Entangled in the Womb? A Pilot Study on the Possible Physiological Connectedness Between Identical Twins with Different Embryonic Backgrounds

Christian Gaden Jensen, MSc.Psych,[1,#] and Adrian Parker, PhD[2]

Objective: Studies of synchronous physiological responses to startle stimuli between monozygotic twins and other paired subjects have suffered from methodological flaws such as post-hoc specifications of "connectedness" criteria. The mechanisms that affect any such connectedness are unknown. With the logistic and financial support of a television company, we conducted a methodological pilot study with predefined objective hit criteria in which we used four pairs of twins with frequent experiences of connectedness.

Methods: While one twin was exposed during a 12-minute period to five randomly presented mild shock or surprise stimuli, the electrodermal activity, blood pressure, breathing, and bodily movements were simultaneously recorded in the second twin. An authorized polygraph expert who was blind to the stimulus exposure times examined the data for deviations from normal physiological patterns during relaxation and delivered precisely timed estimates of such deviations. "Hits" (indications of connectedness) were objectively defined as an estimate lying within a 15-second "hit window."

Results: Overall results were nonsignificant, $P > .7$. However, for one pair of twins, the polygraph expert identified 10 deviating patterns, of which three were hits were $P < .03$. This data set was sent to a second, independent expert, who blindly identified the same three hits, pointing to only eight patterns, $P < .0003$.

Discussion: We argue that the applied methodology for "hit" identification is objective and recommendable. Speculatively, because the "successful" pair of twins was reported to be monochorionic-monoamnionic (as embryos, they shared the same placenta and the same bag of water), embryonic history might be further investigated as a potential factor for connectedness between monozygotic twins.

Key words: Entanglement, monozygotic twins, parapsychology, anomalous experiences

(Explore 2012; 8:339-347.

INTRODUCTION

Research on exceptional experiences of connectedness in twins, such as telepathic-like experiences, dates back to the work of Francis Galton. Since then, many claims have been made that some twins who are physically remote from each other show a sensitivity to each others' thoughts, emotions or actions, pains, and sensations.[1-4] The authors of major survey in the United Kingdom found that 39% of twins believed they might have "the ability to know what was happening to their partner," and a further 15% were convinced of it. Identical twins were twice as likely as nonidentical twins to report these experiences.[5] These findings were given support by a Swedish survey in which 60% of twins reported telepathy-type experiences. Furthermore, frequencies were significantly greater among identical twins and significantly related to the degree of attachment between the pairs of twins.[6] About one-tenth of identical twins report having these experiences regularly (11%:[6]; 10%[7]). Experiences of anomalous connectedness are also common in the general population. For example, in three surveys[8-10] between 25% and 31% of North Americans reported telepathy experiences or beliefs in such experiences. Experiences of telepathy were also reported by 25% of the population surveyed in the United Kingdom,[11] 16% in Canada[12], and 18% in Sweden.[13] In Iceland, 27% reported so-called extrasensory experiences, including telepathy.[14] Cultural endorsements of belief in the possibility of such experiences affect both the prevalence and content of such experiences. Thus, in Brazil, where spiritualist beliefs are widespread, more than 90% of university students reported anomalous experiences such as telepathy or clairvoyance.[15] In China and Japan,[16,17] as well as Israel,[18] high prevalences have also been reported. However, demographic factors such as age, gender, education, race, region of the country,[9] or social marginality,[19] or political, economical, and religious characteristics[20] do not readily appear to explain the available data. The nature of any predisposition to these experiences is not known in much detail,[20] but a review has been published.[21]

Because significantly greater frequencies of these types of experiences have consistently been found in monozygotic twins,[5-7] and because the degree of attachment was related to the frequency of such experiences,[6] genetic kinship or social bonding may be one factor creating a predisposition for such experiences. This hypothesis is supported by the findings, based on phenomenological data from case collections and surveys in several countries, that in the vast majority of cases the content of such experiences

1 Neurobiology Research Unit and Cimbi, Rigshospitalet, University of Copenhagen, Copenhagen, Denmark
2 Department of Psychology, University of Gothenburg, Gothenburg, Denmark

Corresponding Author. Address:
Neurobiology Research Unit, Rigshospitalet, N9201, 9 Blegdamsvej, Copenhagen, DK-2100, Denmark, www.nru.dk.
e-mail: cgjensen@nru.dk

ISSN 1550-8307/$36.00

http://dx.doi.org/10.1016/j.explore.2012.08.001

relates to a person emotionally close to the experient.[22-29] Although it is possible that this is due to the greater opportunity for closer individuals to confirm the content of such experiences,[19] this was not supported by a statistical analysis.[30]

Experiences of anomalous connectedness to distant events typically take place during a relaxed state physically as well as mentally, and while being alone (reviews: Irwin and Watt,[21] Schouten[27,28]).

There have been only a few experimental investigations of the validity of these experiences in twins. In literature reviews,[7,31] authors have concluded that virtually all of these studies have suffered from major methodological flaws. Among the findings, in only one study,[32] in which three pairs of twins were used, did authors find evidence for "thought concordance" (similar thought patterns and associations) rather than telepathy. Two studies focused on joint physiological recording of identical twins. One was an electroencephalography (EEG) study[33] in which the authors examined two pairs of twins and found increased alpha rhythm in one twin while inducing it in the other. However, the analyses were not blinded, and the authors emphasized how the study was only preliminary and encouraged more controlled and extensive research. Another physiological study examined changes in blood volume occurring in the twins when one of them were exposed to affective words, but the results did not allow for any firm conclusions.[34]

Television "demonstrations" of connectedness during mild shocks by author Guy Lyon Playfair have drawn public attention to the area. Yet, these uncontrolled demonstrations did not eliminate coincidental effects due to expectancy build-up, and even more importantly, the analyses of the electrodermal (EDR) recordings were carried out so the assessor was not blinded as to when the shock occurred, but rather based on posthoc, subjective inspections of the visual charts. In addition, apparently no attempts were made to get the results confirmed by independent judges. To our knowledge, this type of controlled physiological study has not been done.

