Journal of Scientific Exploration, Vol. 21, No. 2, pp. 261–279, 2007 0892-3310/07

The Yantra Experiment

Y. H. DOBYNS, J. C. VALENTINO, B. J. DUNNE, AND R. G. JAHN

Princeton Engineering Anomalies Research Laboratory
School of Engineering and Applied Science
Princeton University, Princeton NJ 08544-5263
e-mail: rgjahn@princeton.edu

Abstract—Qualitative and analytical observations of consciousness-related anomalies in random event generator (REG)–based experiments suggest that direct conscious feedback regarding experimental performance may impede rather than facilitate anomalous effects. The Yantra experiment tests this hypothesis by providing no outcome-related feedback to the operator. Feedback is replaced by a visual and auditory environment expected to be conducive to anomalous performance. This environment allows a number of options which operators can adjust to suit their personal taste, or to explore alternative conditions. The lack of feedback intrinsic to the program is reinforced by an experimental policy that forbids an operator to receive feedback before completing 10 experimental sessions or declaring an inability to return for further data collection.

Data analysis assumes that individual operators perform idiosyncratically; that populations distinguished by gender and previous experimental experience may perform differently; and that operator performance may depend on the environmental parameters of the protocol. All of these dependencies are found to exist. The most general test for distinctive individual behavior, a χ^2 constructed from the Z-scores for each segment in which intention, operator, and environment are held constant, produces $\chi^2 = 629.05$ on 558 degrees of freedom, $p = 0.020$. The effect appears to be asymmetric and driven by changes in the high intention data alone. Gender differences in differential success rates are comparable to those seen in earlier experiments and are statistically significant ($Z = 2.213$). Analysis of subgroups distinguished by both gender and previous experience shows that previously experienced female operators produce individually consistent performances regardless of the imposed environment (although variable between individuals), while all other operator subpopulations show strong sensitivity to environmental conditions. Overall, the effect size, as measured by local mean shifts, is approximately four to five times that seen in earlier REG experiments, suggesting that similar no-feedback, environmentally supportive protocols may be fruitful for future research.

Keywords: human-machine anomalies—consciousness-related anomalies—PEAR—REG—psychological correlates—subjectivity—individual variations—feedback

I. Introduction

The Princeton Engineering Anomalies Research (PEAR) program has studied the effect of human intention on microelectronic random event generators (REGs) in experiments dating back to 1979 (Jahn & Dunne, 2005; Jahn *et al.*, 1987, 1997, 2000a). Various modes of performance-related feedback have been used over that time. In the original experiment, feedback was automatic unless the operator went to some effort to avoid it, since a large and conspicuous front panel on the REG device displayed both the current trial value and a running average for the current collection of trials. Moreover, since a final run mean was displayed for the operator to record in a logbook, the "no-feedback" condition was maintained only for the duration of the current trial sequence. Subsequent remote experiments with the same equipment were run in a genuine no-feedback condition. Alternative modes of graphical feedback were introduced in the late 1980s, and proved popular with operators.

The initial introduction of graphical feedback seemed not to have significant consequences for the effect size, except for some operators on an individual basis (Nelson *et* al., 2000). Later experiments, however, suggested that this might not be a universal generalization. An experiment designed specifically for its appealing feedback produced no significant results by overall outcome measures (Jahn ***et*** al., 2000b), while in the extensive replication effort of the IGPP consortium, graphical feedback (chosen as the default mode) actually seemed counterproductive, with two of the three participating laboratories reporting statistically significant differences of performance in which graphical feedback proved inferior to other feedback modes (Jahn *et* al., 2000a, table M.2). In addition, anecdotal reports indicated that at least some operators found outcome-related feedback, with its implications of evaluation and judgment, to be objectionable and preferred to work without feedback of any kind.

These considerations led to the design of an experiment that would provide no feedback regarding experimental outcomes. This design was facilitated by the availability of a new generation of REG sources without front panel displays. With the computer screen relieved of the necessity for a feedback display, it was decided to use the screen to present an image that it was hoped would be conducive to anomalous performance. The specific choice of image was motivated by the experience of the "ArtREG" experiment (Jahn *et* al., 2000b). In that experiment, operators were presented with two superimposed pictures, initially in a "double exposure," with half the pixels on the screen coming from each picture. The balance between the two images varied under the control of an REG input, and the operator's intentional task was to make the chosen target image dominate the screen. While the results of the experiment as a whole were non-significant, there seemed to be a substantial effect size associated with a subset of the images. These images were deemed "numinous," containing significant religious or spiritual imagery from a number of different traditions. After some deliberation it was decided to use a mandala design known as the "Sri Yantra" (see Figure 1) as a numinous visual display to accompany the new experiment.

2. The Yantra Environments

The environmental parameters presented by the Yantra experiment include options for both visual and auditory components intended to facilitate

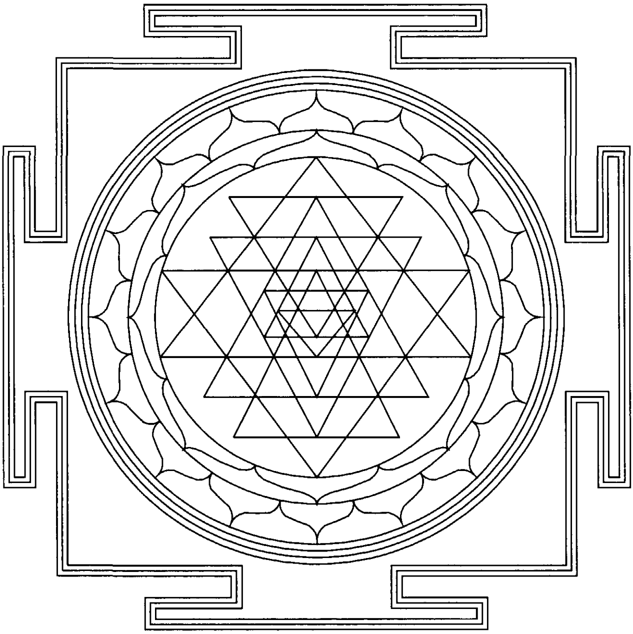

Fig. 1. The Sri Yantra mandala.

a meditative state of mind and suppress analytical focus. The Sri Yantra is a pattern of interlocking triangles at the core of Figure 1, a symbol which is supposed to represent the interpenetration of spirit and the material world. The remainder of the design consists of a series of traditional framing elements commonly used to surround the Sri Yantra, which also appear frequently in other mandala designs.

