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ArtREG: A Random Event Experiment Utilizing Picture-Preference Feedback

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Abstract—An experiment addressing anomalous human/machine interactions utilizing a feedback display of two competing pictures, the relative dominance of which is controlled by a microelectronic random generator, has yielded a number of equivocal results. On the one hand, an ingoing hypothesis that such a visually engaging mode of feedback might facilitate larger anomalous effects has not been supported by the composite results of 49 operators performing some 390,000 experimental trials. Likewise, a smaller *ad hoc* study of the relative efficacy of a subset of target pictures having religious or spiritual themes, although yielding effect sizes comparable with earlier random event generator (REG) data, has insufficient statistical power to resolve the question. Also, an attempt to assess the relative importance of the pictorial feedback, *vis-à-vis* the output of the REG, *per se*, in facilitating operator performance has not been definitive. Yet, certain secondary anomalies in these databases, such as gender disparities, individual operator performances, and serial position effects, show several characteristics akin to those previously found in other human/machine experiments in this laboratory. Whether these indicators can be used to develop more effective experiments of this class or to achieve a more fundamental understanding of the basic phenomena is the focus of ongoing research.

Keywords: random event generator (REG) — random event experiments — human/machine anomalies — visually engaging feedback

Introduction

Two decades of rigorous empirical study of the interaction of human operators with microelectronic random event generators (REGs) in this laboratory have consistently yielded small but statistically significant anomalous departures from chance behavior that correlate with the prestated intentions of the operators (Jahn et al., 1997). These effects, however, have proven remarkably insensitive to any of the attendant physical parameters so far explored, such as data set sizes and acquisition rates, nature of the random physical sources, and spatial and temporal separations of the operators from the functioning equipment (Nelson et al., 1999). What secondary correlations have been observed tend to be of a more subjective nature, relating to the individual operator genders, preferences, strategies, reactions to the feedback, and feelings of resonance with the devices. In an effort to exploit these intangible correlates to yield larger anomalous effect sizes, a group of related experiments have been designed and implemented wherein the feedback provided the operators, and in some cases the random physical processes themselves, have more aesthetically engaging visual or auditory properties than the standard REG experiments. Examples include a large crystal pendulum, a bubbling water fountain, a randomly impacted Native American drum, a mobile robot, and, in the study reported here, a display of two competing pictures superimposed on a CRT screen. It was hypothesized that experiments that offered such aesthetic appeal to the operators would enhance their sense of resonance with them, and thereby enable larger deviations from chance behaviors.

Experimental Design, Protocol, and Analysis

In this article, we shall review the results of several years of experimentation with a target device termed "ArtREG," wherein two attractive pictures compete for dominance on a CRT screen. To achieve this presentation, the screen is illuminated by a field of $640 \times 480 = 307{,}200$ pixels, each of which may correspond to either of the competing illustrations, which are drawn from a library of 24 arbitrarily selected paintings, photographs, and designs previously scanned and digitized (Appendix A). The relative fraction of pixels corresponding to each of the two pictures is controlled by a small REG unit based on microelectronic Johnson noise (Nelson, Bradish, and Dobyns, 1992), in accordance with a software recipe that uses the cumulative deviation of the REG digital output from the chance mean. More specifically, the REG output is collected in trials of 200 sample bits, and the compounding difference of the trial-mean values from 100 is used to determine the fraction of pixels illuminated by each picture, as described more fully below.

The formal experimental protocol, which evolved over a period of informal preliminary experimentation (Appendix B), calls for the operator to examine the library of available pictures and select two for the competition. At the start of each experimental run, these appear superimposed on the screen in equal prominence, after which the balance evolves in accordance with the progress of the REG output. The goal of the operator is to bring one of the pictures into full or at least partial dominance, in accordance with a prerecorded intention. (In one popular variant, the operator may choose only one picture, to compete with a multicolored random pixel illumination, so that the chosen image appears to be sharpening from, or diffusing into, a random noise background.) When saturation by either picture occurs, or if 250 trials have been compounded without saturation, the run is terminated, the results are recorded, and a subsequent run is initiated using the same or the opposite picture preference. Runs are generated until 2,000 trials (400,000 bits) have been accumulated, comprising one experimental series, or session. Operators are constrained to use the same pair of pictures throughout a given session, but the picture preference is optional for each run.

In an effort to focus the operators' attention solely on the visual display, rather than on the REG output *per se*, a pseudorandom algorithm determines whether the emergence of the preferred picture on any given run will be associated with higher or lower deviations of the REG output from its chance expectancy of 100. Because this assignment is not revealed to the operators, they remain blind to the directional criterion that determines the success or failure of a desired run outcome. In this sense, ArtREG protocol differs substantially from that of standard REG experiments, where the feedback presented to the operator directly reflects success or failure in achieving the desired intention to produce higher or lower electronic counts. By keeping the assignment blind in the ArtREG experiment, it was hoped to determine whether the visual feedback or a more direct coupling of the operator's intention to the REG process itself was the more important factor in enabling operator performance.

Data thus are processed under two complementary criteria: success on chosen pictures and success on high or low deviations of the REG trial means. Because the algorithm determining high or low assignment ensures that each series contains equal numbers of trials (1,000) associated with each direction, the high/low analysis in ArtREG is directly comparable to that employed in the benchmark REG experiments, even though in this case the data are produced under "double-blind" conditions. Several other possible correlations also are explored in the data assessments, e.g., the effectiveness of particular pictures or picture combinations, run-level versus series-level success, and operator gender disparities.

Results

The formal ArtREG database consists of 195 series, or sessions, comprising 390,000 trials, generated by 49 volunteer operators: 21 males (98 series) and 28 females (97 series). Their results are summarized in Tables 1 through 4, which show the number of completed series (N_S); the number of "successful" series (S_S) where the average results were consistent with intention; the total number of runs (N_R); the number of successful runs (S_R); and the overall mean shift (μ), standard error (σ), and Z score for each operator. As displayed in the first column of Table 1, of the total of 3,597 runs, 1,798 were partially or completely successful and 1,799 were not. Using a theoretical standard deviation for the binary expectation of success, $\sigma = (.25N)^{1/2} = 29.987$, yields a totally insignificant bottom-line Z score of -0.0167. The next four columns display the correlations of successes with the high and low REG drivers of the preferred pictures and with the gender of the operators. The last four columns further subdivide the results into high-driven and low-driven runs by males and females, respectively. Clearly, none of these sets or subsets displays any anomalous statistical character at this level, with the possible exception of the marginal disparity between male and female results on the low-driven pictures ($Z_{diff} = 1.687$), which probably can be discounted on multiple-test grounds.

Operator-specific representations of the results are presented in Tables 2 and 3 in the form of individual male and female achievements on complete ex-

TABLE 1
Overall Run Score Summaries

Subset	N_R	S_R	$N_R - S_R$	Z-Score*	MRL† (Suc./Tot.)
All	3,597	1,798	1,799	–0.017	107/108
Male	1,792	879	913	–0.803	109/109
Female	1,805	919	886	0.777	106/108
High	1,773	895	878	0.404	109/110
Low	1,824	903	921	–0.421	106/107
$High_M$	885	448	437	0.370	110/111
Low_M	907	431	476	–1.494	108/108
$High_F$	888	447	441	0.201	108/109
Low_F	917	472	445	0.892	105/106

N_R = number of runs
S_R = number of successful runs
$N_R - S_R$ = number of unsuccessful runs
*$Z = (2S_R - N_R)/[(N_R)^{1/2}]$
†MRL = mean run lengths (0–250 trials).

perimental series, again segregated in terms of high-driven versus low-driven trials. At the bottom of each table are listed the sums of χ^2 values over the operators and the corresponding probabilities that the distributions are chance. Also included are the aggregate totals of series performance by the operators. Table 4 compounds the χ^2 and series performance results over all operators. Again, there appears to be little of statistical interest in any of these composite indicators, but despite the overall low yield of the total database, more detailed examination reveals a few potentially instructive features. For example, 11% of the database consists of single series generated by 45% of the operators. Seventeen of these single-series databases, or 74%, yield positive results in the combined high–low data ($Z = 2.558$).