There are several physiological studies of the potential connectedness between biologically related and unrelated participants, with the typical set-up of one person acting as the "sender," and the other person as the receiver. Event-related EEG has been used as the dependent measure of connectedness in studies using photic flashes as the stimulus to the "sender" (for a review, see Watt and Irwin[35]). In one of the most systematic series of studies, Grinberg-Zylberbaum, and colleagues[36,37] found that some pairs of participants who, after being introduced to each other, spent 20 minutes together in meditative silence, obtained significant correlations between their EEG patterns, whereas this was never the case for the participants who were not introduced to each other. The Grinberg-Zylberbaum[36,37] studies have been criticized for methodological flaws[38,39] and a follow-up study[40] could not replicate the effect.

In support of the possible significance of a personal relationship in the aforementioned findings, Kittenis, et al[41] found significant EEG changes in nonstimulated "receivers" of related pairs during photic stimulation of related participants, whereas no effect was found between unrelated pairs or pairs that were never introduced. This was replicated in a second study by Kittenis, but not in a third, and Kittenis[42] concluded that the overall findings did not support interpretations of connectedness. Positive findings were, however, reported in other, similar studies.[43,44] In summary, the EEG findings, as well as conceptually similar findings of functional magnetic resonance imaging,[45-47] are mixed,[35] but the evidence for anomalous connectedness has more often been reported for related pairs than for unrelated pairs.

Assuming that these experiences might have an objective validity, speculations have been made that they might be explained by quantum entanglement at a biological level.[48-50] The transition from possible biological quantum effects to those causal relationships occurring at the classical level has not been researched. In view of this, it is worth noting that identical twins originally were completely physically "entangled" in one cell (one string of DNA), and it can be speculated that even this form of entanglement might create a predisposition towards such experiences.

Genetic "identity" is, however, much more complex than having 100% identical DNA. First, monozygotic twins show nonidentical genetic developments since different genes are activated.[51] Second, the zygote may divide into two embryos at different time points from approximately 0-11 days after conception, thereby affecting the amount of time the two future individuals have shared the same cell bodies. Third, there are physiological variations in the perinatal development. Most identical twins (60%-70%) are monochorionic (one placenta) and diamnionic (two amnionic bags).[52] A smaller proportion (18%-36%) are dichorionic as well as diamnionic.[52] Finally, very few (1%-2%) are both monochorionic and monoamnionic (mo-mo; meaning that they share the same placenta and the same amnionic bag of water).[52]

In the present study, four pairs of identical twins with frequent exceptional experiences of connectedness participated, and one of these pairs was designated a mo-mo twin-pair: The common placenta was documented in the birth journal, and the common amnionic bag was observed by the medical staff. Family witnesses recalled in detail how the girls' navel strings were coiled around the both of them at birth (so they had to be physically "disentangled"), which would be very unlikely to have happened even during the birth, with two separated embryonic bags.

The study to be now reported was carried out with the financial and logistic support of a Danish Television production team. This was accepted because funding opportunities for a larger, more controlled, formal study were virtually nonexistent. Our hypothesis was based on the phenomenological reports of feelings of connectedness and the few scientific studies. We predicted that startle stimuli given at randomized points in time to one twin would enable an independent judge to identify physiological responses in the nonstimulated twin without knowing the stimulus times. The study was exploratory, so we allowed the hypothesis to be tested for each trial as well as for the combined results.

METHODS

The experiment was approved by the Institute of Psychology, Copenhagen University, and the protocol was uploaded to a secure web-mail before the experiment, enabling future documentation of the predefined hit criteria.

Participants

The participants were recruited via a television advertisement in which identical twins with experiences of unusual connectedness were invited to participate in a documentary on consciousness research for the main Danish television (TV) station (DR). Thirty-seven pairs of twins volunteered and were then screened and interviewed by the TV station. The final selection was determined by their degree and amount of experiences of telepathy, synchronicity, perceived closeness, and on their embryological background. Selection criteria gave priority to the inclusion of twins with a strong emotional bond, several experiences of anomalous connections (eg, experiences of telepathy or physiological connectedness, such as feeling each other's pain) and synchronicity (eg, buying the same things, saying the same things, or going the same places at the same time), and male and female pairs. It was prioritized to include mo-mo pairs, when this information was available. Four pairs were included but at the actual test sessions, the polygraph expert judged the data from one pair as invalid because of technical error, so this data set was not included. The remaining three pairs of twins were 9, 18, and 21 years of age.

The mo-mo-pair was selected before our analyses for the documentary, since they clearly reported the most striking experiences of synchronicity. For example, one of these twins suffered from kidney stones as a child, and during painful periods, the other twin would also report physical pains and often know that her twin was in pain. The most extreme example was seen at 11 years, when the twin with kidney stones was anesthetized generally and operated at a hospital. At this exact time, the other twin collapsed in a fun park in another city with stomach pains so severe that the grandparents (who took care of this twin during the operation) called the parents to inform them about the situation—to which the parents remarked that the operation had begun a few minutes ago. Naturally this could be explained by unconscious knowledge about the time of the operation in the unoperated child. Other stories from the participating twins included telepathy-like experiences of knowing the other twin's thoughts and emotions and physical experiences of each other's physical states.

The Polygraph Experts

The two polygraph experts (Terry Mullins and Guy Heseltine) were professional members of the British Polygraph Association and the American Polygraph Association. Both had completed advanced and recent professional courses in polygraph testing in both the United Kingdom and United States.

Applied Stimuli

The principle was to use both pleasant and unpleasant stimuli to elicit some of the basic emotions (such as surprise, fear, joy and disgust). For the 9-year-old children we used: (1) one foot placed suddenly in an ice bucket; (2) lemon juice tasting; (3) A Jack-in-the-box device; (4) popping a balloon behind the child's head; (5) tickling all over the body (performed by the mother).

For the adult pairs we used (1), (2), and (3) as above; as well as (6) the dropping of four porcelain plates suddenly behind the chair; and (7) a mild, electric shock given to the hand with a joke pen.

Procedure

The experiment took place in the Psychology Department of Copenhagen University, in a quiet, designated experimental area. The two rooms used were placed in two different sections of a building approximately 100 meters apart, both in the basement level. The rooms were separated by a long underground hallway, an open space, and another long underground hallway. The two hallways included in total six closed doors of solid wood. Before the experiment, C.G.J. and others made very large noises in the stimulus room, including several people yelling and the smashing of four porcelain plates to the floor. We tested this thoroughly several times, and nothing at all was audible in the relaxation room by A.P. and others. One room was allocated for the stimulus presentation to the first twin (referred to as Twin 1) and the other for the polygraph recording of the second twin (Twin 2).

