Journal of Scientific Exploration, Vol. 17, No. 4, pp. 651–668, 2003 0892-3310/03

Effects of Frontal Lobe Lesions on Intentionality and Random Physical Phenomena

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Abstract—Although data from the PEAR program at Princeton University appear to support a role for intentionality in determining physical phenomena, the use of theoretically based controls raises concerns about validity of the findings. We re-examined claims from the PEAR lab using experimentally derived control data in a study of patients with frontal lobe brain damage and normal subjects. The rationale for including frontal patients follows a suggestion that reduced self-awareness may facilitate effects of intentionality on physical phenomena. Frontal patients may have reduced self-awareness, a state not easily achieved by normal subjects, and may provide a good model for studying the role of consciousness on physical events within a conceptual framework that maximizes the likelihood of detecting possible effects. We found a significant effect of intentionality on random physical phenomena in a patient with left frontal damage that was directed contralateral to his lesion. Moreover, the effect was replicated.

Keywords: consciousness—self-awareness—intentionality—frontal lobe damage—random event generator

Although several studies claim to support a role for intentionality in determining physical phenomena (Schmidt, 1969; Schmidt & Pantas, 1972; Jahn & Dunne, 1987a; Radin & Nelson, 1989; Jahn et al., 1997), concerns about research design and a lack of theoretical models (Alcock, 1987; Jeffers, in press), as well as negative studies (Hall et al., 1977; Jeffers & Sloan, 1992; Ibison & Jeffers, 1998), have been important sources of criticism of the literature in this area. A major methodological problem in research design relates to the issue of inadequate experimental controls (Jeffers, in press). For example, Robert Jahn and his colleagues from the Princeton Engineering Anomalies Research (PEAR) program have reported statistically significant effects whereby subjects, or "operators", have successfully influenced the statistical distribution of outcomes from a Random Event Generator (REG) (Jahn et al., 1987a; Jahn et al., 1997). A concern relates to the nature of the machine calibration data used for comparison to subject generated data (Jeffers, in press). Rather than collecting control data in close temporal proximity to the period when a subject is trying to influence the REG output, the PEAR protocol relies on the assumption that the REG output is always random in the absence of operator influence. This approach does not control for potentially unrecognised factors that may affect the REG output and therefore casts doubt on the interpretation of the experimental findings. In addition, there are theoretical issues raising questions about the findings from Jahn's group, such as the independence of the reported effects from time and distance, that are difficult to reconcile (Jahn et al., 1997; Jeffers, in press). Nevertheless, Jahn and his colleagues have amassed a great wealth of data to support their conclusions that an individual's conscious intention can alter the statistical distribution of random physical phenomena. Because their findings would have immense significance if validated, we re-examined their claims using a methodology with well-designed control conditions.

Some highly interesting but speculative ideas relating anomalous physical activity to consciousness have been advanced by Jahn and Dunne (Jahn et al., 1987a; Jahn & Dunne, 1986). They proposed a metaphor for consciousness based upon quantum mechanical concepts that relates consciousness to anomalous physical phenomena. Based on data from the PEAR lab, they suggest that consciousness has the potential to influence random physical events and that this effect is maximal when consciousness is exhibiting "wave properties" rather than "particle" properties. Although it is unclear how consciousness can be characterised in physical terms, the analogy has interesting implications when taken a step further. Jahn and Dunne propose that the wave properties of consciousness correlate best with a state in which individuals are able to divert their attention away from their self-awareness in relation to events around them. This analogy suggests that states of reduced self-awareness may facilitate the effects of consciousness on physical phenomena. Self-awareness is a highly complex neurological function comprised of several hierarchical levels ranging from visceral knowledge to more abstract concepts of self-image. There is a well-established literature suggesting that this function is mediated by the frontal lobes and that frontal lesions are associated with reduced self-awareness (Stuss & Benson, 1986; Stuss, 1991; Carver & Scheier, 1991), a state that is not easily

TABLE 1
Subject Profiles

Subject	Age	Gender	Etiology
S1 Bilateral frontal	70	F	Frontal leucotomy
S2 Bilateral frontal	60	F	Subarachnoid hemorrhage
S3 Bilateral frontal	58	M	Subarachnoid hemorrhage
S4 Bilateral frontal	61	M	Frontal leucotomy
S5 Left frontal	45	M	Tension pneumocephalus
S6 Right frontal	70	F	Infarct
S7 Normal	25	F	N/A[a]
S8 Normal	43	M	N/A
S9 Normal	61	M	N/A
S10 Normal	69	M	N/A
S11 Normal	51	M	N/A
S12 Normal	26	F	N/A

[a] N/A = not applicable.

achievable by normal individuals. Studying patients with frontal lobe lesions may provide a good model for testing the hypotheses from the PEAR lab within the context of a conceptual framework that would maximise the likelihood of detecting effects, if these in fact exist. We report our findings in patients with frontal lobe lesions and in normal subjects, as well as replication data in one subject with left frontal brain damage.

Methods

Subjects

Subjects with frontal lobe brain damage (n = 6) and normal subjects without brain lesions (n = 6) were studied. The frontal group consisted of subjects with lesions in the following brain regions: bilateral frontal lobes (n = 4), left frontal lobe (n = 1), and right frontal lobe (n = 1). Table 1 shows the age and gender of the subjects and the etiology of the brain lesions in the patients. All subjects with frontal brain damage, except S1, had a CT or MRI scan of the head documenting the site of the lesion. The CT and MRI scans were interpreted blind to the hypotheses by observers with experience in interpreting neuroradiological scans. The patient without a scan had a bilateral frontal leucotomy many years earlier. The normal subjects were comprised of four research staff at one of the study sites (two of whom are authors) and two relatives of the research staff.