As an alternative representation of the individual operator data, Figure 1 displays the fraction of successful runs achieved by each as a function of database size, in units of $(N_R)^{1/2}$, on which are superimposed the loci of one standard error confidence limits. The use of different symbols for female and male operators helps to illustrate the gender differences appearing in these data. Figure 2 is a similar representation in terms of individual operator effect sizes, in units of Z score per series.

Correlation of operator success with particular pictures is somewhat complicated by their use in pairs; that is, while one might endeavor to search for a relative picture-effectiveness distribution that compounds uniformly over all competing pictures, because these are selected at will by the operators, the full competition matrix is far from uniformly populated. Nonetheless, some indications can be extracted. Table 5 lists the overall success ratios for each of the 24 illustrations (displayed in Appendix A) when used as the preferred target, regardless of its competitors. Listed are the ratios of successful runs (S/N) achieved using the picture as a preferred target, along with the corresponding Z scores, for all operators, men alone, and women alone. Also listed in the composite portion of the table are the number of successful runs that saturated compared to the total number that saturated (Sat.), and the average number of trials per run for the successful runs, compared to the average number for all runs (t_s/t_t). Once again, the bottom-line results are indistinguishable from chance, as are the χ^2 goodness-of-fit tests. Figure 3 illustrates the relative successes of the pictures in graphical form.

Table 6 and Figure 4 display lists of the operator achievements under the modified protocol that uses the random noise pattern, rather than a second illustration, as the competitor to the chosen picture. Clearly, there is no indication that this modality is any more effective than the two-picture version in enabling the intended anomalous achievements.

Ad Hoc Experiments

In an admittedly *a posteriori* effort to explore possible causes of the apparent failure of this experimental concept, it was noted that a particular subset of the target pictures seemed to facilitate disproportionately good performances. These images could crudely be subsumed within a category of religious, mystical, or symbolic patterns, labeled as follows: (1) Anubis; (2) Apache; (3) Wave; (7) Mask; (8) Bear; (9) India; and (11) Egypt. Specifically, this subset yielded 521 successful runs out of 961 (54.2%), with a corresponding Z score of 2.613. A similar correlation was found within the single picture versus random background efforts within this group: 134 successes out of 244 (54.9%), $Z = 1.536$. A subsequent *ad hoc* experiment was undertaken using only these seven pictures plus the random background option, within a short-form protocol that permitted more rapid accumulation of data. Specifically, all runs were forced to have equal numbers of trials (100), with only four runs comprising a session, and full saturation was precluded by a progressive difficulty algorithm in the software (*i.e.*, by using a difficulty criterion, d, up to ½ pixel saturation, a difficulty criterion of $2d$ over the saturation interval ½ to ¾, $4d$ over the saturation interval ¾ to ⅞ etc.). Thus, highly successful runs could be sustained near saturation without premature termination of the run. To conserve laboratory and operator time, only 100 series (400 runs) were planned, the minimum deemed necessary to distinguish this subset from the main database.

Despite all these changes in experimental design, the composite results of this phase, as summarized in Tables 7–9 and Figure 5, again were statistically insignificant. Specifically, only 200 runs out of 404 were successful ($Z = -0.1990$); the all-operator performance compounded only to $Z_\Delta = 0.5305$; four of the eight selected pictures now scored below the chance mean; and the χ^2 on both the operator and picture distributions were within chance. On the other hand, it is worth noting that the Z_Δ seems to correspond to an absolute effect size (mean shift) comparable to that of our much larger benchmark REG

TABLE 2
Male Operator Results

Op.	N_S	H/L	S_S	N_R	S_R	μ	σ	Z
14	3	High	1	27	13	–.1000	.1291	–0.7746
		Low	2	22	12	.0483	.1291	0.3744
		Δ	2	49	25			–0.2830
21	4	High	1	36	14	–.1530	.1118	–1.3685
		Low	3	39	20	.0120	.1118	0.1073
		Δ	1	75	34			–0.8918
41	4	High	1	37	16	–.1065	.1118	–0.9526
		Low	2	38	20	–.0063	.1118	–0.0559
		Δ	1	75	36			–0.7131
56	3	High	2	25	14	.0833	.1291	0.6455
		Low	2	26	14	.0617	.1291	0.4777
		Δ	2	51	28			0.7942
65	4	High	1	31	18	.0423	.1118	0.3779
		Low	2	45	21	–.0400	.1118	–0.3578
		Δ	3	76	39			0.0142
84	5	High	1	47	21	–.0962	.1000	–0.9620
		Low	0	48	19	–.1892	.1000	–1.8920(*)
		Δ	1	95	40			–2.0181(*)
184	1	High	0	10	5	–.0400	.2236	–0.1789
		Low	1	7	4	.0410	.2236	0.1834
		Δ	1	17	9			0.0032
187	15	High	9	143	75	.0452	.0577	0.7829
		Low	4	135	59	–.0589	.0577	–1.0196
		Δ	8	278	134			–0.1674
307	14	High	7	122	59	–.0137	.0598	–0.2295
		Low	9	140	74	.0394	.0598	0.6598
		Δ	9	262	133			0.3043
317	1	High	0	9	4	–.1540	.2236	–0.6887
		Low	1	7	5	.3210	.2236	1.4356
		Δ	1	16	9			0.5281
320	8	High	3	75	36	–.0283	.0791	–0.3573
		Low	1	80	29	–.1872	.0791	–2.3685(*)
		Δ	3	155	65			–1.9275(*)
321	1	High	1	9	8	.4520	.2236	2.0214*
		Low	1	6	4	.1560	.2236	0.6977
		Δ	1	15	12			1.9227*
402	1	High	1	11	8	.2700	.2236	1.2075
		Low	0	10	5	–.0320	.2236	–0.1431
		Δ	1	21	13			0.7526
405	1	High	1	9	5	.0850	.2236	0.3801
		Low	0	7	2	–.2000	.2236	–0.8944
		Δ	0	16	7			–0.3637
409	5	High	2	47	24	.0088	.1000	0.0880
		Low	2	47	24	.0134	.1000	0.1340
		Δ	3	94	48			0.1570

TABLE 2
Continued

Op.	N_S	H/L	S_S	N_R	S_R	μ	σ	Z
422	3	High	2	25	15	.0403	.1291	0.3124
		Low	1	33	15	–.0617	.1291	–0.4777
		Δ	1	58	30			–0.1168
501	7	High	3	62	34	.0466	.0845	0.5510
		Low	3	63	30	–.0199	.0845	–0.2350
		Δ	4	125	64			0.2235
507	10	High	4	89	42	–.0667	.0707	–0.9433
		Low	6	87	44	.0146	.0707	0.2065
		Δ	7	176	86			–0.5210
509	3	High	2	28	19	.2430	.1291	1.8823 *
		Low	2	27	12	–.0603	.1291	–0.4673
		Δ	2	55	31			1.0005
515	4	High	1	33	12	–.0990	.1118	–0.8855
		Low	1	34	16	–.0155	.1118	–0.1386
		Δ	1	67	28			–0.7242
599	1	High	1	10	6	.3380	.2236	1.5116
		Low	0	6	2	–.1230	.2236	–0.5501
		Δ	1	16	8			0.6799
All	98	High	44	885	448	–.0003	.0226	–0.0145
		Low	43	907	431	–.0283	.0226	–1.2527
		Δ	53	1792	879			–0.8960

Chi-squared tests:

	χ^2 (21 *df*)	P_χ
High	19.764	0.537
Low	15.461	0.799
Δ	16.945	0.714

Individual operator overall success patterns:

N op.	H/L	$Z > 0.00$ ($P_1 < .5$)	$Z > 1.645$ ($P_1 < .05$)	$Z < 1.645$ ($P_1 > .95$)
21	High	11	2	0
	Low	9	0	2
	Δ	11	1	2
	(CE)	(10.5)	(1.05)	(1.05)

Note: Op. = operator; N_S = number of series; H/L = high or low random-event-generator driver; S_S = number of successful series; N_R = number of runs; S_R = number of successful runs; μ = trial mean shift; σ = standard error; *Z* = *Z* score = μ/σ; *N* op. = number of operators; CE = chance expectation.
* Significant at $P < .05$. (*) Significant at $P > .95$.