Operators have three choices of visual environment. The Sri Yantra mandala can be presented as shown in Figure 1, as a static picture on the computer monitor (in white lines on a blue background screen). Alternatively, sectors defined by the various radial boundaries (the surrounding box, the internal circles bounding the "lotus blossom" patterns, and the Sri Yantra itself) can be presented in differing background colors, with the colorrnap changing in a steady rhythm driven by arrival of REG trials at the computer. (The values of the trials have no effect on this; only their reception by the computer is relevant.) The pattern of specific color changes is chosen by a pseudo-random process unconnected to the experimental data. As a third alternative the monitor can simply be left blank.

Similarly, operators are offered several options for audio environment. By means of a servomotor controlled from an output port and connected to a drumstick, the computer can beat a large Native American drum in the experiment room. The default audio operation is for the drum to beat once with each data reception event (that is, in the same rhythm as the changes in the video if changing video is in use). An alternative rhythm beats the drum twice, quickly, with each trial, producing a pattern of quick double beats separated by slightly less than a second, strongly reminiscent of a heartbeat. A third option is silence, and a fourth allows operators to bring their own music CDs or other recording media to play any soundtrack that appeals to them while doing an experiment.

In addition to these various environmental options, another experimental parameter carried as a variable is the instructed versus volitional assignment of intention deployed in most of PEAR's REG-based experiments. There are thus twenty-four possible combinations of intentional assignment, visual environment, and audio environment. These are chosen freely according to the operator's preferences, although operators who explore more than one environment are encouraged to generate substantial databases in each.

3. Experimental Protocol

In Yantra, as in most PEAR REG experiments, the primary variable is operator intention: operators actively attempt to shift the REG output distribution in the high and low directions, in a balanced design. The basic unit of data collection is a *trial* of 200 random bits, summed to produce a random integer with theoretical mean 100 and standard deviation $\sqrt{50} \approx 7.071$. Trials are produced at a rate slightly faster than 1 per second. Sequences of 100 trials are generated automatically as runs. The basic unit of operator participation is a *series* in which an operator completes two runs in the high intention and two runs in the low intention. This requires approximately 10 minutes in a typical case. Unlike the standard REG protocol, Yantra is bipolar rather than tripolar, with no baseline intention. The assignment of intentions to runs may be made by the operator, or determined by the computer. In the latter case the determination is made by a pseudo-random process seeded by the time at which the program is started. For both volitional and instructed data, the program enforces the constraint that a series contains exactly two runs of each intention.

Since series are quite short, many operators chose to generate multiple series in one session. While operators could, in principle, generate as many or as few series as they cared to, the experimental protocol provides no feedback on their performance until they either (a) complete at least 10 series, or (b) declare that they will not generate any further Yantra data. This policy has the beneficial side effect of assuring that small databases from short-term operators could not be subject to optional stopping, since operators had no information about the outcome of their efforts. While operators could, if they wished, receive feedback after their 10th series, several of those who continued to larger databases chose not to be given feedback until they had completed their entire Yantra involvement.

When the Yantra experiment was launched it was decided that it would be closed after 1000 series had been generated. Practical considerations having to do with the availability and enthusiasm of operators, and the desirability of large operator databases, led to a slight relaxation of this condition, to the stipulation that the experiment would run at least 1000 series and that after the 1000-series mark the experiment would be kept open only for the benefit of operators who were attempting to complete previously declared commitments regarding personal database size. Once these outstanding commitments were completed Yantra had generated a total of 1017 formal series. Space precludes the presentation of the raw data in the current article, but they can be found in the Appendix to the Technical Note on the Yantra experiment (Dobyns et al., 2006).

4. Data Analysis Methods

Yantra analysis was designed from the outset under the assumption that operators would produce individual and idiosyncratic results. Of course, individual Z-scores for operators have always been computed in PEAR experiments; individual variability becomes relevant only when constructing an overall "bottom-line" evaluation for the population of operators. The standard pooled, weighted Z-score test used in earlier experiments is clearly not acceptable under this hypothesis. It is tantamount to assuming that all operators are interchangeable. While it is the most sensitive possible test for detecting a consistent universal effect, individual variations are averaged out and become invisible.

Given the hypothesized situation of effect sizes that will vary among individuals in an unpredictable manner, there is no one statistical test that is optimally sensitive for all conditions; sensitivity depends on the model of variation. A test that is very broadly useful, however, is a χ^2 test based on the 2-scores of components. This is computed by simply squaring the Z-scores of all component databases and summing the squares; the number of degrees of freedom (d.f.) of the χ^2 is equal to the number of components. Two features of this test make it particularly useful and versatile. First, χ^2 values follow an addition rule: the sum of two χ^2 values is another χ^2 value with a number of d.f. equal to the sum of the d.f. in the two contributions. Second, if the composite Z mentioned above is squared and subtracted from the overall χ^2, the result is again χ^2 distributed* with one fewer d.f. This secondary χ^2 is driven solely by the variation between subsets, the mean effect having been removed by the Z-score subtraction. To express these three quantities mathematically, if there are a total of N subsets, with the ith subset comprising n_i data units and having an aggregate Z-score of Z_i, the composite Z, raw χ^2, and variability χ^2 can be written:

$$Z_c = \frac{\sum_{i=1}^{N} Z_i \sqrt{n_i}}{\sqrt{\sum_{i=1}^{N} n_i}}; \quad \chi_r^2 = \sum_{i=1}^{N} Z_i^2 (N \text{ d.f.}); \quad \chi_v^2 = \chi_r^2 - Z_c^2 (N-1 \text{ d.f.}). \quad (1)$$

* This is not a general subtraction property for χ^2; the difference of two χ^2 is not in general χ^2 distributed. It can be shown, however, that in this specific case, the residual, after subtracting the mean Z^2 from a χ^2, is in fact χ^2 distributed.