Experimental Procedure

Subjects were asked to sit in front of a computer monitor showing an image of a horizontal arrow or bar. The midline of the screen was indicated by a line. The subjects were instructed to concentrate on moving the image to the right (intention right) or left (intention left) of the midline, or not to concentrate on

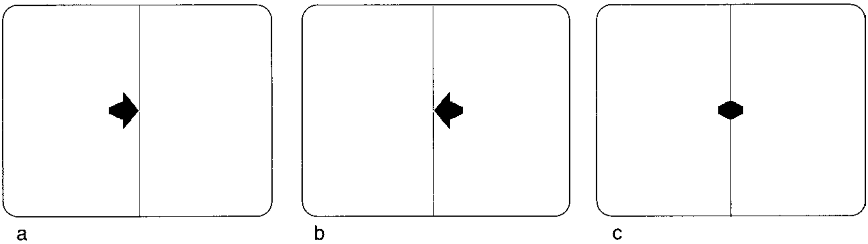

Fig. 1. Illustration of computer screen showing initial position of arrow or bar for each intention: (a) Intention Right; (b) Intention Left; and (c) Intention Baseline.

moving the image (baseline intention). For the right and left intentions, the image was an arrow; for the baseline intention, it was a bar (Figure 1 a–c). The purpose of selecting an arrow or bar was to provide an ongoing cue to help subjects maintain their attention on the specified intent.

The order of intentions (right, left, or baseline) followed a predetermined sequence as shown below (i.e., R L B L B. . .). Subjects who completed more than the following 12 intentions repeated the same cycle until they finished the study.

R	L	B
L	B	R
R	B	L
L	R	B

All six patients and two of the six normal subjects were tested with an examiner in the room. The four normal subjects who were research staff (S7, S8, S11, S12) were tested without an examiner present. The latter is in keeping with the protocol in the PEAR program where laboratory staff maintain a minimal presence during the experiments (Jahn et al., 1987a). Each of the six patients, and the two normal subjects tested by an examiner, were initially seated facing the examiner and were given the following instructions: "There are some people who believe that if we concentrate on something hard enough, we can affect how things happen. Now we don't know if this is true but we have undertaken to test this out. We would like to see if there is a possibility that people can influence something just by concentrating on it." Subjects were then instructed to face the computer screen, which displayed an arrow pointing in the right or in the left direction with the tip at the midline. The experimenter then continued with the instructions: "Now on this screen there is an arrow. What I would like you to do is concentrate on making the arrow move in the direction that it is pointing. I want to see how your concentration can affect the position of the arrow. The arrow will sometimes be on the right and sometimes on the left of the screen, but I want you to keep the arrow on the left/right side as much as possible. Do you have any questions? Remember, I want you to try to keep the arrow on the left/right side as much as possible. I'd like you to begin now."

The examiner then started the computer program, which was designed to move the arrow according to the output of a Random Event Generator (REG). The REG produces a random series of 0's and 1's based upon a sampling of an electronic noise pattern at pre-set regular intervals. The sign of the signal at the time of sampling (i.e., positive or negative) is compared with a regularly alternating sequence of positive and negative pulses. If there is a match (i.e., negative-negative or positive-positive), a ''1'' is generated. If there is no match then a ''0'' is generated (Jahn et al., 1987a). Sampling occurred at a rate of 200 per second. The data were summed as 200-sample bits with expected numerical value of 100 due to a 50% chance of a positive-positive or negative-negative match occurring at each sampling. Each sample of 200 bits of data comprised a trial.

The position of the arrow relative to the midline of the screen moved rightward or leftward according to the cumulative mean of the trials with the midline representing a cumulative mean of 100. An arrow with the tip to the right of midline represented a mean of greater than 100 and an arrow with the tip to the left corresponded to a mean of less than 100. The REG used for the experiment was a portable model of the larger device that has been used in the PEAR program at Princeton University (Jahn et al., 1987a; Nelson et al., 1984; Nelson et al., 1989; Jahn et al., 1987b; Jahn et al., 1997). The portable REG was obtained from the PEAR program.

Each intention (right, left, or baseline) consisted of 10 blocks of 100 trials and lasted approximately 15 minutes. At the end of each block of 100 trials, the examiner confirmed that the subject understood the task, answered any questions, and initiated the next block of 100 trials. After each block of 100 trials, the position of the arrow tip or bar was reset to the midline.

After each intention for right, left, or baseline, a control run of 1,000 trials was carried out without anyone in the room. This completed one full session of 1,000 trials for the relevant intention and 1,000 control trials. Participation was spread across several sessions. The total number of trials varied across subjects due to differences in the time that they could devote to the study.

Results

Primary analyses were carried out to test whether there were significant effects of intention in the frontal subjects (bilateral frontal, left frontal, right frontal, and frontal subjects pooled) and in the normal group. Secondary analyses were carried out to determine whether there were effects for individual subjects.

Primary Analyses

Figure 2 (a–c) shows the mean output of the REG for each intention (right, left, baseline) and the mean control output for the patients with frontal lesions and the normal subjects. Table 2 shows the corresponding number of intention and control trials.