TABLE 3
Female Operator Results

Op.	N_S	H/L	S_S	N_R	S_R	μ	σ	Z
3	1	High	1	8	5	.1100	.2236	0.4919
		Low	0	8	1	–.4270	.2236	–1.9096(*)
		Δ	0	16	6			–1.0024
10	17	High	7	165	86	.0120	.0542	0.2213
		Low	8	150	74	–.0229	.0542	–0.4219
		Δ	9	315	160			–0.1419
16	8	High	4	75	35	–.1026	.0791	–1.2981
		Low	5	81	45	.0813	.0791	1.0277
		Δ	4	156	80			–0.1912
17	10	High	7	90	46	.0266	.0707	0.3762
		Low	5	97	45	–.0227	.0707	–0.3210
		Δ	6	187	91			0.0390
53	1	High	1	13	9	.2950	.2236	1.3193
		Low	1	13	7	.0220	.2236	0.0984
		Δ	1	26	16			1.0024
159	1	High	1	9	5	.1740	.2236	0.7782
		Low	1	7	4	.1280	.2236	0.5724
		Δ	1	16	9			0.9550
173	3	High	2	26	14	.1223	.1291	0.9476
		Low	1	28	11	–.0587	.1291	–0.4544
		Δ	2	54	25			0.3487
327	1	High	1	8	5	.0790	.2236	0.3533
		Low	1	7	5	.2310	.2236	1.0331
		Δ	1	15	10			0.9803
345	1	High	0	8	3	–.2310	.2236	–1.0331
		Low	0	11	5	–.0620	.2236	–0.2773
		Δ	0	19	8			–0.9265
350	1	High	0	9	4	–.0940	.2236	–0.4204
		Low	1	8	5	.2570	.2236	1.1493
		Δ	1	17	9			0.5155
363	1	High	1	8	5	.1080	.2236	0.4830
		Low	1	9	5	.1010	.2236	0.4517
		Δ	1	17	10			0.6609
401	1	High	1	12	8	.3620	.2236	1.6189
		Low	1	9	7	.4350	.2236	1.9454*
		Δ	1	21	15			2.5203*
403	1	High	0	12	4	–.4140	.2236	–1.8515(*)
		Low	1	11	6	.1230	.2236	0.5501
		Δ	0	23	10			–0.9202
406	2	High	0	20	9	–.1160	.1581	–0.7336
		Low	0	16	6	–.1285	.1581	–0.8127
		Δ	0	36	15			–1.0934
500	1	High	1	7	5	.2160	.2236	0.9660
		Low	0	8	2	–.1510	.2236	–0.6753
		Δ	1	15	7			0.2055

TABLE 3
Continued

Op.	N_S	H/L	S_S	N_R	S_R	μ	σ	Z
502	6	High	3	56	30	.0017	.0913	0.0183
		Low	5	63	38	.1033	.0913	1.1320
		Δ	4	119	68			0.8133
503	4	High	2	40	18	–.0260	.1118	–0.2326
		Low	4	39	25	.2223	.1118	1.9879*
		Δ	4	79	43			1.2412
504	1	High	0	8	4	–.0290	.2236	–0.1297
		Low	1	10	7	.3470	.2236	1.5518
		Δ	1	18	11			1.0056
506	10	High	4	88	39	–.0806	.0707	–1.1399
		Low	2	95	42	–.0873	.0707	–1.2346
		Δ	3	183	81			–1.6790(*)
510	11	High	7	89	51	.1049	.0674	1.5561
		Low	5	99	55	.0765	.0674	1.1340
		Δ	7	188	106			1.9022*
514	1	High	0	10	4	–.1000	.2236	–0.4472
		Low	1	10	6	.2460	.2236	1.1001
		Δ	1	20	10			0.4617
543	2	High	0	19	8	–.2095	.1581	–1.3250
		Low	1	21	10	–.0565	.1581	–0.3573
		Δ	0	40	18			–1.1896
609	1	High	0	9	4	–.1510	.2236	–0.6753
		Low	1	8	5	.1540	.2236	0.6887
		Δ	1	17	9			0.0095
623	1	High	1	9	5	.1500	.2236	0.6708
		Low	1	9	4	.0010	.2236	0.0045
		Δ	1	18	9			0.4775
707	4	High	1	36	12	–.2115	.1118	–1.8917(*)
		Low	3	36	21	.1568	.1118	1.4020
		Δ	2	72	33			–0.3463
709	1	High	1	8	5	.0810	.2236	0.3622
		Low	1	10	6	.0810	.2236	0.3622
		Δ	1	18	11			0.5123
813	1	High	0	10	4	–.1920	.2236	–0.8587
		Low	0	11	4	–.3800	.2236	–1.6994(*)
		Δ	0	21	8			–1.8088(*)
830	4	High	3	36	20	.0917	.1118	0.8206
		Low	2	43	21	–.0267	.1118	–0.2393
		Δ	3	79	41			0.4111
All	97	High	49	888	447	–.0051	.0227	–0.2252
		Low	53	917	472	.0267	.0227	1.1765
		Δ	56	1805	919			0.6727

Chi-squared tests:

	χ^2 (28 *df*)	P_χ
High	26.258	0.559
Low	30.706	0.330
Δ	29.390	0.393

TABLE 3
Continued

Op.	N_S	H/L	S_S	N_R	S_R	μ	σ	Z

Individual operator overall success patterns:

N op.	H/L	$Z > 0.00$ ($P_1 < .5$)	$Z > 1.645$ ($P_1 < .05$)	$Z < 1.645$ ($P_1 > .95$)
28	High	15	0	2
	Low	17	2	2
	Δ	18	2	2
	(CE)	(14)	(1.4)	(1.4)

Note: Op. = operator; N_S = number of series; H/L = high or low random-event-generator driver; S_S = number of successful series; N_R = number of runs; S_R = number of successful runs; μ = trial mean shift; σ = standard error; Z = Z score = μ/σ; *N* op. = number of operators; CE = chance expectation.
* Significant at $P < .05$. (*) Significant at $P > .95$.

database (Jahn et al., 1997), as well as to the exploratory data described in Appendix B, even though the low statistical power of this small data set imposes large error bars on this value. These comparisons are illustrated in Figure 6. It also is interesting that significant Z_Δ values were attained by 4 of the 21 operators, compared to roughly one expected by chance, and that on a two-tailed

TABLE 4
All Operator Success Summary

N_S	H/L	S_S	N_R	S_R	μ	σ	Z
195	High	93	1,773	895	–.0027	.0160	–0.1691
	Low	96	1,824	903	–.0009	.0160	–0.0583
	Δ	109	3,597	1798			–0.1608

Chi-squared tests:

	χ^2 (49 *df*)	P_χ
High	46.022	0.595
Low	46.168	0.589
Δ	46.333	0.5823

Individual operator overall success patterns:

N op.	H/L	$Z > 0.00$ ($P_1 < .5$)	$Z > 1.645$ ($P_1 < .05$)	$Z < 1.645$ ($P_1 > .95$)
49	High	26	2	2
	Low	26	2	4
	Δ	29	3	4
	(CE)	(24.5)	(2.45)	(2.45)

Note: N_S = number of series; H/L = high or low random-event-generator driver; S_S = number of successful series; N_R = number of runs; S_R = number of successful runs; μ = trial mean shift; σ = standard error; Z = Z score = μ/σ; *N* op. = number of operators; CE = chance expectation.