Twin 1 was placed in a comfortable armchair and asked to relax with eyes closed. Both twins were "talked into" a relaxed state through a short, guided relaxation. The polygraph recording began hereafter. Running atomic clocks on laptops in all rooms and the camera recordings of these enabled the timing of the recording period to be precisely synchronized.

For the recordings, Terry Mullins used a Lafayette LX4000 polygraph with Lafayette's authorized software (version 10.0) measuring heart rate, blood pressure, galvanic skin response (two recording channels) breathing rate (two channels), and movement responses (via a cushion with movement censors). Terry Mullins was present with Twin 2 throughout the whole session and no one entered the room.

A total recording lasted 15 minutes, but no exposures were given to Twin 1 during the first or last 90 seconds of the session to avoid confounding by disturbances near the beginning or the end of a session.

The stimulus exposure period was predefined as the middle 12 minutes. This period was divided into 48 potential exposure periods of 15 seconds, during which a stimulus could be presented. The five exposure periods and the stimulus order were determined by using a random integer generator (http://www.random.org) with the predefined criteria of having no more than two startle stimuli within one minute and a minimum of 30 seconds between stimuli. In practice, we discarded four randomizations in order to get eight appropriate exposure schedules that fulfilled these requirements.

The procedure for the application of the five stimuli was as follows: Before a session began, the stimulus materials were arranged in the predefined randomized order of the given session. The stimulus material was hidden from open view on a table placed out of sight behind two walls of upright tables built for this purpose inside the stimulus room. When Twin 1 was relaxed and the session began, the room was quiet. There was no one operating the camera filming, and C.G.J. was sitting behind the wall of tables with the stimulus material and stimulus schedule. When a stimulus time approached, C.G.J. walked as silently as possible out behind the wall, appearing behind the back of the twin, and delivered the stimulus.

In some instances, some small noises could not be avoided such as those incurred when carrying in a bucket of iced water, and handling the foot of the twin to drop it into the iced water.

When popping a balloon (children) or dropping five plates to the floor (adults), full surprise was more feasible.

The complete image of both twins, as well as the polygraph expert's computer screen displaying the online running physiological graphs, were professionally filmed, and all film shots also included the laptops displaying the online atomic clock. When C.G.J. appeared behind the wall and delivered the stimulus, this was also filmed, including a laptop next to the stimulated twin displaying the atomic clock. This set-up in all rooms enabled us to identify the exact stimulus times as they were carried out in practice, and also to examine physical reactions and the running physiological chart of Twin 2 at the same points in time.

After the first trial, the polygraph equipment was detached from Twin 2, the twins switched roles and rooms, and another session started. This did mean that the twin attached to the polygraph in the second session was not formally blind as to what might then be happening to Twin 2. However, the twins were not in visual or physical contact at any time during the experiment, and again, the exposure times were randomized, ruling out subconscious memories of exposure patterns.

The Evaluation from the Polygraph Experts

The first polygraph expert, Terry Mullins, was asked to evaluate the charts and define from 0-10 points in time with one-second precision (eg, 16:27:56) within the 15-minute session at which point (if any) he found the beginning of a physiological pattern which in his opinion could not be explained by normal variation. T. Mullins was not informed that the first and last 90 seconds of a session were in fact not part of the stimulus period, which was also evident from his estimates (see Results). We did not apply objective criteria to define such a pattern. Rather, the polygraph expert was asked to look at the total physiological output and evaluate if he at any point saw a pattern of physiological deviation in one or several parameters that he would not attribute to normal variation for a person relaxing calmly in a chair. He was also asked to rank his estimates from 1-10, where 1 indicated the most unexpected pattern.

For reasons that will become apparent in the results section, the dataset from one twin was sent for a second, independent evaluation. The second polygraph expert, Guy Heseltine, was given the same instructions as Terry Mullins but his very specific instructions only asked for 0-8 estimates to increase reliability, and he only received very few details about the study. Perhaps for this reason, he initially mistook the task as being a routine task about lie detection in a single subject. This caused him to rule out any responses, which included physical movement, because this is the usual practice in lie detection. Terry Mullins, who inevitably knew more about the purpose of the study (although he did not know about the actual testing procedure), did not use this method because muscular contractions in Twin 2 were considered potential indicators of a startle response. Thus, we asked Guy Heseltine to do another analysis. We told him this time, that in reality the purpose of this study was to examine startled reactions to bursts of noise coming from a loudspeaker in the room with this single subject. Thus, he was told to look for physiological patterns in the data that could be an indication of a startle stimulus actually *given* to the *nonstimulated twin*. To the best of our knowledge, he was completely unaware of the actual purpose of the study. Naturally, the actual exposure times were not released to any of the polygraph experts at any time.

Data Analyses

Four pairs of twins were tested, but the data for one pair was excluded by Terry Mullins as invalid already at the experimental day, before any analyses were carried out. In addition, the professional TV camera documenting the time of the small shocks given in the stimulus room suddenly malfunctioned during a session, for which reason we could not document three of the exact stimulus times. Thus, only five sets of polygraph data could be analyzed. We predefined a hit as a point in time from −5 to +10 seconds from the second when a startle stimulus was given to the stimulated twin. This, hit window began at −5 seconds because the stimulated twin in practice most often knew about the small shock a few seconds before it was given. For example, we warned the stimulated twins about the small electric shock in advance of asking them to press the pen, and it was impossible to hide completely, eg, the sound of carrying the ice bucket to the chair and placing it under the feet. Likewise, the jack-in-the-box had to be presented several seconds before it actually opened. This procedure may have caused nervousness and thus the beginning of a physiological stress response before the actual startle stimulus. Similarly, if any synchronous connectedness was present, Twin 2 might also show a response in advance of the second of the actual pressing of the pen etc.

A session of 15 minutes contains 900 seconds, whereas the five stimulus periods each with a hit window of 15 seconds total 75 seconds. Thus, the chance of a random hit is 75/900 or 5/60 (8.33%) for the first estimate. However, each estimate will affect the probability for a randomly obtained hit hereafter (after an initial miss, making a hit will have a probability 5/59 if the estimate is in another 15-second section). The following formulas for a hypergeometric distribution take this into account[53,54] providing the probability (p) for given number of hits with a known sample size, a known number of possible hits, and a specified number of drawings from the sample. In accordance, this formula was used to obtain eg, the *P* value for 3 hits with 10 guesses, when the total sample size was 60 (periods of 15 seconds), and the number of potential hits was 5 (stimulus periods). The rankings were only considered on a descriptive basis due to the small sample size.