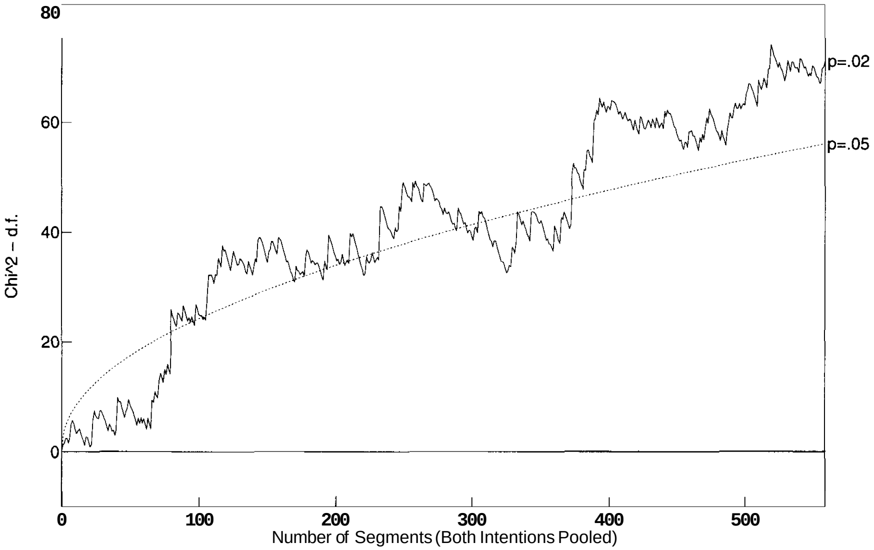

Fig. 2. Cumulative plot of (χ^2 – d.f.) for all data segments distinguished by operator, environment, and intention in the Yantra experiment.

These equations provide the basic tools for most of the Yantra analytical treatments. In addition to inter-operator variability, previous experiments led to an expectation that operators might either individually or collectively vary in their responses to the 24 operating environments, and display distinct effects in high and low intentions. Moreover, it is expected from previous REG observations that if the operator pool is divided into subtypes by gender and previous experience, different patterns of performance appear in the subtypes. Analyses for all of these factors are obviously necessary for the interpretation of the experiment.

5. Results

The total database of 1017 series was contributed by 61 different operators. At least some exploration of each of the 24 possible environments was conducted. The extreme form of the idiosyncratic-effects hypothesis is that a different effect may be seen in any data subset generated by a different operator, in a different environment, in a different intentional effort. The set of all data generated by a single operator in a single intention and environment will be referred to hereafter as a segment. There are 558 such segments in the formal database, 279 in each intention. These segments have a raw $\chi^2 = 629.04$, $p = 0.020$. Figure 2 illustrates the outcome in the closest possible analog of PEAR's traditional cumulative deviation, with the excess of χ^2 over its theoretical expectation (*i.e.*, the number of d.f.) plotted against the number of segments accumulated.

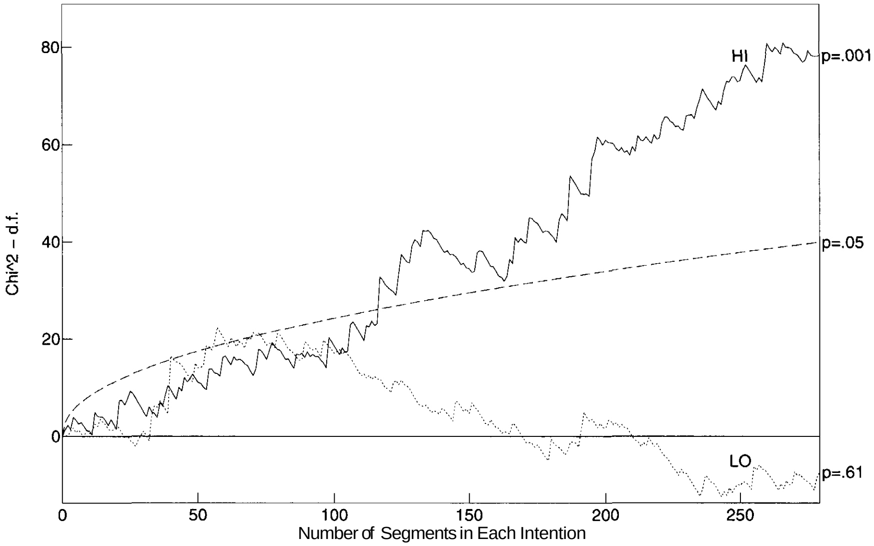

Fig. **3.** Cumulative χ^2 plot of operator × environment segments, with segments in the high intention and low intention shown separately.

Figure 3 illustrates the result of separating the segments according to operator intention. The high segments have $\chi^2 = 357.36$ on 279 d.f., $p = 0.0010$. The low segments, in contrast, have $\chi^2 = 271.68$ (p = 0.612). The effect is thus driven by the large mean shifts observed in the high intention alone, a result similar to that seen in other non-feedback experiments (Dunne & Jahn, 1992). One may also construct the population of 2-scores for the intentional difference: $Z_\Delta = (Z_H - Z_L)/\sqrt{2}$, for each matched pair of segments (*i.e.*, the segments run in the high and low intentions by a given operator in a given environment). Not surprisingly, this produces an intermediate result: $\chi^2_\Delta = 321.59$ on 279 d.f., p = 0.040.

These results are almost purely driven by inter-segment variation. The overall pooled Z_c results are 0.0307 and -0.2070 in the high and low intentions, respectively: the pooled $Z_\Delta = 0.1681$. Subtracting out this average effect yields variability-driven χ^2_v (all with 278 d.f.) of 357.36 (p = 0.00091) in the high intention, 271.64 (p = 0.596) in the low, and 321.56 (p = 0.037) in the high – low difference.

5.1. Individual Operators and Operator Subtypes

The effects are less impressive when operators are considered singly, without regard to environmental differences. Figure 4 shows a scatterplot of the 61 operator performances in the two intentional conditions. These contributions produce overall χ^2 values of 76.165 ($p = 0.091$) in the high, 68.150 (p = 0.247) in the low, and 56.060 (p = 0.655) in the delta condition.