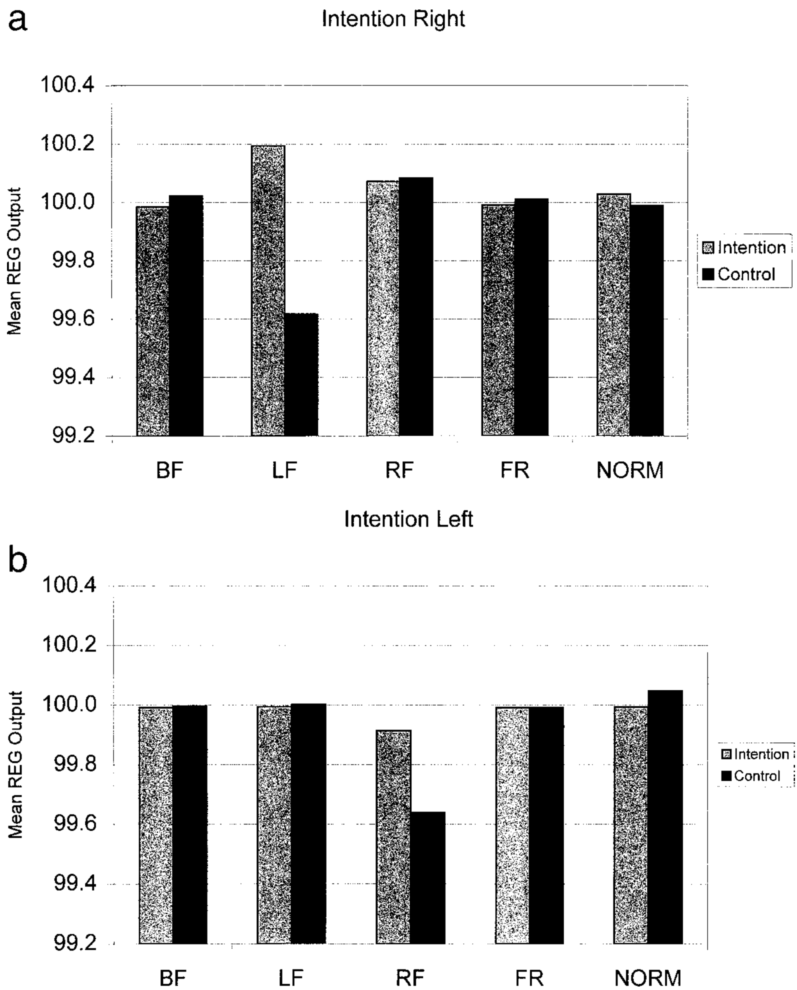

Fig. 2. Mean REG output for patients with brain lesions in bilateral frontal (BF), left frontal (LF), and right frontal (RF) regions, frontal patients pooled (FR), and normal subjects (NORM). (a) Intention Right; (b) Intention Left; and (c) Intention Baseline.

T-tests were carried out using SAS System for Windows (The SAS System for Windows, Release 6.12, 1996) to determine whether there were significant differences between intention and control conditions for the right, left, and baseline intentions. Separate analyses were carried out for patients with lesions in the frontal lobes bilaterally, left frontal lobe, right frontal lobe, all frontal patients pooled, and for the normal subjects. This resulted in a total of 15 analyses. Using a Bonferroni correction for 15 multiple comparisons, a p-value $<0.05/15$ or 0.003 would be required for statistical significance. As shown in

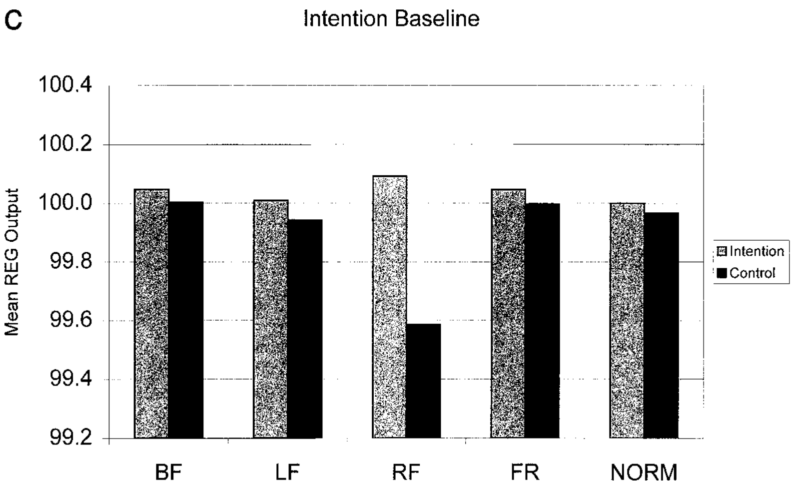

Fig. 2. (Continued).

Table 3, there were no significant differences between the intention and control conditions for the right, left, or baseline intentions in the bilateral frontal subjects, right frontal subject, or normal subjects. In addition, there were no significant differences between the intention and control conditions for the pooled group of frontal subjects.

For the left frontal patient, there was a significant difference between the intention and control conditions for the right intention ($p = 0.0015$). The effect was in the direction of intention and was significant even after Bonferroni correction for multiple comparisons. There were no significant differences between the intention and control conditions for the left or baseline intentions in the left frontal patient.

T-tests were carried out to determine whether there were significant differences between the intention and control conditions for the right, left, or baseline intentions for the entire sample of frontal and normal subjects pooled. There were no significant differences for any intention (*right*, $t[304898] = 0.0480$, $p = 0.96$; *left*, $t[302998] = 0.6709$, $p = 0.50$; *baseline*, $t[299998] = -1.7053$, $p = 0.09$).