Formula for calculation of hit-probability. The formula for this hypergeometric test provides the probability (*p*) for given number of hits with a known sample size, a known number of possible hits, and a specified number of drawings from the sample (Feller, 1968; Wesstein, 2011).

$$P(x) = \frac{\mathrm{K(m,x)} * \mathrm{K(N-m,n-x)}}{\mathrm{K(N,n)}}$$

where

$$K(a,b) = \frac{\mathrm{a!}}{b!\,(a-b)!}$$

P = probability of a hit; x = number of hits; K = binomial coefficient; M = number of possible hits i.e. the number of stimulus exposure periods

(= 5 here); N = total number of periods of 15 seconds; n = the number of periods given by the polygraph expert.

RESULTS

Terry Mullins provided 10 identifications of unexpected physiological patterns for each of the five sessions. These 50 identifications contained five hits. Using the aforementioned formulas, we arrived at a P of $> .7$, which is clearly nonsignificant. The protocol also allowed for an analysis of the results of individual sessions. This revealed that three of the five hits were obtained within a single session. Applying the aforementioned formula, three hits with 10 "guesses," 60 periods, and five potential hit-periods, is significantly more than expected by chance ($P = .027$). Eight (16%) of the 45 "misses" made by Terry Mullins in total occurred within the first or last 90 seconds, confirming that Terry Mullins did not know about the middle 12-minute stimulus period. It might be argued, that the first or last parts in a session were less "psychologically attractive" to Terry Mullins (ie, that there was a lower likelihood of him judging patterns in the first or last periods as "unusual"). However, even when including only the 12-minute stimulus period (48 periods), three hits is still significant ($P < .05$). The "hits" were furthermore obtained with the largest, and (in this session) the three *first* startle stimuli. These were the plates crashing to the floor; the feet placed in the iced water; and the mild electric shock. Thus, Twin 1 tasting lemon juice and opening a jack-in-the-box device did not coincide with notable physiological deviations in Twin 2.

In addition to the statistical results, the graphical data for at least the first, and apparently the strongest startle response (crashing the four plates to the floor behind the chair after five minutes of silent relaxation) were quite impressive (Figure 1) and was described by Terry Mullins as a very strong response. When asked to describe this point in time in written form, he stated: "The GSR [Galvanic skin response] was a massive rise and I believe that she had a reaction which could have caused this as her respiration also changed at this time as well. I indicated the BBR [*BBR* = breath-breath. Terry Mullins marked this down during the session to indicate that a reaction was taking place, affecting the breath; see Figure 1] due to all the reactions. I do not know what you did at this precise point but it certainly had an effect or she shuddered inside. There is not a movement there, unlike a few seconds later," and "If she had taken a deep breath at that point, the GSR would rise, but she didn't. So it must have been something that affected her." (Terry Mullins, e-mails on the 11th and 12th of February 2012, respectively). Thus, T. Mullins did not find the GSR signal confounded by either movement or breathing.

The three hits were ranked as the second (plates crashing), third (ice bucket), and sixth (electric pen) most prominent responses, respectively. The most unusual pattern in Terry Mullins' evaluation was a prolonged stress response in Twin 2 which actually spanned the fifth startle stimulus (jack-in-the-box) given to Twin 1, but this was considered a miss, since the first second of patterns was used to define the pattern's status as a "hit" or a "miss" according to the protocol. The three physiological responses began at −4 seconds (plates crashing), −3 seconds (ice bucket), and +9 seconds (electric pen) to the stimuli.

We considered it important to have this data set analyzed by another polygraph expert.

The second polygraph expert, Guy Heseltine, provided eight estimates in his initial analyses, where movement was only considered as a confounder. In these estimates, he did not include the large GSR deviation at 16.25.57. After being instructed more thoroughly to look for patterns, which could indicate small shocks due to exposure to sudden bursts of noise, and therefore including small, muscular movements as a potential source of information, he excluded two of the former patterns and included two new. Among his final eight patterns were the same three hits that Terry Mullins had identified, a significant result in itself with only eight estimates, $P < .013$. Pooling his total of 10 estimates in one analysis, they still yielded a P value of .027. Furthermore, with the new instructions, Guy Heseltine ranked the large GSR increase at 16.25.57 as the most unusual pattern in the whole chart. He ranked the pattern occurring at the time of the ice bucket stimulus as the second most unusual, and he ranked the GSR rise after the electric pen stimulus as sixth. This second, independent expert evaluation therefore clearly supported Terry Mullins in attributing anomaly to these three specific physiological patterns among all the physiological variations on the 15-minute chart.

DISCUSSION

The present pilot study can claim to have made an advance on previous studies in testing physiological connectedness between pairs of human subjects by including more objective, experimental procedures. The methodological innovations included randomized stimulus times, randomized stimulus order, predefined, objective hit-criteria, blind assessment by independent judges, and a statistical formula applicable to this type of hypergeometric data. We recommend the experimental design for future studies involving precisely measurable stimulus times for one subject and physiological recordings in the nonstimulated subject, but without the possibility for simultaneous assessment of physiological changes in the stimulated subject. The objective method for defining hit-criteria and the statistical formula are also applicable to studies using for example EDR or polygraph data on both twins, where experts could blindly assess points in time showing synchronicity in physiological patterns. This may be easier (and more ecologically valid) in some studies, where computerized numerical data cannot be computed for the running, physiological data, or (as for polygraph data) when several stimulus channels need to be considered together, in order to evaluate any unusual *patterns*, rather than the *P*-value for a marginal correlation between eg, two EDR channels, which are measured in two different individuals in different contexts. In other terms, as the mechanisms of any anomalous connectedness are still unknown, it may be premature to presume that they are identifiable by linear correlations.

