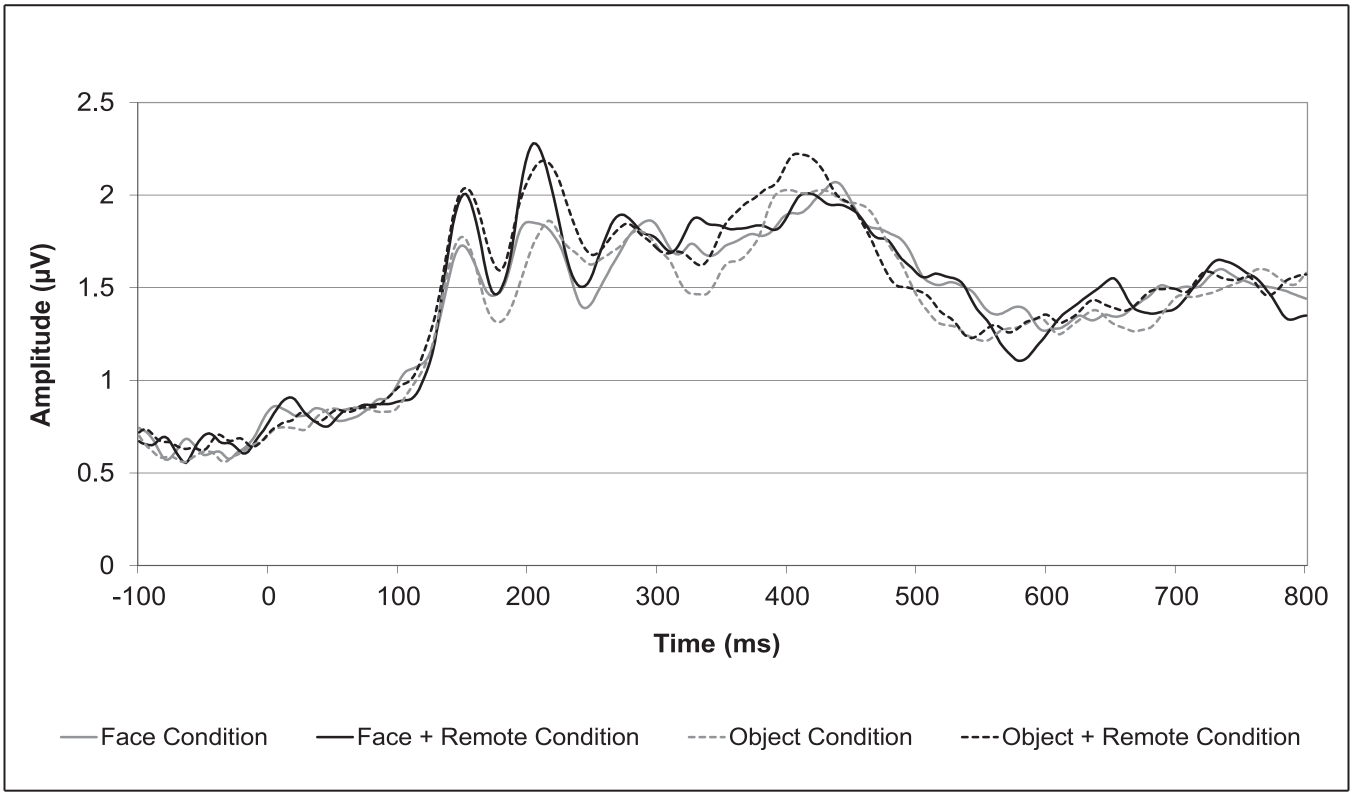

Figure 2. Global field power (GFP) results from all 20 participants for all conditions in Experiment 1.

The results suggested that there was a significant effect of remote staring detection on global measures of brain activity. However, this effect was only present when the remote staring stimulus was administered in conjunction with the face perception stimulus, where the remote staring stimulus apparently significantly reduced peak GFP associated with face processing. There was no significant difference between the global brain activity of the remote staring stimulus on its own compared to the control stimulus.

Experiment 2

The results from the first study were curious as they suggested that remote staring detection does not cause any apparent distinct brain activity in its own right but rather appears to be dependent upon other processing that is occurring concurrently. However, it was unclear from the findings of the first study if this finding represented a unique relationship between face/gaze processing and remote staring detection, or if remote staring detection acted upon any concurrent process.