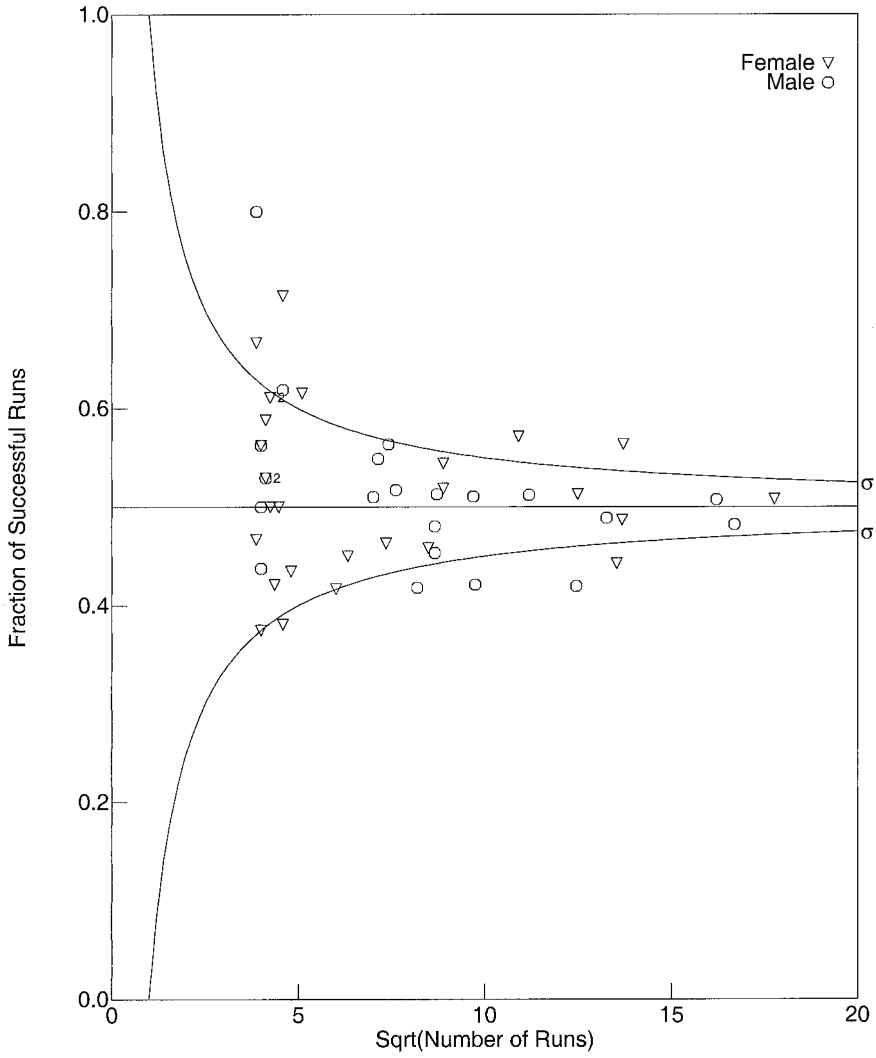


Fig. 1. Runwise success rates by operators.

basis over the separate high and low runs, 9 of the operators scored in the $|Z| > 1.645$ tails. In other words, despite the apparently inconclusive composite results, the individual operator performances display potentially instructive idiosyncratic effects.

Interpretations and Speculations

Given the equivocal character of the data derived from this sequence of ArtREG experiments, any conclusions and interpretations thereof must be re-

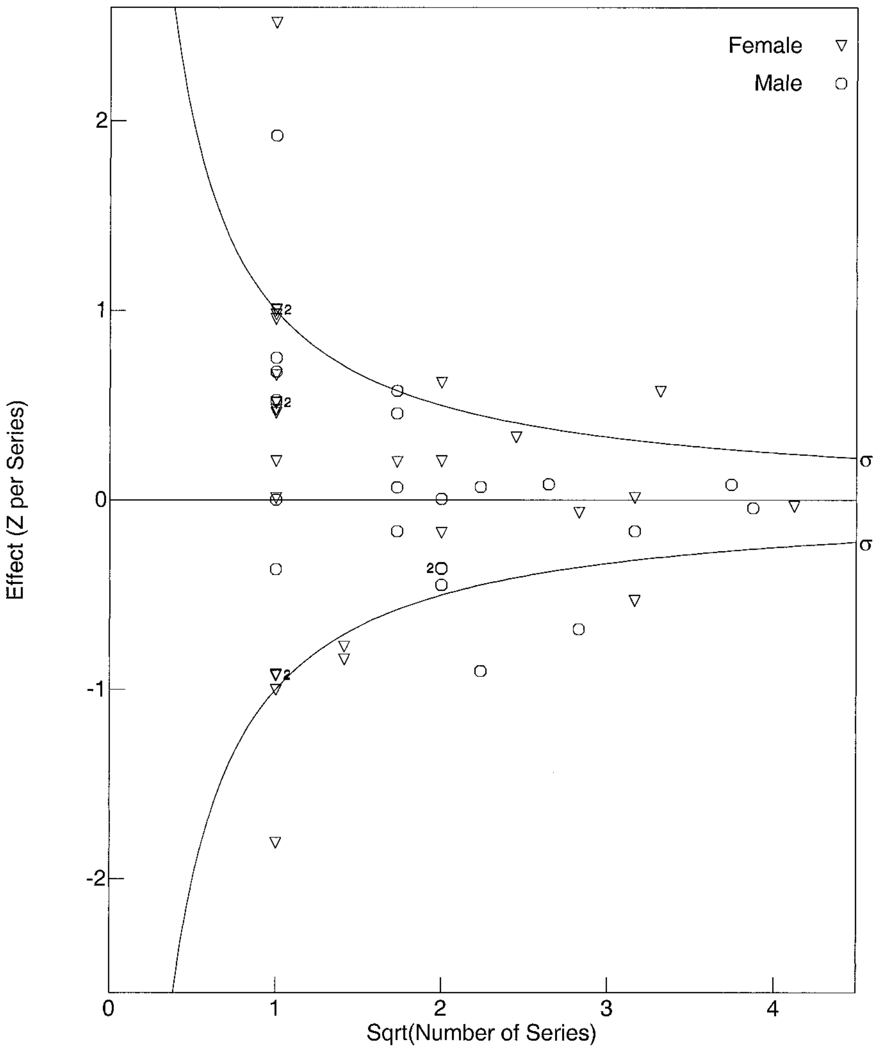


Fig. 2. Effect sizes by operators.

garded as tentative, speculative, and possibly even intuitive. Clearly, the composite results do not support the hypothesis that attractive and engaging feedback displays enable substantially larger anomalous effects, a conclusion that appears to be consistent with the early results of a number of our other visually appealing experiments. The attempt to assess the relative importance of the visual feedback on operator performance compared to that of the REG digital output stream, *per se*, also has been thwarted by the small effect sizes. Indeed, we now might speculate whether the blinding of the operator to the high ver-

TABLE 5
Success Ratios by Picture (Rank Ordered)