Concerning the connectedness hypothesis, the overall results were nonsignificant, which does not support a hypothesis of physiological connectedness across a group of monozygotic twins. However, in one pair of twins, being the pair with the closest (mo-mo) embryonic background, three out of the five startle stimuli given to the stimulated twin co-occurred with

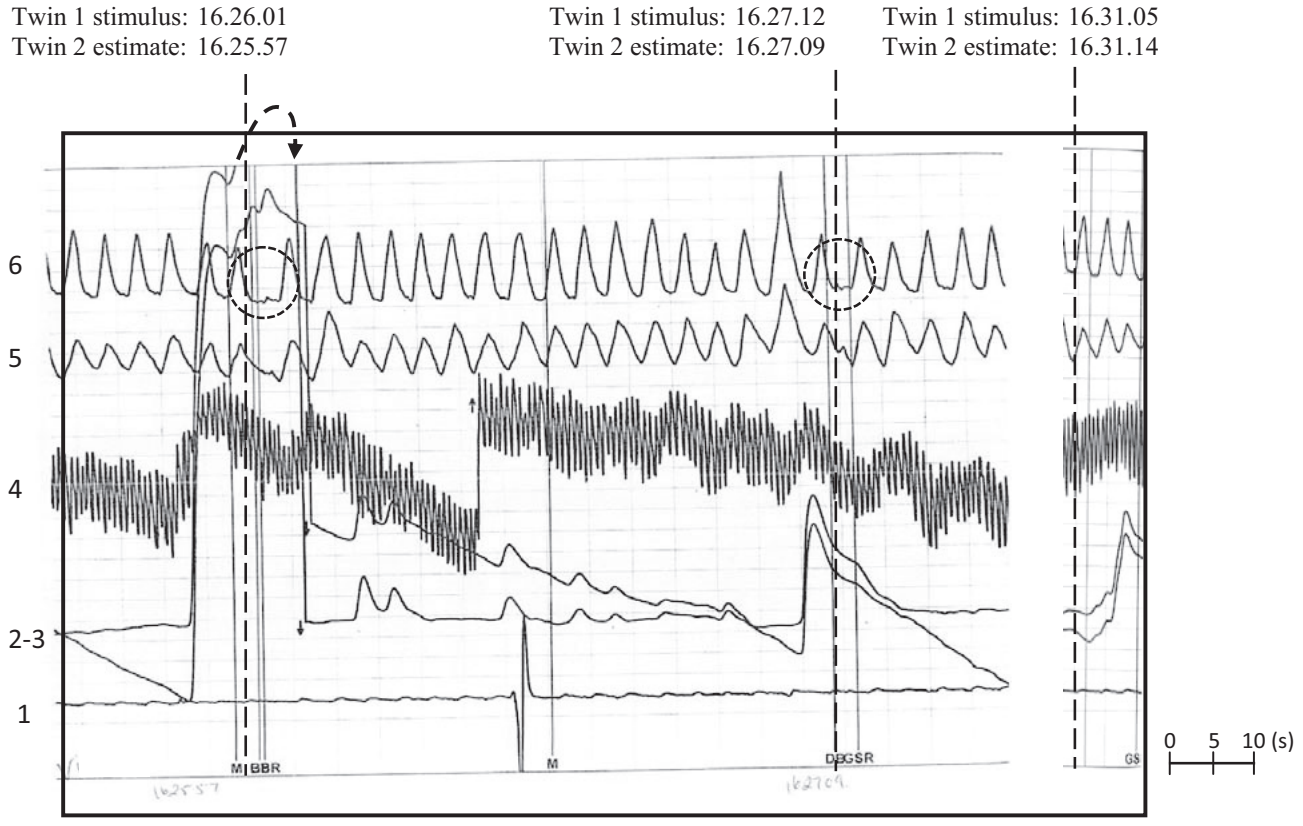

Figure 1. Physiological chart of the *unstimulated* (and acoustically and visually isolated) twin. *Twin 1 stimulus*: The precise times (hr.min.s.) for the startle stimuli. *Twin 2 estimate*: The precise times for Terry Mullin's and Guy Heseltine's identical estimates of the beginning of an anomalous physiological pattern in Twin 2. *1*. Movement activity recorded by a cushion with inlaid movement sensors. *2-3*. The two GSRs. *4*. Blood pressure. *5*. Diaphragm abdominal respiration. *6*. Thoracic chest respiration. The X-axis always indicates duration (the grid in the background shows 5-second intervals). The Y-axis always indicates amplitude. The hand-written times at the bottom of the chart shows Terry Mullins' precisely timed estimates for an anomalous, physiological pattern. For example, he has written 16.25.57 [4 hours, 25 minutes 57 seconds *pm*] below the first anomalous pattern in the physiology of the unstimulated twin to indicate that this was the exact beginning of an anomalous physiological pattern. The video recordings were analyzed by two independent persons from the TV crew (Thomas Breinholt and Margit From), who gave their precise estimates as to when the actual shocks were delivered. This was possible, as all video recordings always showed the same online (and thus synchronized) atomic clock via laptops placed within all camera shots. The two independent viewers were in agreement on the stimulus times for the three hits, which are indicated by the dashed, vertical lines. For example, both viewers agreed that the plates hit the floor at 16.26.01, which was exactly when the GSR curves peaked in the unstimulated twin. The solid vertical lines with letters below were created by Terry Mullins using keyboard presses during the session. They indicate: M, observed movement. Note that the first "M" cannot be the cause of the massive GSR response because it occurs after the increase. This movement was not recorded by the movement cushion, because it was only a brief twitch of the hand in the unstimulated twin, occurring briefly after the first shock was delivered to her identical mo-mo twin. BBR, breath-breath. Terry Mullins marked this down during the session to indicate that a reaction was taking place, affecting the breath. As shown by the circles, especially the thoracic breath sensor showed indications of brief holdings of the breath (called *admens)* after both the first and second shocks. Admens are unusual while relaxing in a chair. DB, deep breath. A deep breath can increase the GSR, but Terry Mullins and Guy Heseltine independently chose the physiological pattern occurring at the time of the second shock as a point of anomalous variation, which was also attributable to the admen here.

identifiable, unusual physiological fluctuations in the nonstimulated twin. These three fluctuations were identified in a blind analysis first by one polygraph expert, yielding significantly more "hits" than expected by chance ($P < .03$). This finding was strengthened by an independent and blinded second polygraph expert who identified the same three physiological patterns, even when asked to look for indications of startle stimuli *given* to the *unstimulated* twin, and did so with fewer estimates, yielding a significantly greater number of hits than expected by chance, ($P < .01$).