In order to examine this, the second experiment exploited the debate concerning *cortical domain specificity* associated with face processing compared to the processing of other objects. Since faces are processed differently than most objects, some researchers have suggested it is due to the specific social importance of faces to humans (e.g., Bentin & Carmel, 2002; Carmel & Bentin, 2002; Itier et al., 2006; Kanwisher, 2000). Therefore, by examining how remote staring detection may impact the processing of both faces and objects, it was possible to discern if the process involved in remote staring detection was a face-specific interaction or a more general interaction involving a wider range of concurrent stimulus processing.

Method

Participants. Twenty participants (7 males and 13 females) took part in this experiment with an average age of 25.3 years (range: 20–38 years). The participants were paid for taking part and were all staff or students at the University of Edinburgh. All but one of the participants were right-handed.

Materials, equipment, and procedure. Apart from relatively minor equipment upgrades, all of the equipment was identical to that used in Experiment 1. The relevant EEG and skin conductance electrodes were attached in the same manner. The same personality questionnaires were administered.

The overall procedure was the same as that used in Experiment 1, except that the conditions that the participant was exposed to were different. Each condition was repeated 60 times in a pseudo-randomised and counterbalanced order. Apart from the rest periods, the participants were presented with either a static picture of the starer on the screen in front of them or by a picture of a chair from the International Affective Picture Set (IAPS) database. A chair was used in order to reflect the maximum degree of processing differences between faces and objects (Itier & Taylor, 2004). In addition, during these times the staree may also have been stared at remotely by the starer via the computer-controlled CCTV system, depending upon the condition. These four conditions are summarised in Table 2.

Table 2
2 × 2 Table of the Independent Variable Manipulation for Experiment 2

		Staree's screen	
		Face displayed	Object displayed
Action of starer	Remote Stare	Face + Remote Stare condition	Object + Remote Stare condition
	No Remote Stare	Face condition	Object condition

The participants' EEG was recorded at 500 Hz (32-bit) sample rate, with a high-pass filter at 0.5 Hz and no low-pass filter (system maximum range was 262.5 Hz) and no notch filter. Each condition lasted for 5,000 ms followed by a 5,000-ms rest period.

Results and Discussion

Again, the EEG data were preprocessed to remove muscle and ocular artifacts, epoched, and averaged into event-related potential (ERP) data for each condition. These epochs were slightly longer than in Experiment 1 in order to encapsulate any potentially later effects (-100 ms to 800 ms). Global field power was the main measure used, and two temporal peaks were identified as being of interest: 150 ms and 208 ms. The GFP data for all participants and for all four conditions can be seen in Figure 3. Shapiro-Wilk analyses revealed that the data did not violate any assumptions of normality and so parametric analyses were conducted.

Separate 2 × 2 (image type × remote staring manipulation) repeated measures ANOVAs were conducted on the two peaks of interest. The initial 150-ms component demonstrated a significant effect for remote staring processing, $F(1,19) = 6.95$, $p = .02$, but no significant difference between face and object processing, $F(1,19) = .18$, $p = .68$, and no significant interaction effect, $F(1,19) = .002$, $p = .97$. The second (208-ms) component mirrors these findings, with a significant effect for remote staring processing, $F(1,19) = 23.23$, $p < .001$, no significant difference between face and object processing, $F(1,19) = .45$, $p = .51$, and no significant interaction effect, $F(1,19) = .02$, $p = .90$. Additional analyses (See Baker, 2007, for more details) revealed that the differences in face and object processing were broadly localised to the right temporal lobe region (i.e., P_8/T_6) as expected (Eimer, 2000; Itier, & Taylor, 2004).

One potential issue with the ERP/GFP analyses is that they examine only a small part of the data; only the first 800 ms of a 5,000-ms epoch. As the phenomenon under investigation has not been examined in this way previously, it was possible that a "remote staring effect" may be noted over a longer duration. However, ERP/GFP analyses are not suited for this. In order to examine (a) the relationship with alpha activity, and (b) a longer time duration, a post hoc analysis of global alpha activity (using fast-Fourier transforms) for all four conditions over the 5-s stimulus period (divided into the averaged activity for each second) was examined. A 4 × 5 (conditions × time [seconds]) repeated measures ANOVA with Greenhouse-Giesser correction revealed no significant differences between the alpha activity of the different conditions, $F(1.077, 20.456) = 0.82$, $p = .38$, and no significant effect of time, $F(1.158, 21.999) = 1.73$, $p = .20$, and no significant interactions, $F(1.069, 20.304) = 0.96$, $p = .34$. This indicated that for the most dominant frequency band in the evoked domain there was no remote staring detection effect over a longer duration; it was only evident in the peak elements of the GFP (see Baker, 2007 for additional post hoc analyses).