There is, nevertheless, evidence of anomalous performance in the operator-

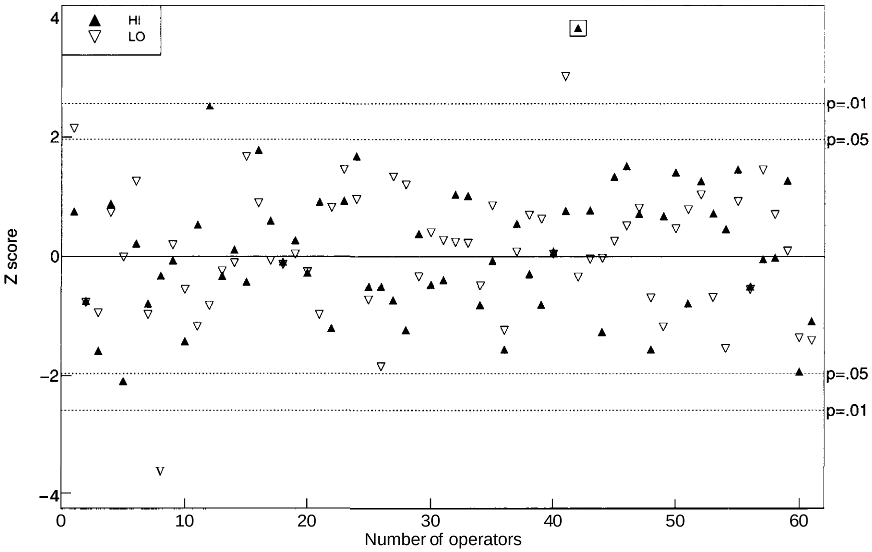

Fig. 4. Scatterplot of all individual operator performances, not divided into environment segments.

by-operator database as well. The largest 2-score attained by any operator (marked by a square in Figure 4) is $Z = 3.833$ ($p = 1.26 \times 10^{-4}$, two-tailed). After Bonferroni correction for having 122 such scores to examine, this remains a conventionally significant value of $p = 0.015$. Nor is this performance alone; datasets by three different operators show $|Z| > 3$, an overpopulation that is a $p = 0.0046$ event.

This would seem, at face value, to indicate that some operators produce consistent, individual effects, though the population as a whole does not. This can be clarified by examining Figure 5, which shows the operator-based χ^2 values for each of the four subsets resulting when the operators are segregated according to their gender and previous experience with REG-type experiments. More specifically, for readier visual comparison this figure shows the ratio of χ^2 to d.f., so that the horizontal line at 1 shows the chance expectation for each test. The plotted letters show the χ^2/d.f. value for the high and low intentions. The dotted lines show the 95% confidence limits for the χ^2; they are at different heights in the different subsets because χ^2/d.f. has different quantiles for different d.f., even though its expectation is always 1. It is clear from Figure 5 that the experienced female operators have highly significant individual effects in both high and low intentions; all of the other operator subtypes show no such effects. It is worth noting that all three of the $|Z| > 3$ databases were produced by such previously experienced female operators. In contrast, Figure 6 shows the segment-based (or operator X environment) χ^2 for these same operator subpopulations. Here we see the interesting outcome that the females with previous experimental experience have a non-significant result, while each of

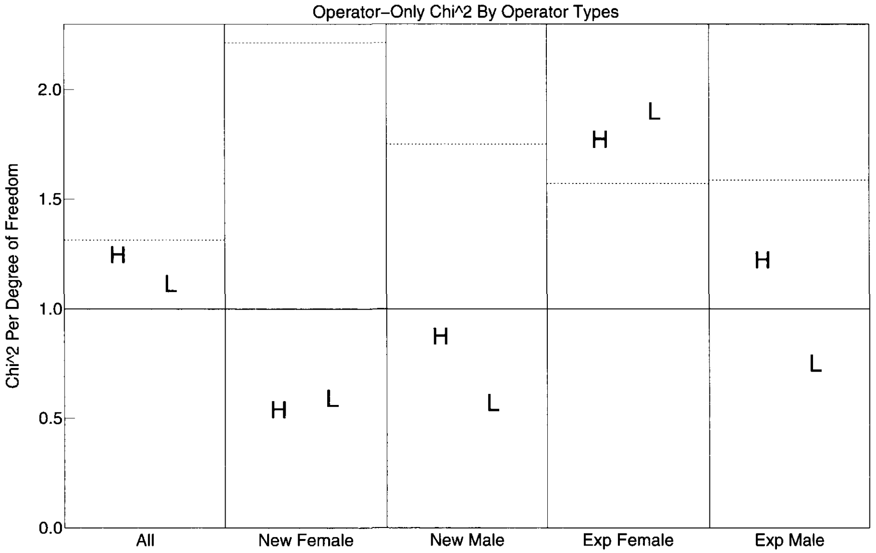

Fig. 5. Operator-based χ^2 values separated by operator gender and experience. The plotted letters show the ratio χ^2/d.f. for each of the two intentions: the solid line at 1 is thus the theoretical expectation. The dotted lines show the $p = 0.05$ confidence limit; they are at different heights in different sections due to different numbers of d.f.

the other operator populations produces a χ^2 in the high intention that exceeds the 95% confidence limit for chance variation. The implications may be clearer if the numeric data are presented in tabular form, as in Table 1.

The first row of each section of Table 1 gives the number of d.f. in the χ^2 for that column. It should be noted that for the operator χ^2, the d.f. do not add up to 61 because five of the "operators" in the full dataset are actually male-female co-operator pairs and cannot be assigned to a specific gender. Below the d.f. entry is the cutoff value for $p < 0.05$ significance in a χ^2 with that number of d.f.

Of particular interest in Table 1 is the comparison between operator-only and operator $\times$ environment χ^2 for the experienced female operators. These 20 operators produce an excess χ^2 of 15.48 above expectation ($p = 0.018$) in the high intention, and 18.06 ($p = 0.0087$) in the low, when an operator-based χ^2 is computed for each operator's total performance. When the data are further subdivided by environment, the number of d.f. increases from 20 to 89, while the χ^2 values increase from 35.483 to 96.687 and from 38.064 to 106.526 in the high and low intentions, respectively. Put another way, the further subdivision of the data adds 69 d.f., while adding 61.204 and 68.462 to the two χ^2 values. We thus see that the previously experienced female operators show strong evidence for an effect when their total databases are examined, but the subdivision by environments increases the χ^2 only by amounts such as would be expected from the increase in d.f., that is, consistent with these operators displaying only