As mentioned in the introduction, theories have proposed quantum entanglement as a potential explanation for experiences of anomalous connectedness.[48-50] Although we are not drawing any conclusions of this nature, it seems important to put on record that the significant findings were obtained with the pair of twins with the closest embryonic background, their

original zygote separating into two embryos later than for other twins, and only about one day before the zygote would have become a Siamese couple with a physically integrated nervous system.[52] A small-scale pilot study, we cannot draw any conclusions concerning factors for connectedness between monozygotic twins, but the results were at least intuitively meaningful, as the closest embryonic development corresponded to the largest degree of reported connectedness, and the largest number of hits. It is also worth noting that the largest sign of connectedness, according to the rankings by the polygraph experts, was found using the first stimulus (plates crashing), which according to the EDR and to the video recording also gave the largest startle response for the stimulated twin. The two other, apparently major startle stimuli were the ice bucket and the electric pen while the remaining two startle stimuli, tasting lemon juice and opening a jack-in-the-box device, did not produce identifiable, physiological alterations. This corresponds with phenomenological reports of connectedness between twins or related people, which almost always occur when large (physiological) shocks have been experienced by the one part, such as accidents (or death), or very stressful experiences, such as serious threats.[20]

We do not consider stimulus overflow (Twin 2 being *directly* affected by the stimuli) a likely explanation. First, we thoroughly tested the acoustical shielding for the smashing plates stimulus, and nothing could be heard at the distance of 100 yards behind six closed doors in a different building. Second, the two remaining hits were obtained with very low levels of sound (talking to Twin 1 about the electrical pen; moving an ice bucket). We also do not consider cheating or fraud a serious, potential explanation for these results, although it cannot be ruled out. Leakage of stimulus times between T. Mullins, G. Heseltine, and the TV crew would have required outright fraud by both polygraph experts, and by the TV crew, who were the only ones to possess the unedited film material documenting the precise stimulus times, besides the authors. Moreover, the graphical data again clearly supported the estimates, which therefore did not seem to be artificially "fitted to" the stimulus times. This was also reflected in a written statement from Terry Mullins, in which he described the change in GSR in the nonstimulated twin as "a massive rise."

The fact that the first and second physiological responses began just a few seconds before the plates hit the floor or the feet by were lowered into the iced water, respectively, can be interpreted in at least three ways. First, we cannot exclude that the patterns were unrelated to the events in the stimulus room, but this was found to be statistically unlikely. Second, the stimulated twin may have heard CGJ moving into the room with plates or the bucket with iced water, which may have affected the stress response, and with that, perhaps, the stress response of the nonstimulated twin. It was in practice impossible not to make a little bit of noise before delivering the stimuli, and an expectation about startle stimuli when CGJ entered the room is likely to have been conditioned after the first stimulus. Again, this was precisely the reason that the hit-period was predefined as beginning at −5 seconds before the actual stimulus was delivered. Third, it may be that the nervous system of the stimulated twin was causally affected by the future startle response a few seconds in advance, which could then have been reflected in the data for the unstimulated twin. Although this represents a radical idea, some evidence within parapsychology has been centered around this phenomenon of "presentiment" of arousing events. Presentiment experiments have found GSR responses just prior to negatively arousing or erotic pictures but not prior to the presentation of neutral or low arousing pictures.[55,56] This has also been found using bursts of noise,[57] and an functional magnetic resonance imaging study showed increased neural blood flow prior to emotionally stimulating pictures but not in advance of neutral stimuli.[58] Finally, in a recent, thorough series of studies published in the prestigious *Journal of Personal and Social Psychology*, retroactive effects of future emotionally salient pictures were found on cognitive tests, while neutral stimuli did not affect cognition prior to their appearance[59] (for a review of presentiment experiments, see Radin,[48] pp. 161−180). Precognitive events are also reported in phenomenological studies, and, again, the content of such "premonitions" is most often about future shocking or potentially fatal events (for a review, see Irwin,[19] pp. 95−97, and Targ et al[20]). Finally, parapsychological studies have also examined physiological effects of a distant human's intentions on the physiological state of an isolated individual within the paradigm called Direct Mental Interactions with Living Systems. The authors of a meta-analysis of Direct Mental Interactions with Living Systems studies found a small-but-significant overall effect but also noted that the effects were not significant across a small sample of the most rigorous studies.[60] More research is needed on distant, physiological interactions between humans.

Of the aforementioned three explanations, the first was found to be statistically unlikely. The most 'simple' explanation would be the second, since it did not refer to retroactive mechanisms. Future studies could improve the control for pre-stimulus stress responses in the stimulated individual due to conditioning/mounting expectations by employing completely surprising startle stimuli (eg, a hidden loudspeaker giving random bursts of noise or an attached stimulator giving random mild electrical bursts). Overall, the design could be much improved by using physiological measures on both twins. In this case, and especially when correlations between the two physiological measures cannot be computed for technical reasons, a simpler statistical methodology using a forced-choice paradigm where polygraph experts are to chose stimulus periods in all twins included, without knowing their pairings, could be recommended (see Parker, Jensen and Brusewitz, in press). The data for the present mo-mo pair of twins did not relate to interaction mechanisms, but only supported that random, physiological variation seemed an unlikely explanation.

The experiment was limited in sample size by the context that was offered by a TV documentary. Inevitably, this also involves a weakened experimental control, but we do not consider the data security endangered here. First, the stimulus schedule was stored on one personal laptop behind a password. Second, the stimulus schedule was not precise because in practice the timing was always only an approximation to the schedule. The actual stimulus times were only documented by film, showing the startle stimuli delivered with an atomic clock in the shot. Third, the graphs, which could not have been falsified since they were documented 'online' by a camera, clearly supported the poly-

graph experts' estimates (Figure 1), which therefore again did not seem to be "fitted" to the stimulus times. To our knowledge, this is the first time atomic time clocks have been documented within all camera shots enabling a precise determination the exact times of the startle stimuli given as well as simultaneous inspection of the running polygraph data and the physical reactions of the nonstimulated twin. This method opened up for an *objective* determination of whether an estimate from a polygraph expert could be viewed as a "hit" or a "miss." The objectivity of the hit/miss status lay in the correspondence between timed estimates from polygraph experts and timed shocks documented by video, but not in the physiological pattern. To ensure the quality of the evaluations of patterns, we used two independent experts. Predefined, objective physiological criteria were not aimed for, since the mechanisms of anomalous, physiological connectedness are unknown and since the analyses of polygraph data rely on many parallel parameters, often with complex interactions.

The accuracy and reliability of polygraph recordings in a forensic setting is controversial and may not justify its use for lie detection.[61] However, the use and validity of EDRs as a means of recording emotional responses (which sometimes may not be fully conscious) is well established.[62] In addition, two independent experts identified the same three patterns, and two of three hit EDRs were supported by visible breaks in the rhythm of the breath.