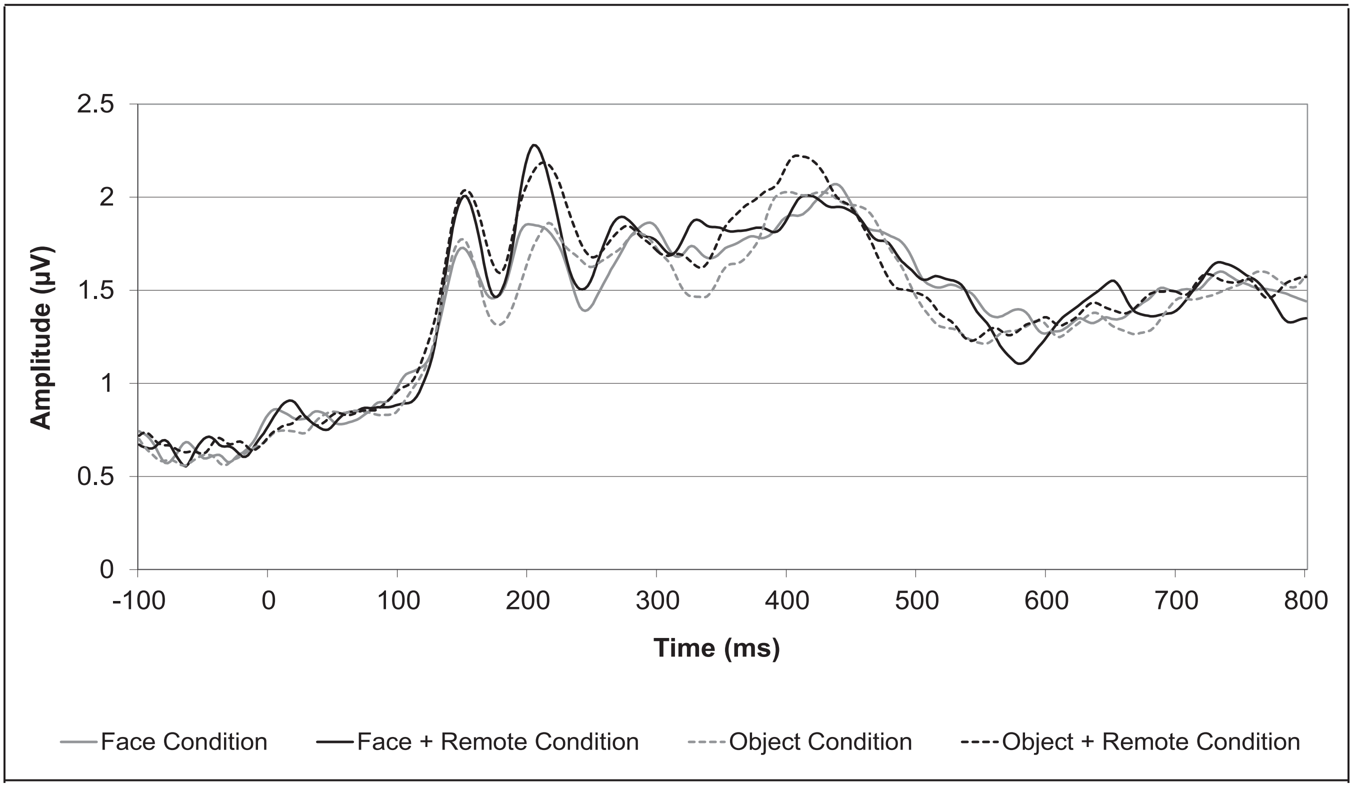

Figure 3. Global field power (GFP) results from all 20 participants for all conditions in Experiment 2.