		All				Male			Female		
		S/N	Z_S	Sat.	t_s/t_t	S/N	Z_S	Rank	S/N	Z_S	Rank
1.	Anubis	117/202	2.252	86/151	117/113	57/91	2.411	1	60/111	0.854	4
2.	Apache	133/238	1.815	110/196	99/105	76/133	1.648	2	57/105	0.873	3
3.	Wave	192/353	1.650	161/280	108/110	83/159	0.555		109/194	1.723	1
4.	Petals	90/167	1.006	68/128	102/106	35/64	0.750		55/103	0.690	
5.	Random	100/188	0.875	76/148	118/112	52/101	0.299		48/87	0.965	2
6.	Abduction	5/8	0.707	3/6	120/113	5/8	0.707		––	––	––
7.	Mask	93/179	0.523	73/148	117/112	48/95	0.103		45/84	0.655	
8.	Bear	71/136	0.514	53/112	107/107	30/52	1.109	4	41/84	–0.218	
9.	India	63/121	0.455	53/101	107/98	13/26	0.000		50/95	0.513	
10.	World 2	57/110	0.381	48/88	103/112	17/31	0.539		40/79	0.113	
11.	Egypt	44/85	0.325	36/72	104/102	21/43	–0.152		23/42	0.617	
12.	Toledo	42/84	0.000	34/68	108/110	24/51	–0.420		18/33	0.522	
13.	Arch	4/8	0.000	2/5	165/173	4/8	0.000		—	—	—
14.	Rug	68/139	–0.255	55/115	93/100	27/61	–0.896		41/78	0.453	
15.	Shield	28/58	–0.263	20/42	113/119	20/35	0.845		8/23	–1.460	22
16.	Horserug	17/37	–0.493	11/28	87/102	8/12	1.155	3	9/25	–1.400	21
17.	World	179/371	–0.675	149/311	104/104	83/189	–1.673	22	96/152	0.741	
18.	Acacia	64/138	–0.851	53/107	117/117	21/49	–1.000		43/89	–0.318	
19.	Hand	110/235	–0.978	88/184	117/115	63/141	–1.263	21	47/94	0.000	
20.	Surf	21/49	–1.000	18/36	78/112	18/41	–0.781		3/8	–0.707	
21.	Calder	104/223	–1.004	84/184	103/106	53/116	–0.928		51/107	–0.483	
22.	Japan	42/96	–1.225	34/77	121/116	29/54	0.544		13/42	–2.469	24
23.	Leopard	102/231	–1.776	83/188	101/103	71/167	–1.934	23	31/64	–0.250	
24.	Park	52/141	–3.116	43/117	107/106	21/65	–2.853	24	31/76	–1.606	23
		$\chi^2_T = 33.25$ (24 df) ($P_\chi = 0.099$)				$\chi^2_M = 33.61$ (24 df) ($P_\chi = 0.092$)			$\chi^2_F = 21.70$ (22 df) ($P_\chi = 0.478$)		

Note: S/N = successful runs/total number of runs; Z_S = Z score of S/N; Sat. = successful runs saturated/total number of saturated runs; t_s/t_t = average number of trials for successful runs/average number of trials for all runs.

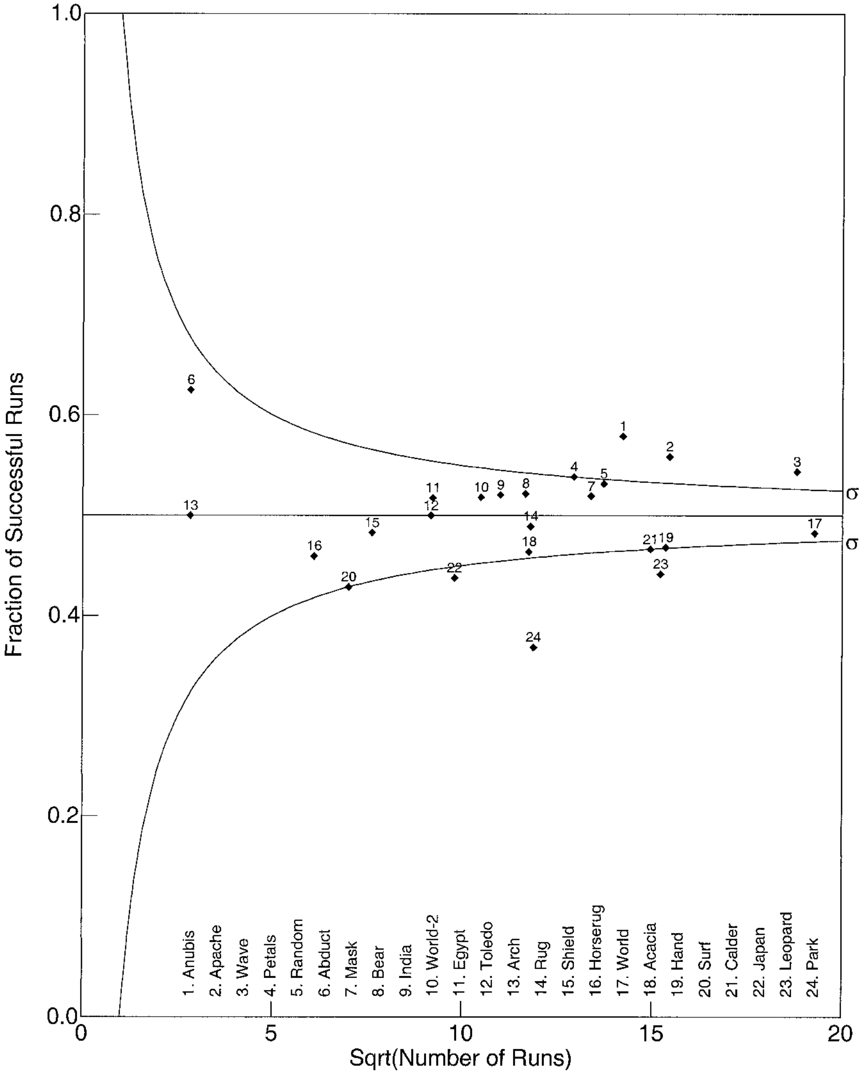


Fig. 3. Runwise success rates by target image.

sus low outputs of REG might be implicated in the reduction of effect size in the main group of experiments. Yet, as in many earlier studies, both "successful" and "unsuccessful," various details appear in the ArtREG data that if better comprehended could possibly point to more incisive experimental and theoretical strategies and to better understanding of the underlying phenomena.

The somewhat better yield from the mystical or symbolic image subset also prompts a few intuitive speculations. First, it may be that the explicit artistic feedback characteristic of most of the pictorial targets, rather than enhancing

TABLE 6
Success Ratios by Picture Versus Random Background (Rank Ordered)

		S/F	$Z_{S/F}$
1.	Wave	19/12	1.257
2.	Anubis	23/16	1.121
3.	Mask	41/34	0.808
4.	Bear	18/14	0.707
5.	Apache	21/17	0.64999
6.	Leopard	52/48	0.400
7.	India	9/10	–0.229
8.	World	56/60	–0.371
9.	Toledo	3/4	–0.378
10.	Hand	21/24	–0.447
11.	World 2	14/17	–0.539
12.	Calder	14/19	–0.870
13.	Park	5/9	–1.069
14.	Acacia	12/18	–1.095
15.	Egypt	3/7	–1.265
	All	311/309	0.0803
	$\chi^2 = 10.09$ (15 *df*)		($P_\chi = 0.81$)

Note: S/F = successful runs/failed runs; $Z_{S/F}$ = Z score of S/F.

the resonance of the operator with the experiment, actually may inhibit such because of its specificity. That is, just as a fully random physical source appears to be requisite raw material for production of a more ordered digital stream in our standard REG experiments (Jahn et al., 1997), so the operator's consciousness may prefer less associative constraint on the imagery it employs to achieve its resonance with the experimental task than the fully articulated pictures allow. Only in the more vague and symbolic illustrations, such as those used in the *ad hoc* experiment, may some relief from this encumbrance be provided. Alternatively, it may be the symbolic, personalized *meaning* of the feedback, *i.e.*, its particular relevance to the operator, that is the crucial ingredient in establishing a productive human/machine bond, and that the mystical subset carries more such individualized meanings to the operator. Or finally, all of these weak results may just be another indication that feedback, in any form, is not a major requisite in producing such anomalous effects. This interpretation would be consistent with the positive results of our Remote REG (Dunne and Jahn, 1992), Remote Perception (Nelson et al., 1996), and FieldREG experiments (Nelson et al., 1998), in which success is achieved even though no form of immediate feedback is available. Indeed, it is even possible that the anomalous effect sizes are fundamentally unamplifiable by any experimental strategy, *i.e.*, that their scale is intrinsically constrained to at best a few parts per thousand, so that major statistical effects can be found only in very large individual or collective databases.