Secondary Analyses

Secondary analyses were carried out using t-tests to determine whether there were significant differences between intention and control conditions for each subject. Table 4 shows the results of the analysis for each subject. Significant differences at the $p = 0.05$ level were found between the intention and control conditions in three instances: intention right ($p = 0.0015$) (S5, left frontal patient); baseline ($p = 0.03$) (S8, normal subject); intention right ($p = 0.004$) (S9,

TABLE 2
Total Number of Trials (Includes Intention Plus Control Trials)

Subjects	Right	Left	Baseline
Bilateral frontals	200,900[a]	201,000	200,000
Left frontal	6,000	8,000	6,000
Right frontal	2,000	2,000	2,000
Frontals pooled	208,900[a]	211,000	208,000
Normals	96,000	92,000	92,000

[a] There were 100 fewer intention trials than control trials for the right intention in the bilateral frontals.

normal subject). The effect was in the intended direction for S5 and S9. Using a Bonferroni correction for 36 multiple comparisons, a p-value $<0.05/36$ or 0.0014 would be required for statistical significance. None of these p-values exceeded this threshold.

As stated in the methodology section, four normal subjects were research staff (S7, S8, S11, S12) and were tested without an examiner in the room. In addition, subjects S9 and S10 were relatives of the research staff but were tested with an examiner present. These six subjects were divided into two groups for separate analysis. One group was comprised of the normal subjects who were research staff (S7, S8, S11, S12) and the other group was comprised of subjects S9 and S10. T-tests were carried out to determine whether there were significant differences between the intention and control conditions for the right, left, and baseline intentions for these two groups. This resulted in a total of six analyses. Using a Bonferroni correction for six multiple comparisons, a p-value of $<0.05/6$ or 0.008 would be required for statistical significance. There were no significant differences between the intention and control conditions for the group comprised of subjects S7, S8, S11, and S12 (*right*, $p = 0.69$; *left*, $p = 0.61$; *baseline*, $p = 0.24$). For the group comprised of subjects S9 and S10 there was a difference between the intention and control conditions for the right intention ($p = 0.0164$) that was in the direction of intention. However, this was not significant after correction for multiple comparisons. There were no significant differences between the intention and control conditions for the left ($p = 0.14$) or baseline ($p = 0.48$) intentions for the group comprised of S9 and S10.

In addition to statistical control for multiple comparisons using a Bonferroni correction, we performed an additional study to experimentally control for the numerous statistical tests. ‘‘Pseudodata’’ were created by repeating the entire experimental procedure except that there was no subject or experimenter in the room during the intention condition. Two sets of pseudodata were generated: the first at the same site where the original data were collected (pseudodata 1) and the second in a different building (pseudodata 2). The data were labeled to correspond to the intentions of the subjects as in the real study.

As shown in Tables 5a and 5b, the number of statistically significant results ranged from one (pseudodata 1) to four (pseudodata 2). Moreover, one of the

TABLE 3
Analysis of Frontal and Normal Subjects (Intention vs Control Conditions)

Subjects	Intention	t	df	p-value
Bilateral frontals	right	1.1920	200,898	0.23
	left	0.1213	200,998	0.90
	baseline	−1.3874	199,998	0.17
Left frontal	right	−3.1691	5,998	**0.0015**[R]
	left	0.0524	7,998	0.96
	baseline	−0.3656	5,998	0.71
Right frontal	right	0.0375	1,998	0.97
	left	−0.8754	1,998	0.38
	baseline	−1.6084	1,998	0.11
Frontals pooled	right	0.6377	208,898	0.52
	left	0.0441	210,998	0.96
	baseline	−1.5794	207,998	0.11
Normals	right	−0.8538	95,998	0.39
	left	1.1474	91,998	0.25
	baseline	−0.7036	91,998	0.48

Note: **R** = Direction of effect was to the right.

significance levels was greater in the pseudodata than in the real data. However, none of the effects were in the direction of intention and in three instances the significant effects occurred during the baseline intention.

Replication Study

The primary analyses showed a statistically significant effect in the direction of intention to the right for the patient with a left frontal lesion. This effect was significant even after Bonferroni correction for multiple comparisons. To examine the possible effects in this patient further, we carried out a second study to determine whether the findings could be replicated. The planned hypothesis was that he would show a statistically significant effect of intention to the right but not to the left or in the baseline intention (i.e., that the findings would be the same as before). The left frontal subject was retested using the methodology described for the original study.

During testing, a printer error (data was always printed after each block of 100 trials) occurred at the end of the fifth block of 100 trials during a baseline session and the program exited while the bar was still on the screen. Although the complete data for these 100 trials were still captured, a replacement set of 1,000 baseline and control trials for the entire intention was collected on a separate day. However, the possible impact of the printer error is considered negligible due to the small number of trials involved, the fact that none of the data were lost, and because it occurred during the baseline condition in which the subject was asked not to concentrate on moving the arrow. On another occasion, a baseline session should have preceded a right intention session but the order was