Finally, the skin conductance data for each of the 60 administrations of each stimulus for each person were averaged and compared for each condition. Analysis indicated no significant differences in skin conductance between the Face condition and Face and Remote Stare condition ($z = -0.58$, $p = .56$) or between the Object condition and the Object and Remote Stare condition ($z = -1.85$, $p = .07$). However, skin conductance responses to stimuli can rapidly habituate in as little as 2 to 8 stimulus administrations (Dawson et al., 1990). In order to investigate this, two post hoc analyses examined the averaged skin conductance responses to the first 16 (similar to previous skin conductance studies into remote staring detection: e.g., Schlitz & LaBerge, 1997), then first 8 administrations of each stimulus, similar to above. However, none of these comparisons approached significance (see Baker, 2007, for more details).

The results suggest that remote staring detection has an effect upon the global processing of both faces and objects—increasing the GFP in both cases—and does not appear to be a face-specific effect. In conjunction with the results of the first study, it suggests that remote staring detection apparently does not have an electrocortical processing in its own right, but rather acts upon any concurrent processing.

The lack of any processing of remote staring detection on its own and the fact that the impact of remote staring detection on faces reversed between the two studies (in the first study it *reduced* the peak GFP, in the second study it *increased* the peak GFP) was concerning. This reversal might be due to the subtle methodological differences between the two studies. In the first experiment, the randomisation sequence resulted in participants effectively being presented with an image at fairly random intervals, whereas in the second experiment the image presentation was very regular. This may have altered alpha activity generation between the experiments and produced different effects (Shaw, 2003). Alternatively, it may have revealed a potential artifact that caused this significant "remote staring effect." The third experiment was designed to replicate the previous effects and test for the possibility of an artifact.

Experiment 3

The third experiment replicated the conventional face processing condition and the face and remote stare condition used in the two previous experiments in order to examine the reversal of the effects between experiments one and two in more detail. In addition to this, the third experiment also examined the possibility that the effect of the remote staring detection was an artifact. This was done by simply removing the remote staring stimulus altogether for half of the experiment, but otherwise conducting the experiment as before. The rationale behind this was simple: remove the remote stare, and—if it was a genuine effect—this should remove the effect itself.

Method

Participants. Twenty participants (10 males and 10 females) took part in this experiment with an average age of 27.8 years (range: 18–50 years). The participants were paid 5 pounds for taking part and were all staff or students at the University of Edinburgh. All but two of the participants were right-handed.

Materials, equipment, and procedure. All of the EEG and skin conductance equipment, the other experimental hardware, and the questionnaires were the same as for the last experiment. The overall procedure was the same as for the last two experiments, apart from some minor alterations due to the type of conditions that the participants were exposed to in this experiment. In order to examine the effect of the removal of the starer on the remote staring effect, a pseudorandomised and counterbalanced spilt-half design was used. For 50% of the sessions, the starer was physically present for the first half of the session and absent for the second half of the session. For the other 50% of the sessions, this was reversed. The order in which this occurred was randomised (without replacement) by an independent party (the second author), and the experimenter (the first author) was not aware of the order of any session prior to the session beginning. Within each half of the session, the order of the Face or the Face + Remote Stare conditions was also pseudorandomised and counterbalanced. This resulted in four conditions that are summarised in Table 3.

Table 3
2 × 2 Table of the Independent Variable Manipulation for Experiment 3

		Staree's screen (and remote stare manipulation)	
		Face Only displayed	Face + Remote Stare
Action of starer	Starer Present	Face (Starer Present) condition	Face + Remote Stare (Starer Present) condition
	Starer Absent	Face (Starer Absent) condition	Face + Remote Stare (Starer Absent) condition

The participants' EEG was recorded using the same parameters as the second experiment.

Results and Discussion

As in the two previous experiments, the EEG data were preprocessed to remove muscle and ocular artifacts, then epoched and averaged into event-related potential (ERP) data for each condition (epochs of

-100-ms to 800-ms duration). Once again, global field power was the main measure used, and two temporal peaks were identified as being of interest: 120 ms and 174 ms. The GFP data for all participants and for all four conditions can be seen in Figure 4. Shapiro-Wilk analyses revealed that the data did not violate any assumptions of normality and so parametric analyses were conducted.