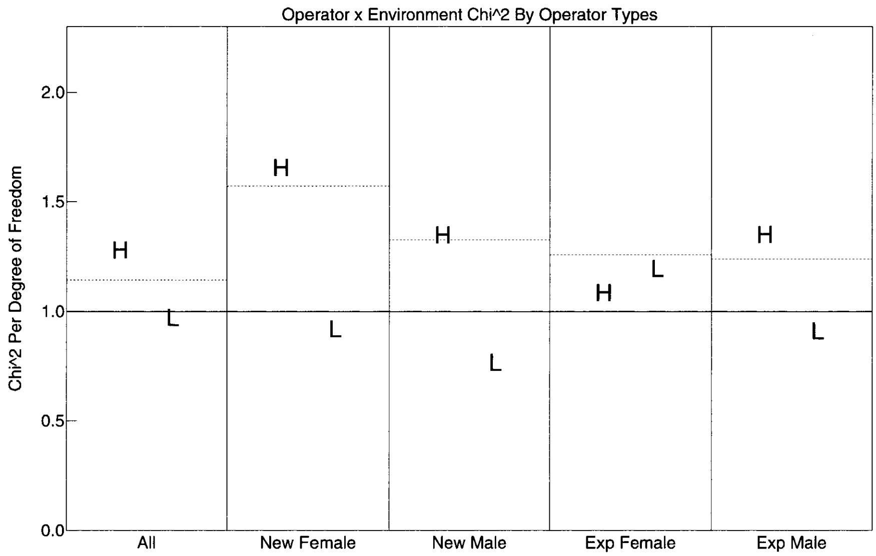

Fig. 6. Operator × environment χ^2 values separated by operator gender and experience. C ' Figure *5*.

random variation between environments. We may thus conclude that they show characteristic personal effects which are unaffected by the operating environment.

In contrast, the other operator subgroups (females without prior experience, and both experienced and inexperienced males) show only the expected level of random variation in their overall personal performances, but they show variation far beyond chance levels when their data are subdivided by environment. (This is evident in the high intention, as is obvious from Figure 6; the pooled high data from Table 1 for these operators has $\chi^2 = 250.63$ on 181 d.f., $p = 0.00047$. The

TABLE 1
Analysis by Operator Subtype

Subtype	New Female	New Male	Exp Female	Exp Male
Operator d.f.	5	12	20	19
$p < 0.05$ cutoff for this d.f.	11.07	21.03	31.41	30.14
Op χ^2, HI	2.700	10.506	35.483	23.257
Op χ^2, LO	2.964	6.874	38.064	14.279
Op χ^2, Δ	0.981	8.835	28.840	12.490
Op × env d.f.	20	57	89	104
$p < 0.05$ cutoff	31.41	75.62	112.02	128.80
Op × env χ^2, HI	33.146	76.912	96.687	140.572
Op X env χ^2, LO	18.429	43.718	106.526	94.904
Op × env χ^2, A	28.698	60.665	98.281	125.239

Note: Exp = experienced; Op = operator; HI = high intention; LO = low intention; env = environment.

low data are at chance levels, but even pooled across both intentions the high results drive a marginally significant outcome: $\chi^2 = 407.681$ on 362 d.f., $p = 0.049$, for high and low intentions combined.) We may conclude from this that all operators, except experienced females, produce anomalous effects that are not only personally idiosyncratic, but also strongly influenced by the operating environment.

This analysis by gender does not include the co-operator subset, for which a meaningful assignment of gender cannot be made. While previous analyses have suggested that co-operators display interesting gender-like effects according to their status as same-sex or opposite-sex pairings (Dunne, 1991), the co-operator database in Yantra is too small and homogeneous to extract meaningful results from such a breakdown. There are five co-operators, all opposite-sex pairs, contributing operator-based χ^2 values of $\chi^2_h = 4.217$, $\chi^2_l = 5.974$, and $\chi^2_\Delta = 4.914$, none of which are significant. They contribute 9 of the 279 segments in each intention, for segment-based χ^2 of $\chi^2_h = 10.045$, $\chi^2_l = 8.104$, and $\chi^2_\Delta = 8.703$, all likewise nonsignificant.

5.2. Gender Analysis

While the above subdivision into types has been instructive, it differs from the gender analysis performed by Dunne (1998), which found striking gender-based differences in a much simpler statistic, namely, the rate of differential success by operator gender. That is, if one simply counts, for each gender, how many operators "succeed" in their intentional effort (have a higher mean in the high intention than in the low), one finds different success rates for male and female operators.

This effect has been exactly replicated in Yantra, as shown in Figure 7, where 20 of the 31 male operators succeed in the direction of intention, while only 9 of the 25 females do so. (For completeness, we may note that 4 of the 5 co-operators do so.) The difference is equally present in the data of experienced and new operators; only the smallness of the database prevents it from achieving statistical significance among the new operators. It would appear that despite the numerous distinctions between Yantra and other REG-type experiments, a basic gender-based difference in response remains pervasive.

5.3. Operating Conditions

The strongest effects in the Yantra database are the excess of variation seen in the high intention, when the data are split into segments according to both operator and environment, and the consistent personal performances of experienced female operators. All of this has been established from a viewpoint that individual operator performance is primary, and that operating conditions provide extra sources of variation within a particular operator's database. This is not, however, the only way the Yantra data segments can be organized. We may ask equally well whether there are characteristic patterns of operator performance

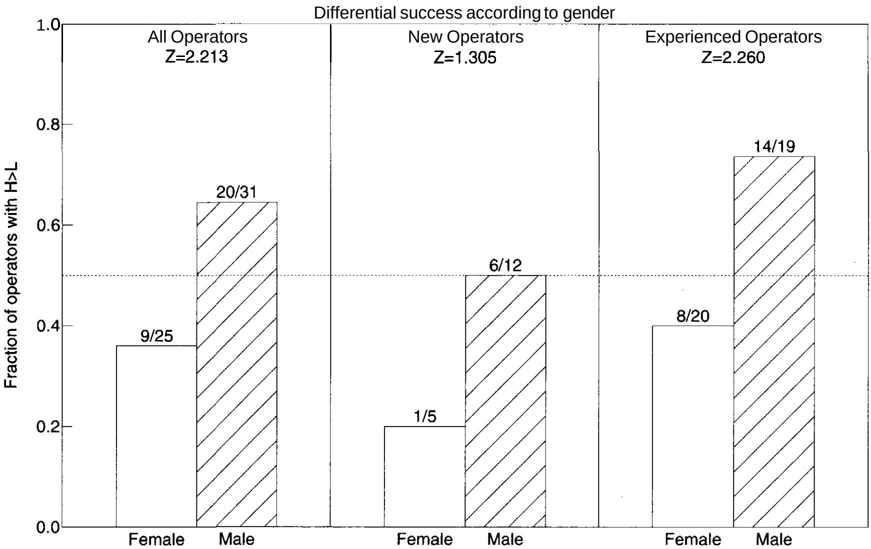

Fig. 7. Differential success rates in direction of intention by operator gender and previous experience.

in particular operating environments, and how much inter-operator variation occurs within a fixed environment.