The rankings provided some support of the different effectiveness of the startle stimuli: For both polygraph experts in combination, the rankings of the patterns at the time of the two first startle stimuli were first, second, second, and third, whereas the electric pen was only ranked as the sixth most prominent response by both polygraph experts. The rankings were, however, considered secondary. First, they did not relate to the statistical probability of obtaining a given number of hits. Second, anomalous fluctuations defined as "misses" could in principle have resulted from "real connectedness" occurring outside a stimulus time, so the relevance of such rankings cannot be firmly established with the chosen method.

In summary, we found the results encouraging and the methodological initiatives may serve as a starting point for larger experimental studies, which are needed. The largest deviations were noted in the EDR activity and in the breathing channels. Future studies might explore the most sensitive physiological parameters. It would be of interest to obtain records of the embryonic background and prioritize the recruiting of mo-mo twins. Such a sample might lead to a pool of participants with reproducible, significant effects, and to new empirically founded knowledge about potential factors for psychological and physiological connectedness, and thus to scientific progress being made.

Acknowledgments

This research was sponsored by Danmarks Radio (DR1), Denmark. We thank Thomas Breinholt and Margit from at DR1; Thomas W. Teasdale is thanked for valuable statistical discussions and Guy Lyon Playfair for discussions concerning the design of the study.

REFERENCES

1. Newman HH. Telepathy between twins. *J Am Soc Psychical Res*. 1949; 43:108-111.
2. Playfair GL. Identical twins and telepathy. *J Soc Psychical Res*. 1999; 63:86-98.
3. Sommer R, Osmund H, Pancyr L. Selection of twins for ESP experimentation. *Int J Parapsychol*. 1961;3:55-73.
4. Zorab G. Reports from other countries. *J Soc Psychical Res*. 1978;49: 742-752.
5. Cherkas L. What is it like being a twin? 2005; Available at: http://www.twinsuk.org.uk/wp-content/uploads/2012/03/Newsletter_Issue1_Jan2005.pdf. Accessed September 22, 2012.
6. Brusewitz G, Parker A, Cherkas L. Exceptional experiences amongst twins: a preliminary investigation. In: *Papers at the International Conference of the Society for Psychical Research*; 2010, p. 35-37.
7. Parker A. A ganzfeld study using identical twins. *J Soc Psychical Res*. 2010;73:118-126.
8. Gallup GH, Newport F. Belief in paranormal phenomena among adult Americans. *Skeptical Inquirer*. 1991;15:137-146.
9. Moore WD. Three in four Americans believe in paranormal. The Gallup Organization Poll Releases [Internet]. 2005. Available at: http://www.gallup.com/poll/16915/Three-Four-Americans-Believe-Paranormal.aspx. Accessed August 28, 2012.
10. Newport F, Strausberg M. Americans' belief in psychic and paranormal phenomena is up over last decade. The Gallup Organization News Service [Internet]. 2001. Available at: http://www.gallup.com/poll/4483/americans-belief-psychic-paranormal-phenomena-over-last-decade.aspx. Accessed September 22, 2012.
11. Blackmore SJ. A postal survey of OBEs and other experiences. *J Soc Psychical Res*. 1984;52:225-244.
12. Ross CA, Joshi S. Paranormal experiences in the general population. *J Nerv Ment Dis*. 1992;180:357-361.
13. Morhed SE. Att förklara det oförklarliga. En livsåskådningsstudie om människors tolkningar av paranormala fenomen i en vetenskaplig tidsålder. [*To Explain the Unexplainable. Interpretations Paranormal Phenomena in a Scientific Era*]. Uppsala: Acta Universitatis Upsaliensis; 2000.
14. Haraldsson E. Representative national surveys of psychic phenomena: Iceland, Great Britain, Sweden, USA and Gallup's multinational survey. *J Soc Psychical Res*. 1985;53:145-158.
15. Zangari W, Machado FR. Incidence and social relevance of Brazilian University Students' Psychic Experiences [Internet]. In: Proceedings of the 37th Parapsychological Associations Convention, Amsterdam, 1994. Available at: http://archived.parapsych.org/pa_convention_abstracts_1994.html. Accessed August 28, 2012.
16. McClenon J. Surveys of anomalous experience in Chinese, Japanese, and American samples. *Sociol Relig*. 1993;54:295-302.
17. McClenon J. Surveys of anomalous experience: a cross-cultural analysis. *J Am Soc Psychical Res*. 1994;88:117-135.
18. Glicksohn J. Belief in the paranormal and subjective paranormal experience. *Pers Individ Dif*. 1990;11:675-683.
19. Irwin HJ. *An Introduction to Parapsychology*. 4th ed. Jefferson, NC: McFarland; 2004.
20. Targ E, Schlitz M, Irwin HJ. Psi-related experiences. In: Cardeña E, Lynn SJ, Krippner S (eds). *Varieties of Anomalous Experience: Examining the Scientific Evidence*. Washington, DC: American Psychological Association; 2004, p. 219-251.
21. Irwin HJ, Watt CA. *An Introduction to Parapsychology*. 5th ed. Jefferson, NC: McFarland; 2007.
22. Green C. Analysis of spontaneous cases. *Proc Soc Psychical Res*. 1960; 53:97-161.
23. Irwin HJ. Extrasensory experiences and the need for Absorption. *Parapsychol Rev*. 1989;20:9-10.