Separate 2 × 2 (presence of starer × remote staring manipulation) repeated measures ANOVAs were conducted on the two peaks of interest. The initial 120-ms component demonstrated a significant effect for both remote staring processing, $F(1,19) = 10.18$, $p = .005$, and for the presence of a starer, $F(1,19) = 12.01$, $p = .003$, but no significant interaction effects, $F(1,19) = 0.01$, $p = .87$. The second (174 ms) also suggested a significant effect for remote staring processing, $F(1,19) = 54.89$, $p < .001$, but no significant effect for the presence of a starer, $F(1,19) = .03$, $p = .87$, and no significant interaction effects, $F(1,19) = 1.72$, $p = .21$.

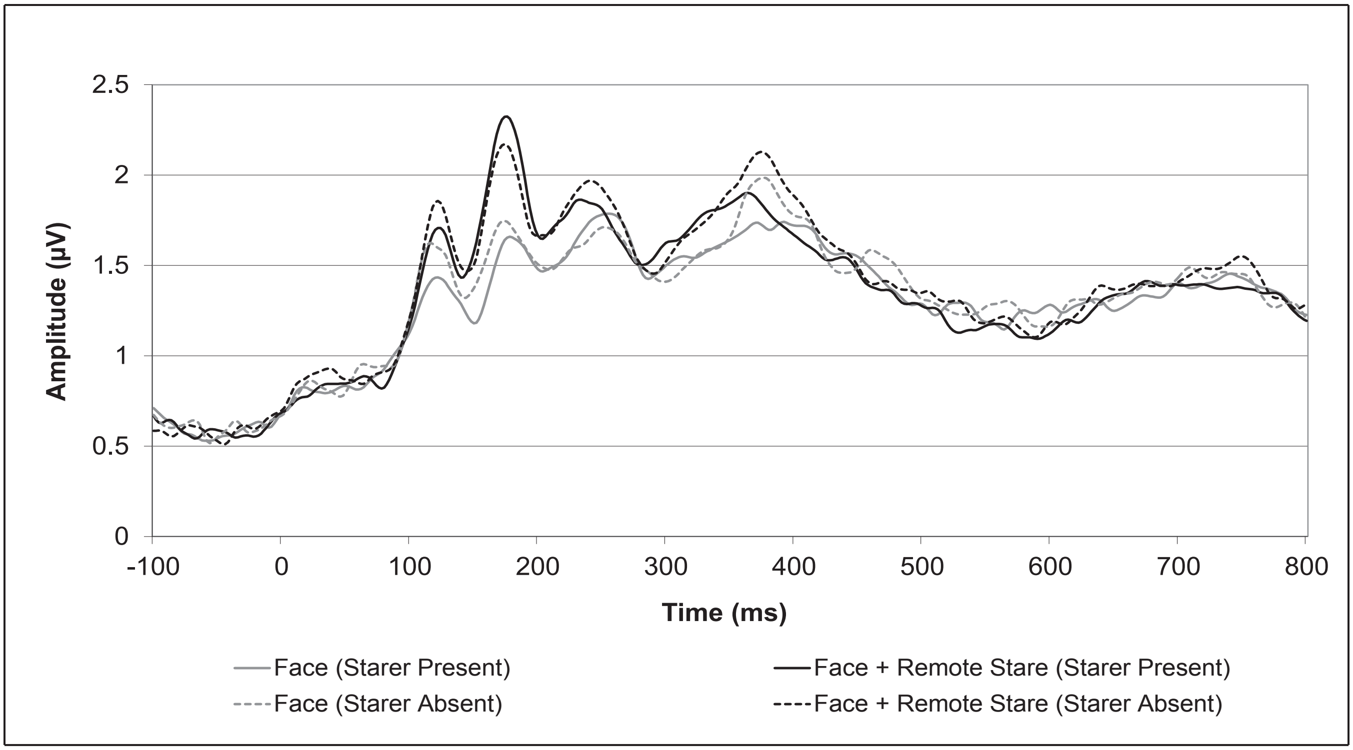

Figure 4. Global field power (GFP) results from all 20 participants for all conditions in Experiment 3.