TABLE 4
Single Subject Analysis

Subject	Intention	Mean REG Output: Intention	Mean REG Output: Control	t	p-value	Trials (n)
S1	right	99.98	100.01	0.4982	0.62	40,000
	left	99.97	100.03	0.8491	0.40	40,000
	baseline	100.03	100.04	0.2000	0.84	40,000
S2	right	99.99	100.07	0.8302	0.41	22,900[a]
	left	99.88	99.91	0.3145	0.75	24,000
	baseline	100.03	100.01	−0.1708	0.86	24,000
S3	right	99.89	100.02	1.7414	0.08	34,000
	left	100.11	100.00	−1.3408	0.18	33,000
	baseline	100.13	100.04	−1.0462	0.30	32,000
S4	right	100.02	100.02	−0.0341	0.97	104,000
	left	99.99	100.00	0.2488	0.80	104,000
	baseline	100.03	99.97	−1.3896	0.16	104,000
S5	right	100.19	99.62	−3.1691	**0.0015[R]**	6,000
	left	99.99	100.00	0.0524	0.96	8,000
	baseline	100.01	99.94	−0.3656	0.71	6,000
S6	right	100.07	100.08	0.0375	0.97	2,000
	left	99.91	99.64	−0.8754	0.38	2,000
	baseline	100.09	99.59	−1.6084	0.11	2,000
S7	right	99.84	99.91	0.6708	0.50	16,000
	left	100.02	99.98	−0.3481	0.73	16,000
	baseline	99.94	99.94	−0.0022	1.00	16,000
S8	right	100.00	100.06	0.7071	0.48	24,000
	left	100.03	100.02	−0.1489	0.88	24,000
	baseline	100.09	99.89	−2.1274	**0.0334[R]**	24,000
S9	right	100.21	99.91	−2.8790	**0.0040[R]**	18,000
	left	100.00	100.12	1.0737	0.28	16,000
	baseline	99.94	99.99	0.4375	0.66	16,000[b]
S10	right	100.01	100.04	0.1845	0.85	6,000
	left	99.88	100.14	1.1721	0.24	4,000
	baseline	99.74	99.90	0.7088	0.48	4,000
S11	right	100.02	100.02	−0.0477	0.96	16,000
	left	99.99	100.05	0.6132	0.54	16,000
	baseline	100.05	100.04	−0.1077	0.91	16,000
S12	right	100.07	100.00	−0.6514	0.51	16,000
	left	99.95	100.07	1.0216	0.31	16,000
	baseline	100.00	100.03	0.2445	0.81	16,000

Note: n = number of intention trials + control trials; **R** = direction of effect was to the right.
[a] There were 100 fewer intention trials than control trials.
[b] 500 baseline control trials were collected incorrectly and replaced by trials collected at a different time. Although this introduced a potential bias, the difference between the intention and control conditions was too far from significant for a small number of 500 trials to have had an impact.

reversed. This resulted in two right intention and two baseline sessions being run consecutively. The right intention sessions were on the same day, whereas the baseline sessions were on different days. Another occurrence consisted of the subject seeing double arrows during a right intention session. Finally, during a left

TABLE 5a
Pseudodata Analysis 1

		Mean REG Output				
Subject	Intention	Intention	Control	t	p-value	Trials (n)
PS1	right	99.97	100.05	1.1636	0.24	40,000
	left	100.11	100.03	−1.0648	0.29	40,000
	baseline	100.07	99.95	−1.7586	0.08	40,000
PS2	right	99.95	100.10	1.5873	0.11	22,900
	left	99.98	100.04	0.6576	0.51	24,000
	baseline	99.94	100.06	1.4214	0.16	24,000
PS3	right	99.96	100.02	0.8405	0.40	34,000
	left	99.91	100.02	1.3635	0.17	32,000[a]
	baseline	100.07	99.99	−0.9442	0.35	32,000
PS4	right	100.03	99.99	−1.0667	0.29	104,000
	left	100.06	99.99	−1.7887	0.07	104,000
	baseline	100.01	99.99	−0.2984	0.77	104,000
PS5	right	99.82	99.93	0.6322	0.53	6,000
	left	100.20	100.00	−1.2473	0.21	8,000
	baseline	99.88	99.93	0.2343	0.81	6,000
PS6	right	99.99	100.31	1.0198	0.31	2,000
	left	99.79	100.06	0.8638	0.39	2,000
	baseline	99.63	100.31	2.1474	**0.0319**[**L**]	2,000
PS7	right	100.02	100.05	0.2463	0.81	16,000
	left	99.99	100.13	1.2288	0.22	16,000
	baseline	100.05	99.99	−0.5196	0.60	16,000
PS8	right	100.06	99.96	−1.1546	0.25	24,000
	left	100.05	100.07	0.2370	0.81	24,000
	baseline	100.00	99.97	−0.2564	0.80	24,000
PS9	right	99.95	100.11	1.5199	0.13	18,000
	left	99.96	100.02	0.5973	0.55	16,000
	baseline	100.05	99.95	−0.8764	0.38	16,000
PS10	right	100.07	99.93	−0.7168	0.47	6,000
	left	99.97	100.16	0.8457	0.40	4,000
	baseline	99.81	99.87	0.2792	0.78	4,000
PS11	right	100.05	100.14	0.8604	0.39	16,000
	left	100.01	100.06	0.4769	0.63	16,000
	baseline	100.09	99.97	−1.0813	0.28	16,000
PS12	right	99.93	100.10	1.5528	0.12	16,000
	left	100.01	100.12	0.9288	0.35	16,000
	baseline	99.98	100.13	1.3483	0.18	16,000

Note: n = number of intention trials + control trials; **L** = direction of effect was to the left.
[a] Pseudodata contained 500 fewer intention and control trials as compared to real data.

intention session, the building intercom came on at the end of the fourth block of 100 trials. The subject stated that this affected his concentration only slightly. In all cases described above, the complete set of data was used for analyses, including the replacement trials that followed the printer error (i.e., no data were discarded).