24. Prasad J, Stevenson I. A survey of spontaneous psychical experiences in school children of Uttar Pradesh, India. *Int J Parapsychol*. 1968; 10:241-261.
25. Rhine LE. Hallucinatory psi experiences: I. An introductory survey. *J Parapsychol*. 1956;20:233-256.
26. Sannwald G. On the psychology of spontaneous paranormal phenomena. *Int J Parapsychol*. 1963;5:274-292.
27. Schouten SA. Analysing spontaneous cases: a replication based on the Sannwald collection. *Eur J Parapsychol*. 1981;4:9-48.
28. Schouten SA. Analysing spontaneous cases: a replication based on the Rhine collection. *Eur J Parapsychol*. 1982;4:113-158.
29. Stevenson I. *Telepathic Impressions: A Review and Report of Thirty-Five New Cases*. Charlottesville, VA: University Press of Virginia; 1970.
30. Schouten SA. A different approach for analyzing spontaneous cases with particular reference to the study of Louisa E. Rhine's case collection. *J Parapsychol*. 1983;47:323-347.
31. Playfair GL. *Twin Telepathy: the Psychic Connection*. London: Vega Books; 2002.
32. Blackmore SJ, Chamberlain F. ESP and thought concordance in twins: A method of comparison. *J Soc Psychical Res*. 1993;59:89-96.
33. Duane TD, Behrendt T. Extrasensory electroencephalographic induction between identical twins. *Science*. 1965;150:167.
34. Esser AH, Etter TL, Chamberlain WB. Preliminary report: physiological concomitants of "communication" between isolated subjects. *Int J Parapsychol*. 1967;9:53-56.
35. Watt CA, Irwin HJ. Processes underlying the phenomena of mysterious minds: Laboratory Evidence for ESP. In: Krippner S, Friedman H (eds). *Mysterious Minds: the Neurobiology of Psychics, Mediums, and Other Extraordinary People*. Los Angeles, CA: Praeger; 2010, p. 45-63.
36. Grinberg-Zylberbaum J, Delaflor M, Sanchez-Arellano ME, Guevara MA, Perez M. Human communication and the electrophysiological activity of the brain. *Subtle Energies*. 1993;3:25-43.
37. Grinberg-Zylberbaum J, Delaflor M, Attie L, Goswami A. The Einstein-Podolsky-Rosen paradox in the brain: the transferred potential. *Phys Essays*. 1994;7:422-427.
38. McDonough BE, Don NS, Warren CA. Gamma band ("40 Hz") EEG and unconscious target detection in a psi task. Paper presented at the 43rd Annual Convention of the Parapsychological Association, Freiburg, Germany, 2002.
39. Wackermann J, Seiter C, Keibel H, Walach H. Correlations between brain electrical activities of two spatially separated human subjects. *Neurosci Lett*. 2003;336:60-64.
40. Sabell A, Clarke C, Fenwick P. Inter-subject EEG-correlations at a distance: the transferred potential. Paper Presented at the 44th Annual Convention of the Parapsychological Association, New York, 2001.
41. Kittenis MD, Caryl PGC, Stevens P. Distant physiological interaction effects between related and unrelated participants. Paper presented at the 47th Annual Convention of the Parapsychological Association, Vienna, Austria, 2004.
42. Kittenis MD. Event-related EEG correlations between physically isolated participants. (Unpublished doctoral thesis). Scotland: University of Edinburgh; 2007.
43. Radin DI. Event-related electroencephalographic correlations between isolated human subjects. *J Altern Complement Med*. 2004;10: 315-323.
44. Standish LJ, Kozak L, Johnson LC, Richards T. Electroencephalographic evidence of correlated event-related signals between the brains of spatially and sensory isolated human subjects. *J Altern Complement Med*. 2004;10:307-314.
45. Achterberg J, Cooke K, Richards T, Standish L, Kozak L, Lake J. Evidence for correlations between distant intentionality and brain function in recipients: an fMRI analysis. *J Altern Complement Med*. 2005;11:965-971.
46. Moulton ST, Kosslyn SM. Using neuroimaging to resolve the psi debate. *J Cogn Neurosci*. 2008;20:182-192.
47. Richards TL, Kozak L, Johnson LC, Standish LJ. Replicable functional magnetic resonance imaging evidence of correlated brain signals between physically and sensory isolated subjects. *J Altern Complement Med*. 2005;11:955-963.
48. Radin DI, Minds E. *Extrasensory Experiences in a Quantum Reality*. New York: Paraview and Pocket Books; 2006.
49. Roll WG, Williams BJ. Quantum theory, neurobiology, and parapsychology. In: Krippner S, Friedman H (eds). *Mysterious Minds: the Neurobiology of Psychics, Mediums and Other Extraordinary People*. Santa Barbara: Praeger; 2010, p. 1-34.
50. Walker EH. *The Physics of Consciousness*. New York: Basic Books; 2000.
51. Gilbert SF. Non-identical monozygotic twins [internet], *Develop Biol*. Sunderland, MA: Sinauer Associates; 2006. Available at: http://8e.devbio.com/article.php?id=111. Accessed August 28, 2012.
52. Bomsel-Helmreich O, Al Mufi W. The phenomenon of monozygosity: spontaneous zygotic Splting. In: Blickstein I (ed). Multiple Pregnancy. Epidemiology, Gestation, and Perinatal Outcome. London: Taylor & Francis; 2005, p. 95.
53. Feller W. The hypergeometric series. In: *An Introduction to Probability Theory and Its Applications*. Vol. 1. New York: Wiley; 1968, p. 41-45.
54. Weisstein EW. Hypergeometric distribution [internet]. Wolfram MathWorld. 2011. Available at: http://mathworld.wolfram.com/HypergeometricDistribution.html. Accessed August 28, 2012.
55. Bierman DJ, Radin DI. Anomalous anticipatory response on randomized future conditions. *Percept Mot Skills*. 1997;84:689-690.
56. Radin DI. Unconscious perception of future emotions: an experiment in presentiment. *J Sci Explor*. 1997;11:163-180.
57. Spottiswoode SJP, May EC. Skin conductance prestimulus response: Analyses, artifacts and a pilot study. *J Sci Explor*. 2003;17: 617-641.
58. Bierman DJ, Scholte HS. Anomalous anticipatory brain activation preceding exposure of emotional and neutral pictures. In: *Proceedings of presented Papers: The, Parapsychological Association 45th Annual Convention*. Cary, NC: Parapsychological Association; 2002. p. 25-36.
59. Bem DJ. Feeling the future: experimental evidence for anomalous retroactive influences on cognition and affect. *J Pers Soc Psychol*. 2011;100:407-425.
60. Schmidt S, Schneider R, Utts J, Walach H. Distant intentionality and the feeling of being stared at: two meta-analyses. *Br J Psychol*. 2004;95:235-247.
61. Iacono WG. Oral statement regarding polygraph screening of federal employees and Job applicants [internet]. Submitted by Prof. William G. Iacono to the U.S. Senate. Judiciary Committee Hearing. 2001. Available at: http://www.fas.org/sgp/congress/2001/042501_iacono.html. Accessed August 28, 2012.
62. Boucsein W. *Electrodermal Activity, Plenum Series in Behavioral Psychophysiology and Medicine*. New York: Plenum Press; 1992.