These questions can be answered directly by computing an overall composite Z for all of the segments produced in a given operating environment. The sum of the squared 2-scores of all segments in the environment is the basic χ^2 for that environment. As discussed in section 4, when the squared composite Z_c is subtracted from this we are left with a χ^2 showing the degree of inter-operator variability. It has, of course, one less d.f. than the number of segments in that environment.

Adding up the inter-operator variability χ^2 for each of the environments yields a χ^2 with $279 - 24 = 255$ d.f., driven by the amount of inter-operator variability that exists when environmental conditions are held constant. Similarly, the sum of all of the Z_C^2 for the 24 environments is a χ^2 derived from any effects that are consistent within environments, although they may vary between environments. From the construction of these two values it is obvious that they must add up to the same total segment-based χ^2 presented in earlier analyses, with the same total d.f. This is why the calculation is referred to as an alternative way of organizing the Yantra data. Instead of partitioning the list of segments by operators and then examining within-operator variability from environmental conditions, here we are partitioning the segments by environments and then examining within-environment variability from operators.

Figure 8 shows the results of this partitioning. Somewhat surprisingly, it indicates that both inter-operator variation and consistent mean shifts contribute

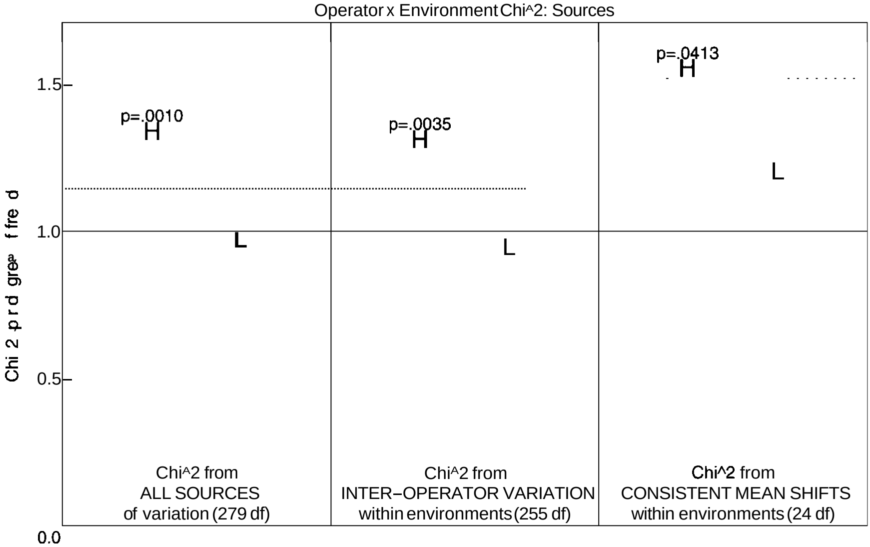

Fig. 8. Sources of the operator X environment χ^2: consistent performance in conditions vs. operator variation within conditions.

significantly. In addition to the expected inter-operator variability component, there is also a significant contribution from consistent performance across operators within each environment. Indeed, considered in terms of effect size (the proportional increase in the χ^2 over its expectation), the latter is more than twice as large as the more highly significant effect of inter-operator variation.

Figure 9 plots the 24 operating environments individually against these two measures of anomalous effect. The three-letter codes indicate the three features of the environment: assignment of intention (volitional [V] or instructed [I]), type of visual display (changing [C], static [S], or none [N]), and type of audio environment (single beat [S], heartbeat [H], none [N], or other [O]). This plot shows only the high intention, since the low intention data are indistinguishable from chance in this representation. The vertical axis is Z_c for that environment, the pooled Z-score for all data run under those environmental conditions. The horizontal axis is constructed by converting the inter-operator variability χ^2 for that condition to its equivalent Z-score (specifically by applying the inverse normal distribution to the p-value calculated for the χ^2). The dotted circle shows the 95% confidence bounds for the null hypothesis in such a plot; if the points are distributed according to two independent, normally distributed variables, 95% of them should fall within the circle. Five of the 24 points are clearly well outside this circle (the three-letter labels are centered over the exact points); in fact, a sixth (the VCH condition at upper left) also falls just outside the boundary. Thus, 6 of the 24 environments exceed the $p < 0.05$ criterion for their distribution along these two parameters of consistent internal effect and inter-operator variation; this overpopulation is itself a $p = 0.00096$ event by exact binomial calculation.

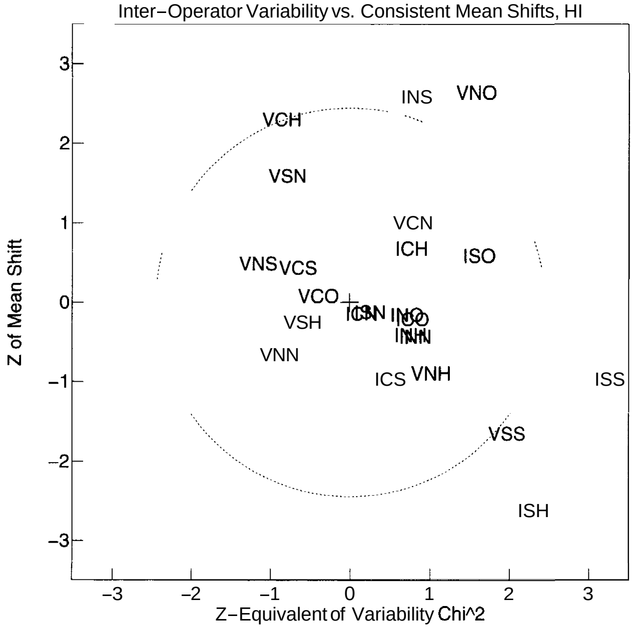

Fig. 9. The 24 conditions, plotted against their consistent effect (vertical axis) and inter-operator variation (horizontal axis). Dotted circle shows 0.95 confidence limits of null hypothesis; 95% of plotted points expected to fall within this circle. High intention data only.