TABLE 5b
Pseudodata Analysis 2

Subject	Intention	Mean REG Output Intention	Mean REG Output Control	t	p-value	Trials (n)
PS1	right	99.95	100.01	0.8327	0.41	40,000
	left	99.96	99.95	−0.2329	0.82	40,000
	baseline	100.03	100.00	−0.4994	0.62	40,000
PS2	right	100.01	99.95	−0.6746	0.50	22,900
	left	100.00	99.91	−0.9721	0.33	24,000
	baseline	99.96	99.99	0.3060	0.76	24,000
PS3	right	100.11	100.08	−0.4347	0.66	34,000
	left	99.98	100.01	0.3522	0.72	32,000[a]
	baseline	100.05	100.00	−0.6143	0.54	32,000
PS4	right	99.94	100.05	2.6336	**0.0084**[L]	104,000
	left	100.01	99.95	−1.3071	0.19	104,000
	baseline	99.98	99.97	−0.2664	0.79	104,000
PS5	right	99.86	100.05	1.0582	0.29	6,000
	left	100.03	100.05	0.1187	0.91	8,000
	baseline	100.02	99.95	−0.3727	0.71	6,000
PS6	right	99.68	99.93	0.7972	0.43	2,000
	left	99.90	99.76	−0.4402	0.66	2,000
	baseline	100.08	99.60	−1.5583	0.12	2,000
PS7	right	99.90	99.95	0.4285	0.67	16,000
	left	100.18	100.02	−1.4678	0.14	16,000
	baseline	99.83	99.96	1.1654	0.24	16,000
PS8	right	100.08	100.05	−0.2559	0.80	24,000
	left	100.16	99.84	−3.5151	**0.0004**[R]	24,000
	baseline	100.02	100.02	−0.0648	0.95	24,000
PS9	right	100.01	99.98	−0.2441	0.81	18,000
	left	100.17	99.98	−1.6610	0.10	16,000
	baseline	99.93	99.83	−0.8404	0.40	16,000
PS10	right	100.09	100.14	0.2525	0.80	6,000
	left	100.18	100.00	−0.7789	0.44	4,000
	baseline	99.87	100.22	1.5658	0.12	4,000
PS11	right	100.06	100.10	0.3433	0.73	16,000
	left	99.92	100.00	0.7129	0.48	16,000
	baseline	100.07	99.86	−1.9258	**0.0541**[R]	16,000
PS12	right	99.97	99.86	−1.0275	0.30	16,000
	left	100.02	99.99	−0.2967	0.77	16,000
	baseline	99.78	100.01	2.0961	**0.0361**[L]	16,000

Note: n = number of intention trials + control trials; **R** = direction of effect was to the right; **L** = direction of effect was to the left.

[a] Pseudodata contained 500 fewer intention and control trials as compared to real data.

Results of Replication Study

Figure 3 shows the mean REG output for each intention (right, left, baseline) and the control output for the left frontal subject. There were 19,000 intention and control trials for the right intention, and 20,000 trials for each of the intention and control conditions for the left and baseline intentions.

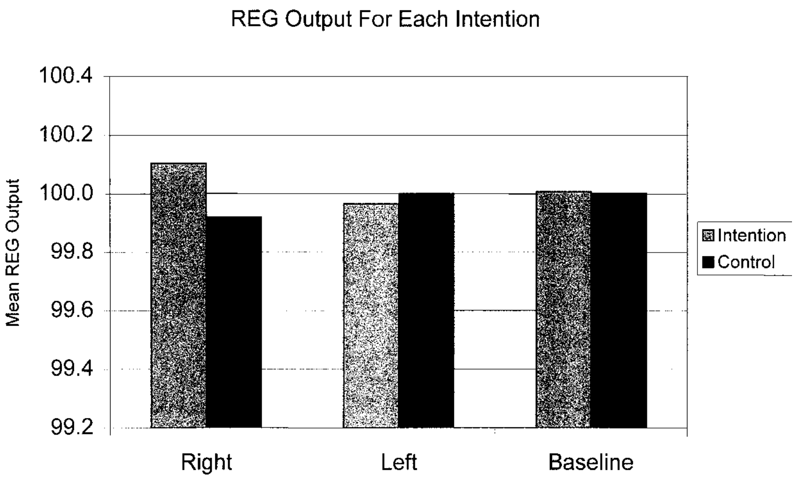

Fig. 3. Mean REG output for the left frontal patient in replication study.

T-tests were carried out using SAS System for Windows, Release 8, to determine whether there were significant differences between the intention and control conditions for the right, left, and baseline intentions. There was a significant difference between the intention and control conditions for the right intention ($t[37998] = -2.53$, $p = 0.0115$) but not for the other two intentions (left, $t[39998] = 0.49$, $p = 0.6269$ and baseline, $t[39998] = -0.07$, $p = 0.9418$). The significant effect for the right intention was in the direction of intention, as in the original study.

Since the investigation was run in blocks of 1,000 trials, we examined the data using blocks as the unit of measurement and the averaged output across trials as the measure in each block. An F-ratio test with condition (intention vs control) as the source of variance of interest and the interaction between condition and block as the error term showed an effect of condition ($p = 0.0578$). This suggests that the left frontal subject would show comparable findings on another series of 19 pairs of blocks of 1,000 trials with 94% confidence.