However, these results can only be understood to their fullest extent by examining them with paired-sample *t* tests. Two comparisons for each peak of interest were conducted. The first compared the Face (Starer Present) and the Face + Remote Stare (Starer Present) conditions. As the starer was physically present during each of these conditions, this test is equivalent to the Face and the Face + Remote Stare comparisons that were conducted in the first two experiments, and therefore ostensibly tests for the impact of remote staring detection on the global processing of faces. The second comparison examined the differences between the Face + Remote Stare (Starer Present) and the Face + Remote Stare (Starer Absent) conditions. The test between these two conditions more clearly examines the impact of physically removing the remote starer from the experiment than the analyses above. Significant results here would suggest the remote starer is important to this effect, nonsignificance would support the existence of a potential artifact.

The initial 120-ms peak demonstrated a significant difference between the Face (Starer Present) and the Face + Remote Stare (Starer Present) conditions, $t(19) = -2.16$, $p = .04$, but it did not suggest a significant difference between the Face + Remote Stare (Starer Present) and the Face + Remote Stare (Starer Absent) conditions, $t(19) = -1.21$, $p = .24$. The findings for the second peak (174 ms) mirror these findings, with a significant difference between the Face (Starer Present) and the Face + Remote Stare

(Starer Present) conditions, $t(19) = -5.56$, $p = .001$, and no significant difference between the Face + Remote Stare (Starer Present) and the Face + Remote Stare (Starer Absent) conditions, $t(19) = 0.89$, $p = .39$.

Finally, a 2 × 2 ANOVA (remote staring × presence of starer) analysis of the averaged skin conductance responses for the 60 administrations of the different conditions suggested that there were no significant effects for remote staring detection, $F(1,19) = 1.3$, $p = .26$, or for the effect of the presence or absence of a starer, $F(1,19) = 0.03$, $p = .86$, or any significant interaction between these two factors, $F(1,19) = 0.004$, $p = .95$.

These results suggested that the "remote staring effect" was potentially caused by some form of experimental artifact. As the experiment was computer-controlled and the conditions were the same in all conditions—with the exception of whether the camera feed to the starer's monitor was masked or not—it suggested that there was some alteration of the images that the staree was looking at (and therefore the electrocortical processing associated with them). As the image that the staree was presented with was the same computer file for all conditions, the image presentation for the different conditions needed to be examined in case the physical properties of the image were somehow changing between conditions and the participants were reacting to this change.

Experiment 4

In order to examine the physical properties of the image, a sensitive photodiode was used in order to examine the luminance levels of the image presentation in the different conditions. As the Starer Present and Starer Absent conditions from Experiment 3 were equivalent from an equipment perspective, only the Face (Starer Absent) and Face + Remote Stare (Starer Absent) conditions were used for the comparison. This was important because in the Face conditions the camera feed was masked, and in the Face + Remote Stare it obviously was not.

Method

Materials, equipment, and procedure. The experimental setup was as similar as possible to the procedure of the third experiment. The only main difference was that there was a photodiode reacting to the images on the staree's screen rather than a participant. The photodiode (BPW21: OSRAM Opto Semiconductors) was positioned 150 mm away from the center of the staree's screen. The photodiode had a relative spectral sensitivity that is close to that of the human eye. It was connected to a Gould Advanced Digital Storage Oscilloscope OS4000 (Advance Electronics Limited; Wrexham, UK) in order to record the differences in output in response to the different stimuli. The stimuli tested were the Face (Starer Absent) and Face + Remote Stare (Starer Absent) conditions from Experiment 3. These two conditions had the same program code except that in the former the code instructed the camera-feed to the starer's monitor to be masked, and in the latter condition it was unmasked. This code was the same regardless of whether or not the starer was physically present (as per the experimental manipulation of the third experiment). The face image displayed on the staree's screen was the identical file for both conditions (and indeed, for all of the experiments).

Results and Discussion

The first test was to examine the different stimuli for any differences in the overall output of the photodiode (and therefore the luminance) for the full 5,000 ms of exposure. There was no difference, with both conditions providing a mean output of 266 mV.

The second test was a more specific analysis examining the luminance profiles at the onset of the image display. The test revealed a small difference between the two conditions, with the image in the Face + Remote Stare (Starer Absent) condition taking slightly longer to step up incrementally to full luminance than the image in the Face (Starer Present) condition. This difference lasted for approximately 20 ms and corresponded with a difference of approximately 2.5 cd/m^2 (candela per meter squared; approximately 0.2 lux or 0.7 foot-lambert). As revealed by the first test above, this difference did not continue beyond the first 20 ms as the screen was ramping up to full luminance.