In any case, these results have taught us that we must broaden our range of potentially important variables beyond those so far explored to include subtler

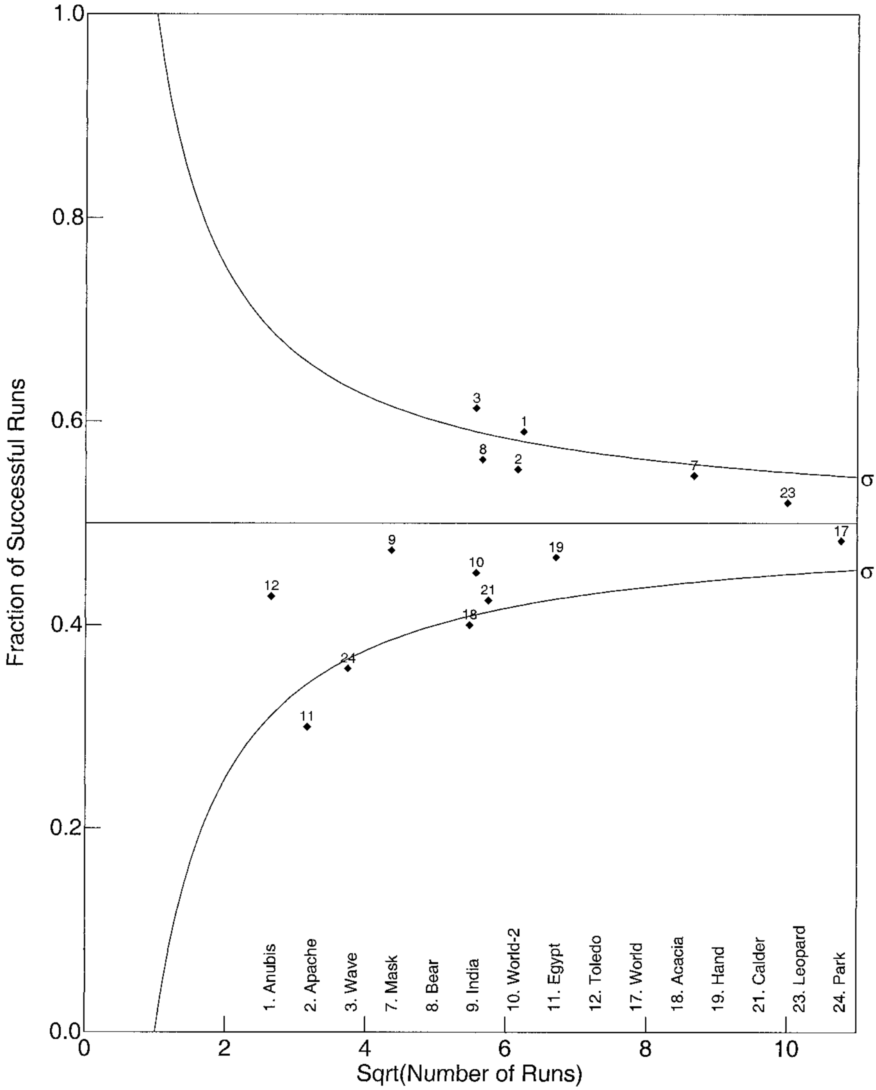


Fig. 4. Runwise success rates for targets versus random.

TABLE 7

Ad Hoc Experiment: Overall Run Score Summaries

	All	High	Low
No. of runs	404	202	202
No. of successes	200	96	104
No. of failures	204	106	98
Z score (successes/failures)	–0.1990	–0.7036	0.4222

TABLE 8
Ad Hoc Experiment Operator Result

Op.	N_S	H/L	S_S	N_R	S_R	μ	σ	Z
10	8	High	6	16	10	.2737	.1768	1.5486
(F)		Low	5	16	10	.3581	.1768	2.0259*
		Δ	6	32	20			2.5275*
14	7	High	4	14	8	.2436	.1890	1.2889
(M)		Low	2	14	2	–.3329	.1890	–1.7613(*)
		Δ	3	28	10			–0.3341
17	10	High	4	20	8	–.0835	.1581	–0.5281
(F)		Low	4	20	9	–.0780	.1581	–0.4933
		Δ	4	40	17			–0.7222
21	5	High	2	10	5	–.0280	.2236	–0.1252
(M)		Low	3	10	6	–.0340	.2236	–0.1521
		Δ	2	20	11			–0.1961
41	10	High	2	20	5	–.3655	.1581	–2.3116(*)
(M)		Low	5	20	11	.0165	.1581	0.1044
		Δ	4	40	16			–1.5608
196	1	High	0	2	0	–.3200	.5000	–0.6400
(M/F)		Low	1	2	1	.4000	.5000	0.8000
		Δ	1	4	1			0.1131
213	1	High	1	2	2	.9150	.5000	1.8300*
(M/M)		Low	1	2	2	.4900	.5000	0.9800
		Δ	1	4	4			1.9870*
240	2	High	0	4	1	–.1625	.3536	–0.4596
(M/F)		Low	1	4	1	–.2625	.3536	–0.7425
		Δ	1	8	2			–0.8500
263	1	High	0	2	0	–.8900	.5000	–1.7800(*)
(M/F)		Low	1	2	1	.4500	.5000	0.9000
		Δ	0	4	1			–0.6223
282	2	High	1	4	2	–.3275	.3536	–0.9263
(M/F)		Low	1	4	2	–.1550	.3536	–0.4384
		Δ	0	8	4			–0.9650
307	10	High	4	20	10	.2080	.1581	1.3155
(M)		Low	4	20	9	–.1805	.1581	–1.1416
		Δ	4	40	19			0.1230
318	2	High	0	4	1	–.3875	.3536	–1.0960
(F)		Low	0	4	2	–.2525	.3536	–0.7142
		Δ	0	8	3			–1.2800
373	5	High	2	10	6	.1660	.2236	0.7424
(F)		Low	4	10	7	.3800	.2236	1.6994*
		Δ	5	20	13			1.7266*
412	1	High	1	2	2	.1100	.5000	0.2200
(M)		Low	0	2	1	–.0250	.5000	–0.0500
		Δ	1	4	3			0.1202
462	8	High	6	16	11	.3481	.1768	1.9693*
(M)		Low	4	16	10	.1594	.1768	0.9016
		Δ	7	32	21			2.0300*

TABLE 8
Continued

Op.	N_S	H/L	S_S	N_R	S_R	μ	σ	Z
500	6	High	2	12	4	–.3725	.2041	–1.8249(*)
(F)		Low	2	12	7	.0650	.2041	0.3184
		Δ	3	24	11			–1.0652
516	3	High	1	6	3	–.1183	.2887	–0.4099
(F)		Low	2	6	3	–.1633	.2887	–0.5658
		Δ	1	12	6			–0.6899
549	10	High	7	20	11	.2705	.1581	1.7108*
(M)		Low	3	20	9	–.0970	.1581	–0.6135
		Δ	6	40	20			0.7759
551	3	High	1	6	2	–.1183	.2887	–0.4099
(F)		Low	2	6	3	.0167	.2887	0.0577
		Δ	1	12	5			–0.2490
552	3	High	2	6	2	–.0117	.2887	–0.0404
(M)		Low	2	6	4	.3133	.2887	1.0854
		Δ	3	12	6			0.7389
555	3	High	1	6	3	–.0733	.2887	–0.2540
(M)		Low	2	6	4	.0767	.2887	0.2656
		Δ	2	12	7			0.0082
All	101	High	47	202	96	.0250	.0498	0.5025
		Low	49	202	104	.0123	.0498	0.2478
		Δ	55	404	200			0.5305

Chi-squared tests:

	χ^2 (21 *df*)	P_χ
High	31.762	0.062
Low	18.204	0.636
Δ	27.089	0.168

Individual operator overall success patterns:

N op.	H/L	$Z > 0.00$ ($P_1 < .5$)	$Z > 1.645$ ($P_1 < .05$)	$Z < -1.645$ ($P_1 > .95$)
21	High	8	3	3
	Low	11	2	1
	Δ	10	4	0
	(CE)	(10.5)	(1.05)	(1.05)

Note: Op. = operator; N_S = number of series; H/L = high or low random-event-generator driver; S_S = number of successful series; N_R = number of runs; S_R = number of successful runs; μ = trial mean shift; σ = standard error; Z = Z score = μ/σ; *N* op. = number of operators; CE = chance expectation.
* Significant at $P < .05$. (*) Significant at $P > .95$.