Whereas the mean REG output for the right intention was above the expected value of 100, the output for the control condition was below 100 (Figure 3). To examine the possibility that the significant difference between the intention and control condition was due solely to low output during the control condition, as opposed to high output during the intention condition, we tested whether the output for the intention condition was significantly different from a constant value of 100. This value is the theoretical mean output of the REG assuming truly random and unbiased output. The control values for the left and baseline conditions are approximately equal to this theoretical mean. The REG output for the right intention was significantly different than 100 and in the direction of intention ($t = 2.01$, $p = 0.045$, two-tailed test). For the control condition, the mean REG output was less than (although not significantly different from) 100 ($t = -1.56$, $p = 0.12$).

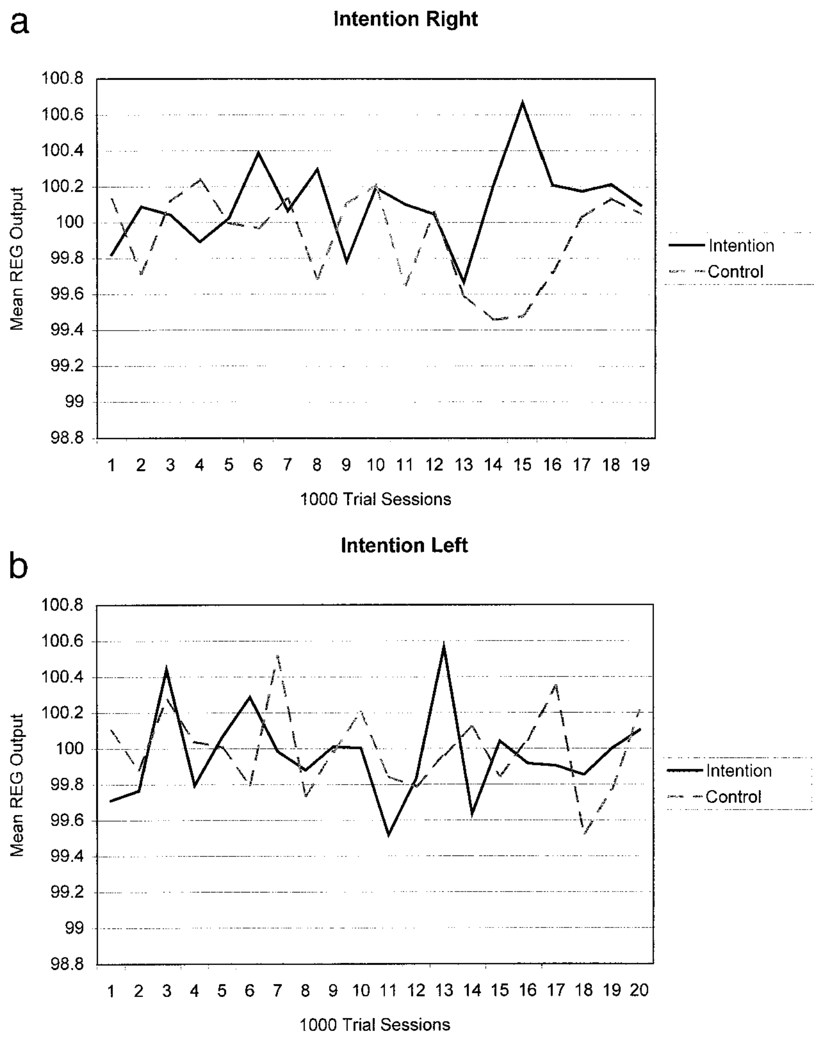

Fig. 4. Mean REG output for each 1,000 trial session in replication study. (a) Intention Right; (b) Intention Left; and (c) Intention Baseline.

Figure 4 (a–c) shows the mean output of the REG broken down by consecutive 1,000 trial sessions for each intention (right, left, and baseline) and for the control output. For the right intention, Figure 4 shows that on most pairs of blocks of 1,000 trials, the mean REG output follows a fairly consistent pattern in which the means are either higher compared to the control condition or about the same. In contrast, the data for each of the left and baseline conditions show a pattern with less separation between conditions.

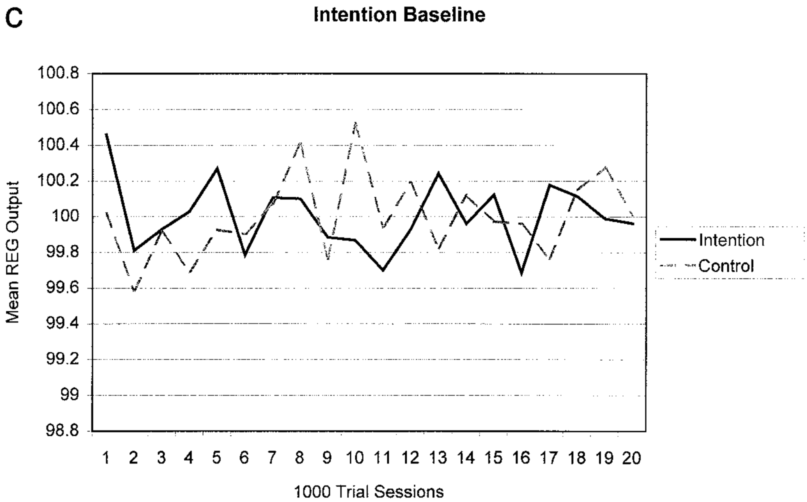

Fig. 4. (Continued).