This figure also provides potential insights into which environments actually are more conducive to producing anomalous yields, either in a global or an operator-specific mode. Of the six individually significant outliers, three used instructed assignment and three volitional, indicating no preference. All involved some form of audio stimulation—the no-audio environments are all well within the circle. Moreover, three of the six involve specifically the single-drumbeat audio. Since each of the four audio options appears in 6 of the 24 possible environments, this means that fully half of the single-drumbeat environments show individually significant anomalous performance.

To determine the effects of the particular environmental parameters individually on the anomalous yield, a segment-wise χ^2 may be computed on those segments containing those parameters. Different parameter values can then be compared by an F-ratio test. Table 2 summarizes these results for the high intention only, again because only the high intention results display an overall anomalous effect.

While it appears that instructed assignment is driving the effect and the volitional condition contributes little, this assessment must be made with caution. The F-ratio test between these two χ^2 values is 1.267 on 198 and 81 d.f., $p = 0.111$. There is thus a reasonable likelihood that the instructed and volitional databases are samples from the same underlying distribution, and the

TABLE 2
Individual Environmental Parameters

Parameter Value	d.f.	χ^2	p-Value
Assignment of Intention			
Instructed (I)	198	270.16	0.000495
Volitional (V)	81	87.20	0.299
Video Environment			
Changing (C)	157	164.60	0.323
Static (S)	77	131.81	0.000102
None (N)	45	60.96	0.0565
Audio Environment			
Single beat (S)	100	140.95	0.00440
Heartbeat (H)	84	111.09	0.0256
Other (O)	15	23.69	0.0705
None (N)	80	81.63	0.428

lack of significance in the volitional segments is a combination of happenstance and smaller database size.

For the video environment, the face-value conclusion is that the changing video offers no anomalous yield, while the static video contains a strong effect. In contrast to the previous case, this is confirmed by an F-test between the two: $F = 1.633$ on 77 and 157 d.f., $p = 0.0051$. Even after a factor-of-three Bonferroni correction to allow for the fact that there are three ways to pick two comparison sets out of a group of three, this remains clearly significant at $p = 0.015$. The no-feedback condition is intermediate between the two in both effect size and significance, and F-tests confirm that it cannot be distinguished reliably from either.

For the audio environment, both of the drum-based environments show robustly significant effects. The "Other" environment, indicating an operator-provided audio background, appears to contain comparably strong effects, although its small size precludes statistical significance. In contrast, the no-audio condition is clearly null. Unfortunately, this distinction, while highly suggestive, may also be subject to overinterpretation, since the comparison of the no-audio condition with the pooled results of the active audio conditions still only achieves a marginal F-ratio of 1.358 on 199 and 80 d.f., $p = 0.0585$. The factor-of-four Bonferroni correction required reduces this almost-significant result to nonsignificance, indicating that although the anomalous yields appear to be present only when audio feedback is used, we cannot claim statistical confidence that this correlation is not coincidental.

As a final note on environmental effects, it is worth recalling that the environment of every experimental series is chosen by the operator to suit his or her current mood and preferences. Despite this, many of the environments seem to produce no anomalous yield. Statistical scrutiny of the environmental components confirms that the most popular choice of video display is associated with a null result that can validly be distinguished from that of the rest of the experiment. It thus would seem that the aesthetic preference for a particular environment is no guarantee of its facilitation of anomalous performance, even for the particular operator expressing the preference. We may observe that this is consistent with the outcome of the ArtREG experiment (Jahn et al., 2000b), wherein most operators reported that they found the experience enjoyable, but which nevertheless produced no overall anomalous yield.

5.4. Miscellaneous Observations

Three operators, all males lacking previous experience, performed a sub-experiment within the main Yantra experiment. These operators were all practitioners of a Japanese healing discipline known as Johrei. They intentionally employed Johrei techniques in exactly half their Yantra data, and refrained from using Johrei in the other half. These data have been reported in more detail elsewhere (Jahn et al., 2006). The results may be summarized by noting that these operators produced strong segment-based responses in their Johrei data and null results in their non-Johrei data. Since the Johrei condition was not part of the formal definition of Yantra segments, this distinction has been diluted in the current analysis. Taking Johrei use into account as a fourth "environmental" condition would slightly increase the statistical significance of the segment-based analysis for the overall data and for the inexperienced male operators, but it would produce no qualitative change in the conclusions drawn thus far.

The overall effect size in the Yantra experiment appears to be larger than that seen in the original REG studies. Since Yantra expects, and uses statistical tests for, idiosyncratic effects that vary in both size and direction between operators, direct comparisons with the overall average effect size seen in the original REG experiment are somewhat problematic. In terms of the size of the mean shift driving the anomalous effects, however, we may note that the χ^2 for the pooled high and low data is 629.0425 on 558 segments, indicating a mean Z^2 on the segments of 1.1273. Since the mean length of segments is 729 trials, if the excess in Z^2 is (as hypothesized) driven by consistent mean shifts within segments, this mean effect amounts to a Z of 0.01321 per trial, or a mean shift of 0.0932. Although this is an estimate resting on several assumptions about the nature of the effect, it may be compared to the observed mean shift of 0.0208 in the original REG experiment; the Yantra figure is approximately 4.5 times larger. It is notable that the only other fully non-feedback experiment in the REG repertoire, the remote database, shows an effect size that is indistinguishable from the original REG, although it displays the same high/low asymmetry as Yantra (Dunne & Jahn, 1992).