TABLE 9
Ad Hoc Experiment: Success Ratios by Picture (Rank Ordered)

Rank		Prior rank	S/N	Z_S
1.	Apache	(2)	29/45	1.938
2.	India	(9)	26/43	1.3725
3.	Egypt	(11)	21/39	0.4804
4.	Random	(5)	14/26	0.3922
5.	Anubis	(1)	43/92	–0.6255
6.	Mask	(7)	16/38	–0.9733
7.	Bear	(8)	28/64	–1.000
8.	Wave	(3)	23/57	–1.4570
	All		200/404	–0.1990
	$\chi^2 = 10.486$ (8 *df*)		($P_\chi = 0.23$)	

Note: S/N = successful runs/total number of runs; Z_S = Z score of S/N.

personal factors, such as environmental influences, operator and experimenter attitudes, and the role of subjective meaning, in our future experimental designs if we are to acquire deeper understanding of these consciousness-related physical phenomena.

Appendix A: ArtREG Illustrations

All of the pictures utilized in the main body of ArtREG experiments and in the *ad hoc* subset are reproduced here in black and white to reduce printing costs. A few sets of full color reproductions are retained in our laboratory.

Appendix B: Prior Explorations

The formal ArtREG experiments reported in the body of this paper devolved from an earlier informal set of exploratory studies performed as the equipment was being brought on line and the protocols were being refined. These initial experiments closely followed our standard REG protocols, using series of 1,000 trials taken under the three directional intentions: high, low, and baseline. These were grouped in four sets of 250-trial runs per direction, with the operators blind to the randomly assigned directions. All runs required completion of 250 trials, even though picture saturation may have been achieved during the run. All told, 13 operators completed a total of 37 series, with the results displayed in Table 10. Although none of the operators, nor the group as a whole, achieved statistical significance in the high-low separation, the overall effect was in the intended direction, with an absolute size comparable to that characteristic of our much larger benchmark REG studies (Jahn et al., 1997), and hence regarded as propitious for more formal and extensive experiments.

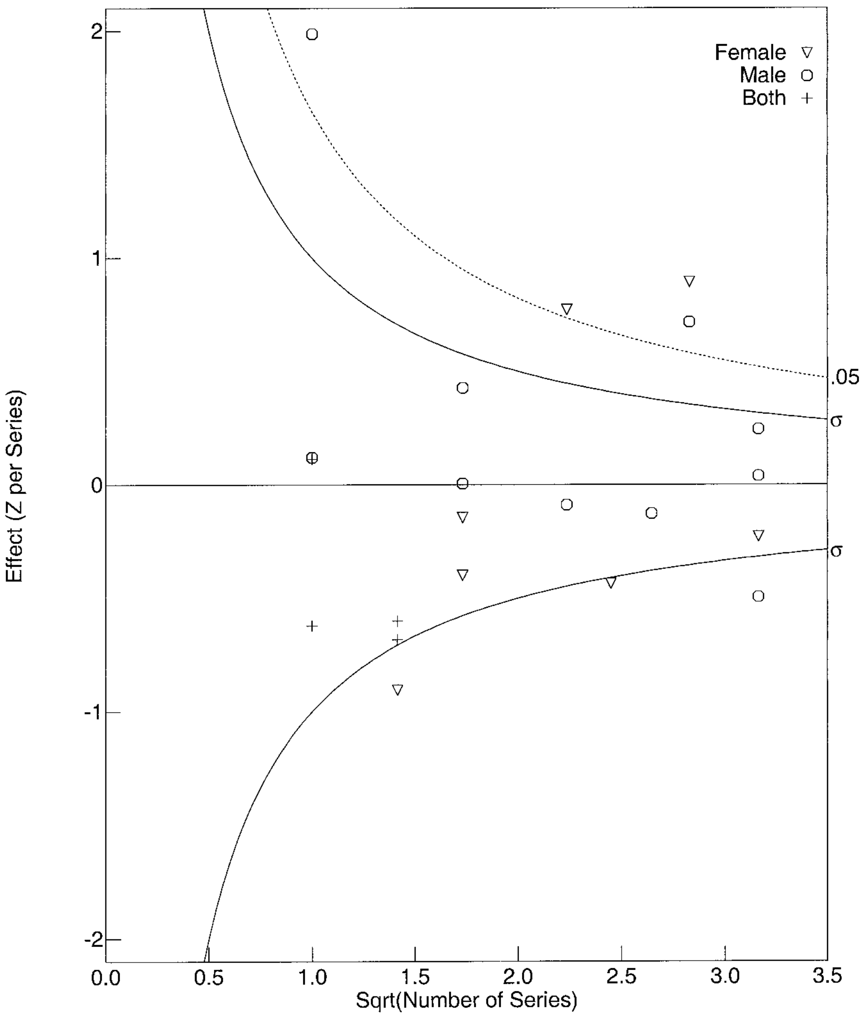


Fig. 5. Effect sizes by operators in *ad hoc* exploration.

Based on the reactions of several of these operators, a number of changes in processing and protocol were implemented before the formal experiments were begun, namely:

1. The baseline direction was eliminated.
2. Runs were allowed to terminate on saturation in either direction.
3. The total number of trials per series remained at 1,000 for the high and

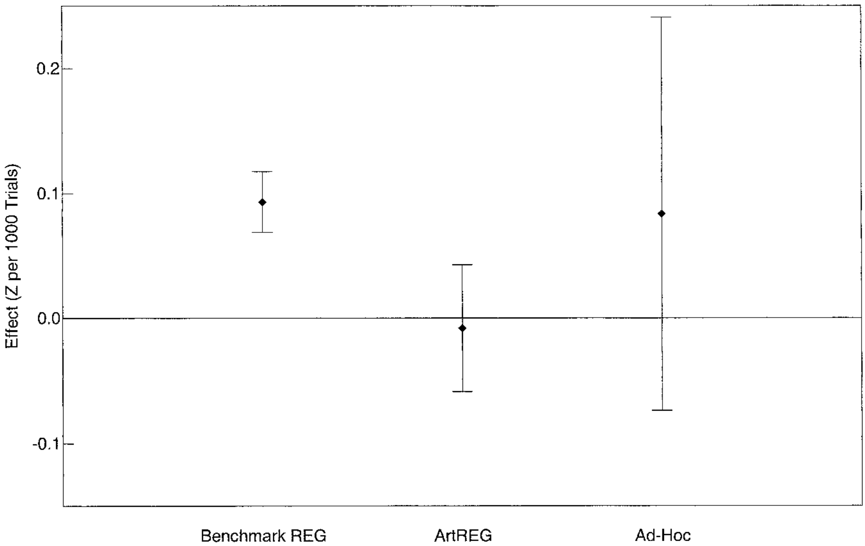


Fig. 6. Effect-size comparisons.

the low directions, but these included some shortened (saturated) runs, as well as full 250-trial runs.