These results suggest that, although there was no difference between the luminance levels of the images on the staree's screen once the image reached its full luminance level, there was a small difference between the images when they were being initially presented on the screen. This may have, in turn, had an impact upon the corresponding electrocortical processing of that image or provided the participants with some information concerning the particular condition they were experiencing at any one time.

Overall Discussion

The body of research presented here initially began as an exploration of the potential electrocortical activity associated with the processing of remote staring detection. However, as it progressed it became an investigation of a possible artifact that has the potential to impact upon a wide range of cognitive neuroscience and psychophysics studies, particularly those that employ event-related measures of electrical brain activity. The most parsimonious explanation for the effects reported in this paper is that they represent the ability of the human brain to process very small and rapid luminance differences between visual stimuli. The mere possibility of the luminance effect providing condition-relevant information that could be processed by the participant potentially undermines any claims of a remote staring detection effect. It should be noted that this potential artifact is related specifically to the methods utilised in this paper, specifically exposing the staree to conventional stimuli concurrently to a remote stare. This would not apply to previous remote staring detection studies, as they did not use this methodology and they also employed the comparatively slow measure of skin conductance. However, whilst it is true that the findings of the third experiment and the photodiode study do suggest a possible luminance difference between the two conditions, the differences involved are so small, namely 2.5 cd/m^2 for 20 ms, that they represent a potential anomaly in their own right. Previous research has not found significant changes in electrocortical processing for such small luminance differences.

There is relatively little research in the psychophysics literature exploring the luminance detection threshold in isolation. This is at least partially because it is a difficult phenomenon to test and is reliant upon a multitude of other environmental and psychological factors. The absolute threshold of human luminance difference detection is approximately 0.00001 cd/m^2 after 40 min in absolute darkness (Kolb, Fernández, & Nelson, 2012), but as participants in the experiments reported here were not in absolute darkness it is an inaccurate benchmark. It has been noted that luminance differences can be perceived as low as 0.75 cd/m^2 (Peli, Yang, Goldstein, & Reevesi, 1991), or even as low as 0.005 cd/m^2 (Plainis & Murray, 2000), but the authors in both studies note that due to the perception of luminance differences being logarithmic (i.e., the Weber-Fechner law) and due to the artificial nature of these psychophysics studies, the reliability of these values is to be questioned. One of the main issues is that the majority of psychophysics studies use threshold detection, which involves conscious awareness. However, electrocortical processing studies such as those reported here do not necessarily involve conscious processing, and there are few studies that examine subliminal processing of luminance shifts. In fact, a study that used ERPs to examine the processing of luminance differences failed to find significant effects when comparing the processing of bright (15.5 foot-lambert) versus dim (0.4 foot-lambert) stimuli (Johannes, Münte, Heinze, & Mangun, 1995). As Johannes et al. failed to find significant differences in the processing of simple stimuli with over a 15 foot-lambert difference between them, it is problematic that stimuli with approximately only a 0.7 foot-lambert difference between them for only 20 ms at stimulus onset found in this study could have such a significant impact upon global electrocortical processing. Additionally, a pure luminance processing effect is an elementary feature of a stimulus and should theoretically have an effect on only relatively early components and not on faces that are processed comparatively late (see Allison et al., 1999).

Therefore the findings presented here offer an interesting problem to parapsychologists, psychophysicists, and cognitive neuroscientists. The problem for parapsychology is that ideally these experiments need to be repeated—controlling for any potential luminance differences—in case these results do not represent an artifact and remote staring detection *does* have an impact upon global electrocortical processing of other stimuli. For psychophysics, these results may demonstrate the complexity of basic luminance differences and the possibility of examining these using "below-threshold" detection methods. Finally, for cognitive neuroscience, these results open the possibility that the often-published effects noted in basic face and object processing may be confounded by very small differences in the luminance levels of different stimuli.