Discussion

We examined the claims from the PEAR program that an individual's intentions can influence the statistical distribution of random physical phenomena. Our main focus was to test these claims using well-designed control conditions in a population that might maximize the likelihood of detecting any effects that may exist. Our choice of studying patients with frontal lobe lesions was based on the concept that the potential to influence random physical events may be optimized when attention is diverted from self-awareness (i.e., such as when self-awareness is reduced). This state can occur following frontal brain damage (Stuss et al., 1986; Stuss, 1991; Carver et al., 1991). Our findings showed a significant effect for the right intention in a subject with left frontal brain damage. Moreover, this effect was in the direction of intention. In contrast, there were no significant effects in the other groups (i.e., bilateral frontal, right frontal, pooled frontal, or normal subjects).

Although the result in the left frontal patient on the right intention was statistically significant, even after correction for multiple comparisons, this finding was interpreted with great caution. First, it was based on a relatively small number of intention trials ($n = 3{,}000$) and was derived from only one subject. Second, we found a p-value for an individual "subject" in the pseudodata that would also have met criteria for significance using a Bonferroni correction and that was even less than the p-value of 0.0015 obtained from the left frontal subject. Although the effect of this "pseudopatient" was not in the direction of intention, the fact that it was significant raised caution for interpreting the effect in the left frontal patient. However, the replication of the findings in the left frontal patient in a second well-designed study for each of the three intentions: right, left, and baseline, suggests that the effect in this subject may be more than chance occurrence.

Additional support for a reliable effect in the left frontal subject comes from further analysis of his data suggesting about a 94% chance of his showing a similar finding if another series of 19 pairs of blocks of 1,000 trials were run again. Furthermore, the profile of REG output data for the right intention showed a fairly consistent separation whereas this was not the case for the left or baseline intentions.

A comment is warranted about the REG output for the left frontal patient being lower for the control condition on the right intention, or more to the left, as compared to the control conditions for the left or baseline intentions. One might argue that the significant effect on the right intention was an artifact of comparison to control data that was in the left direction and that this widened the difference between the intention and control data. However, this argument is not tenable because the effect on the right intention was significant even when the REG output was compared to a theoretical mean of 100—a value which is approximately equal to the control means for the left intention (99.99985) and the baseline intention (100.0011).

The patient's cognitive deficits and brain lesion have been described elsewhere (Marras et al., 1998). He suffered from a tension pneumocephalus which resulted in cognitive deficits and epileptic seizures. The cognitive deficits include decreased mental flexibility on the Trail-Making Test, poor attention, reduced fluency, and impaired spatial planning and visuospatial problem solving. MRI showed an extensive left frontal lesion but the right frontal lobe was intact. Psychometric testing and SPECT suggested the addition of right frontal dysfunction. The SPECT findings provide a measure of function, as opposed to structure, and were subtle.

As indicated above, frontal lesions have been associated with reduced self-awareness (Stuss et al., 1986; Stuss, 1991; Carver et al., 1991), a state that is difficult for normal individuals to achieve. The rationale for studying patients with damage to the frontal lobes was that decreased self-awareness might facilitate the effects of intentionality on random physical phenomena. Brain regions that mediate neurological processes underlying self-awareness include the frontal lobes bilaterally, particularly on the right (Stuss et al. 2001a; Stuss & Alexander, 2000a; Stuss & Alexander, 2000b; Stuss et al., 2001b). Whereas the patient's right-sided brain dysfunction may have been insufficient to produce a deficit in self-awareness, the extensive lesion on the left may have resulted in reduced self-awareness when attention was directed towards the right. However, it remains unclear why positive results should be found only following damage to the left frontal region and not after bilateral or right frontal lesions. One speculation is that the effect on random physical events may require reduced self-awareness combined with relatively intact attentional mechanisms. The association of frontal lobe lesions, especially on the right, with impaired attention (Stuss & Levine, 2002) may explain the negative findings in the setting of bilateral or right frontal damage. Whether deficits related to left frontal abnormalities can explain the observed effects on the REG output warrants further study. Moreover, the question whether normal processes associated with intact frontal lobe function, together with preserved self-awareness, may serve to inhibit effects of intentionality on random physical phenomena needs to be addressed.

The strength of our conclusions rests largely on a well-designed methodology and replication of our findings. Although our results did not replicate the findings reported by Jahn and his colleagues in normal subjects (Jahn et al., 1987a, 1997), they support their claims that intentionality can alter the output of a random event generator. Furthermore, our findings suggest that patients with frontal lobe lesions may serve as a good model for future studies of the effects of consciousness on random physical events.

Acknowledgments

We gratefully acknowledge Dr. Donald Stuss for his helpful advice and support throughout the study, and for reviewing the manuscript and for his helpful suggestions; Dr. Louis Siminovitch for helpful advice and support; Patricia Ebert and Dr. Donald Stuss for assisting with analysis of lesion localization for the CT and MRI scans; Janice Pogue for statistical advice; Lee Ferreira for testing the subjects; John Sloan for assistance with data collection; Tania Xerri for assistance with data analyses; and Tania Xerri, Maedean Brown, Wanna Mar, and Melissa Ziraldo for preparation of materials for publication. We also gratefully acknowledge Professor Robert Jahn, Brenda Dunne, Dr. Roger Nelson, Dr. York Dobyns, and John Bradish at the PEAR lab for their helpful advice and for providing the portable REG and software for the study. This study was supported by the Fetzer Institute. Dr. Freedman was supported by the Saul A. Silverman Family Foundation, Toronto, Canada, as a Canada-International Scientific exchange program (CISEPO) project.

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