If anomalous performance in the high and low intentions were independent, or were present only in one intention, we would expect the χ^2 in the Δ condition (the high minus low difference for a given segment) to be intermediate between the χ^2 for high and low. This is in fact observed for the operator $\times$ environment tests. In contrast, if effects were symmetric (that is, an operator attained the same mean shift in the direction of intention regardless of the sign of the intention), the χ^2 on the A condition would be substantially larger than that in either intention. This is not seen in any of the Yantra analyses. Instead, the operator-based χ^2 (without regard to environment) consistently shows a χ^2_Δ that is *smaller* than χ^2_h or χ^2_l. This is especially pronounced for the experienced female operators, where both intentions have significant χ^2 while A does not. This odd behavior suggests that there may actually be a correlation between the two intentions at the level of operators' complete databases, or a tendency for operators to produce mean shifts in the same direction in both high and low intention, regardless of environment. Indeed, of the 61 operators, 37 have the same sign in their overall high and low databases, *vs.* 24 who produce opposite signs in high and low. The correlation coefficient between the high and low intentional results, operator-by-operator, is $\rho = 0.2201$, $p = 0.044$ (one-tailed).

6. Conclusions

The analysis of the primary intentional data in the Yantra experiment leads to the following conclusions:

1. As a whole, the operators have anomalously shifted the means of the intentional data, although the mean shift is asymmetrical between intentions and its direction varies unpredictably among operators and among environmental conditions.
2. Female operators who have previously participated in REG experiments show consistent individual anomalous performance in both high and low intentions, regardless of environment, although the performance still varies unpredictably among operators.
3. Female operators new to REG experimentation, and male operators in general, show strong sensitivity to environmental conditions, and collectively produce effects only in the high intention.
4. Despite the fact that operators choose environments that appeal to them, certain environments are apparently conducive to anomalous yield while others are not. This suggests that an environment's ability to foster anomalous effects may not correlate with its aesthetic appeal, as was noted in the ArtREG experiment.
5. The gender-based patterns of differential success seen in earlier experiments are replicated in Yantra, on very similar scales.
6. Examination of the individual components of the environments suggests that instructed assignment of intention is more conducive to anomalies than is volitional assignment, and that drumbeat accompaniment is more conducive than is silence. However, the statistical confidence of these conclusions is modest.

7. Examination of the video component of the environment, in contrast, shows that the static Sri Yantra mandala produces strong anomalous yields, while the changing mandala does not, a distinction that is statistically robust. The state involving no visual stimulus at all is intermediate between the two and cannot be resolved statistically from either.
8. The overall Yantra effect size can be estimated to be between four and five times the effect size seen in the original REG experiments. Given that the effect seems to be concentrated in certain conducive subsets, the actual increase in effect size in those cases may be even larger.

These observations provide valuable hypotheses for future research. For example, would experiments focusing on the conditions found to be conducive in Yantra in fact produce larger yields? Despite the fact that the experiment as a whole produced unpredictable anomalous mean shifts with considerable inter-operator variation, some environments showed consistent mean shifts in the direction of intention, while others showed consistent mean shifts contrary to that direction. Can such tendencies be used to foster more consistent intentional performance among operators? What are the implications, in this context, of the gender-related differences in differential intentional success? We may conclude that while it shows a resounding confirmation of the basic hypothesis that anomalous human-machine interactions may take place in the complete absence of feedback, and while it displays numerous intriguing structural features which hint at the nature of the anomalous effect, the Yantra experiment actually raises more questions than it answers.

Acknowledgments

The PEAR laboratory gratefully acknowledges the support of Sekai Kyusei Kyo, the Hygiea Foundation, the Institut für Grenzgebiete der Psychologie und Psychohygiene, and numerous private philanthropists. PEAR also expresses its gratitude to the many uncompensated volunteer operators without whom these data could not have been collected.

References

Dobyns, Y. H., Valentino, J. C., Dunne, B. J., & Jahn, R. G. (2006). *The Yantra experiment.* Technical Note PEAR 2006.04. Princeton Engineering Anomalies Research, Princeton University, Princeton, NJ.

Dunne, B. J. (1991). *Co-operator experiments with an REG device.* Technical Note PEAR 91005. Princeton Engineering Anomalies Research, Princeton University, Princeton, NJ.

Dunne, B. J. (1998). Gender differences in human/machine anomalies. *Journal of Scientific Exploration, 12,* 3–55.

Dunne, B. J., & Jahn, R. G. (1992). Experiments in remote human/machine interaction. *Journal of Scientific Exploration, 6,* 311–332.

Jahn, R., Dunne, B., Bradish, G., Dobyns, Y., Lettieri, A., Nelson, R., Mischo, J., Boller, E., Bosch, H., Vaitl, D., Houtkooper, J., & Walter, B. (2000a). Mind/Machine Interaction Consortium: PortREG replication experiments. *Journal of Scientific Exploration, 14,* 499–555.

Jahn, R. G., & Dunne, B. J. (2005). The PEAR Proposition. *Journal of Scientific Exploration, 19,* 195–245.

Jahn, R. G., Dunne, B. J., & Dobyns, Y. H. (2006). *Exploring the possible effects of Johrei techniques on the behavior of random physical systems.* Technical Note PEAR 2006.01. Princeton Engineering Anomalies Research, Princeton University, Princeton, NJ.

Jahn, R. G., Dunne, B. J., Dobyns, Y. H., Nelson, R. D., & Bradish, G. J. (2000b). ArtREG: A random event experiment utilizing picture-preference feedback. *Journal of Scientific Exploration, 14,* 383409.

Jahn, R. G., Dunne, B. J., & Nelson, R. D. (1987). Engineering anomalies research. *Journal of Scientific Exploration, I,* 21–50.

Jahn, R. G., Dunne, B. J., Nelson, R. D., Dobyns, Y. H., & Bradish, G. J. (1997). Correlations of random binary sequences with pre-stated operator intention: A review of a 12-year program. *Journal of Scientific Exploration, 11,* 345–367.

Nelson, R. D., Bradish, G. J., Dobyns, Y. H., Dunne, B. J., & Jahn, R. G. (1996). FieldREG anomalies in group situations. *Journal of Scientific Exploration, 10,* 111–141.

Nelson, R. D., Jahn, R. G., Dobyns, Y. H., & Dunne, B. J. (2000). Contributions to variance in REG experiments: ANOVA models and specialized subsidiary analyses. *Journal of Scientific Exploration, 14,* 73–89.

Nelson, R. D., Jahn, R. G., Dunne, B. J., Dobyns, Y. H., & Bradish, G. J. (1998). FieldREG II: Consciousness field effects: Replications and explorations. *Journal of Scientific Exploration, 12,* 425454.