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Abstracts in Other Languages

French

UNE ANOMALIE D'ANOMALIE : ETUDE DE L'ELECTROPHYSIOLOGIE
CORTICALE DE LA DETECTION DU REGARD À DISTANCE

RESUME : S'il y a des éléments de preuve d'un effet global de la détection du regard à distance, alors il devrait théoriquement y avoir d'autres preuves d'un processus électrophysiologique de traitement de cette information dans le cerveau. Une série de 3 expérimentations examinant les corrélats électrocorticaux potentiels de la détection du regard à distance est présentée, suivie par une 4^{e} expérience pour examiner un artefact potentiel. La 1ère expérience fournit une exploration initiale de cet effet, montrant d'abord que « la détection du regard à distance » ne correspond pas de façon évidente à un processus repérable dans le temps mais agit plutôt sur les processus se produisant au même moment. La 2^{e} expérience fournit des preuves que cet effet n'est pas spécifiquement en lien avec le processus de reconnaissance de visage mais peut avoir un impact sur d'autres processus. La 3^{e} expérience met en lumière un potentiel artefact qui pourrait expliquer l'effet de « regard à distance », qui est vérifié dans l'expérimentation finale. Les résultats globaux sont discutés à la lumière d'un subtil et intéressant effet de luminance psychophysique qui pourrait potentiellement avoir un impact sur une large variété d'expérimentations qui emploient des mesures relatives à des événements de processus électrocorticaux.

Spanish

ANOMALÍA DE UNA ANOMALÍA: INVESTIGANDO LA ELECTROFISIOLOGÍA
CORTICAL DE LA DETECCIÓN DE SER OBSERVADO A DISTANCIA

RESUMEN: Si hay evidencia de un efecto general de poder detectar si alguien nos observa a distancia, teóricamente también debería haber evidencia del procesamiento electrofisiológico de dicha información en el cerebro. Presentamos una serie de 3 experimentos que examinaron posibles correlatos electrocorticales de la detección de ser observado a distancia (DOD), seguidos por un cuarto experimento para examinar un posible artefacto. El primer experimento fue una exploración inicial de este efecto y encontró principalmente que DOD no está asociado a un procesamiento sincronizado evidente, sino que actúa sobre otros procesos que ocurren al mismo tiempo. El segundo experimento proporcionó evidencia de que este efecto no está relacionado específicamente con el procesamiento de rostros, pero puede tener un impacto en otras formas de procesamiento. El tercer experimento mostró evidencia de un posible artefacto que podría explicar el efecto DOD, verificado en el experimento final. Discuto los resultados globales a la luz de un interesante y sutil efecto psicofísico de luminancia que podría tener un impacto en una amplia variedad de experimentos que emplean medidas relacionadas con los eventos de procesamiento electrocortical.

German

EINE ANOMALIE EINER ANOMALIE: ZUR UNTERSUCHUNG DER KORTIKALEN
ELEKTROPHYSIOLOGIE BEIM NACHWEIS DES BEOBACHTETWERDENS (REMOTE STARING)

ZUSAMMENFASSUNG: Wenn sich ein Hinweis auf einen Gesamteffekt bei der Nachprüfung des Remote Staring finden lässt, dann sollte es auch einen Hinweis auf die elektrophysiologische Informationsverarbeitung im Gehirn geben. Eine Serie von drei Experimenten zur Überprüfung möglicher elektrophysiologischer Korrelate beim Nachweis des Remote Viewing wird vorgestellt, gefolgt von einem vierten zur Überprüfung eines möglichen Artefakts. Das erste Experiment stellte eine erste Überprüfung dieses Effekts dar, bei der sich hauptsächlich zeigte, dass der "remote staring-Nachweis" offensichtlich keinen mit sich selbst verknüpften, zeitlich gekoppelten

Verarbeitungsprozess darstellt, sondern sich vielmehr auf andere Prozesse auswirkt, die gleichzeitig ablaufen. Das zweite Experiment ergab Hinweise darauf, dass sich dieser Effekt nicht spezifisch auf die Gesichterverarbeitung auswirkt, sondern auch andere Verarbeitungsformen beeinflussen kann. Das dritte Experiment fand einen Hinweis auf ein mögliches Artefakt, das den "remote staring-Effekt" erklären konnte, was im letzten Experiment bestätigt wurde. Die Gesamtergebnisse werden im Licht eines interessanten und subtilen psychophysikalischen Luminanzeffektes diskutiert, der möglicherweise für eine größere Anzahl von Experimenten von Bedeutung sein könnte, die ereignisbezogene Messungen der elektrokortikalen Verarbeitung verwenden.