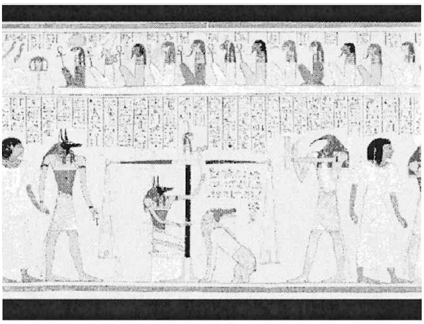
4. Additional pictures were added to the library, and a few were removed.

Acknowledgments

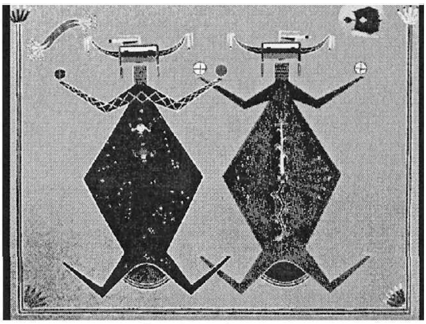
The authors would like to acknowledge their indebtedness to Dr. Andrei Berezin of Moscow, Russia, who, in the course of an extended visiting appointment in our laboratory, first proposed an REG experiment with an artistic visual feedback display. Although the details of the ArtREG implementation have evolved considerably since his original conception of the idea, it was nonetheless seminal to the studies reported here.

We also would like to thank the many operators who, without compensation or identification, have generously provided the databases of this project. Several other members of the Princeton Engineering Anomalies Research (PEAR) staff, other than the authors, have also played important roles in the conduct and interpretation of the experiments, as well as in the preparation of this report. In particular, Lisa Langelier-Marks has spent a considerable amount of time and effort implementing an effective and attractive technical text.

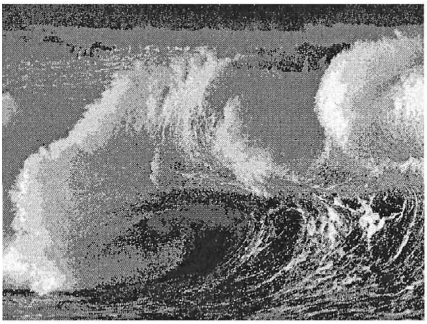
The PEAR program gratefully acknowledges the enduring financial support of the Institut für Grenzgebiete der Psychologie und Psychohygiene; The Lifebridge Foundation, Richard Adams; George Ohrstrom; Laurance Rockefeller; Donald Webster; and numerous other private contributors.



1. Anubis

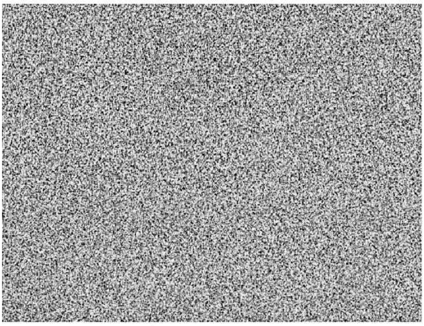


2. Apache



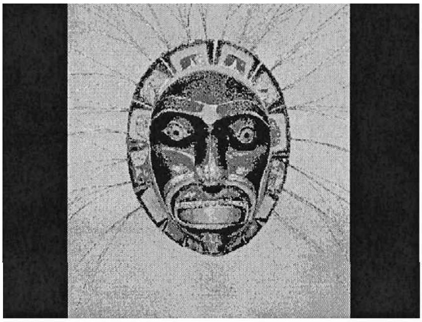
3. Wave

4. Petals

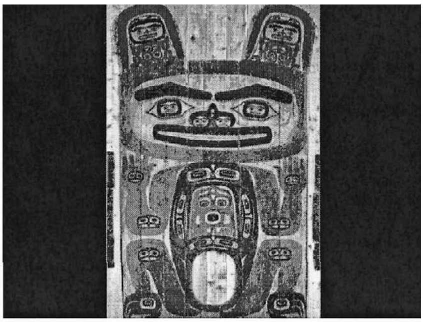


5. Random

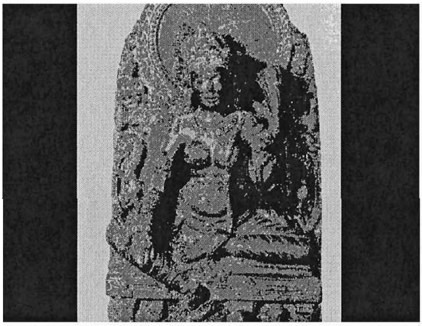
6. Abduction



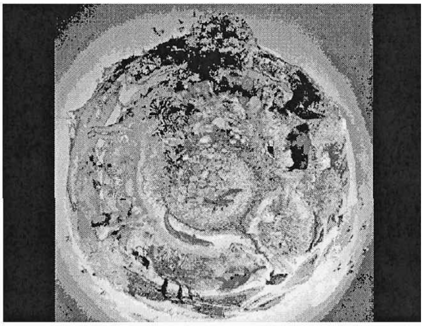
7. Mask



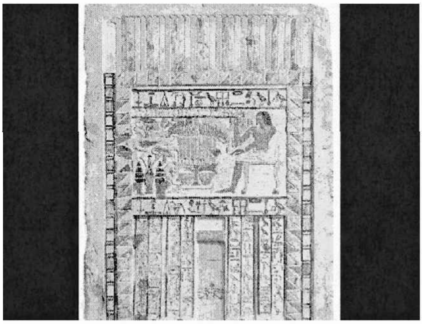
8. Bear



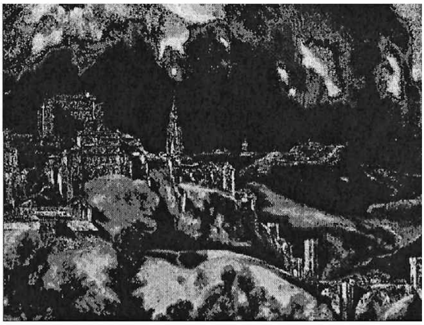
9. India



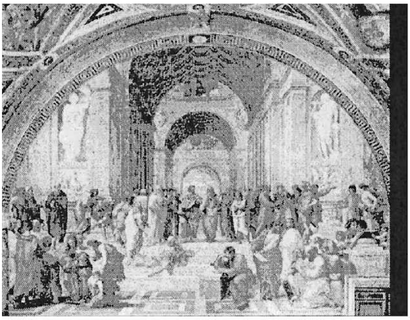
10. World 2



11. Egypt

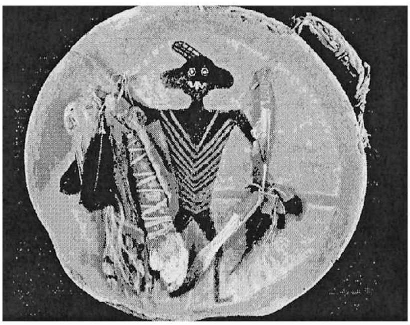


12. Toledo

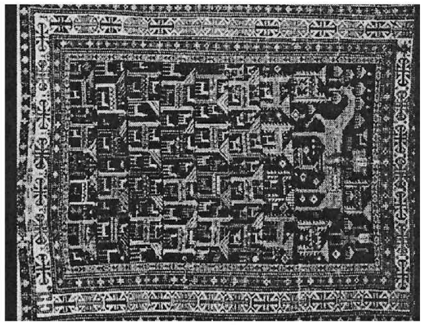


13. Arch

14. Rug

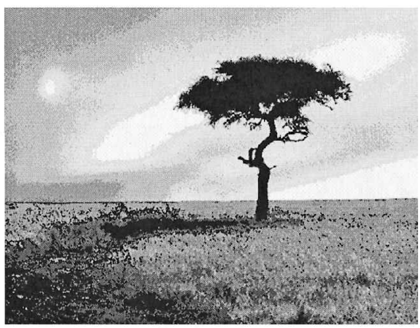


15. Shield

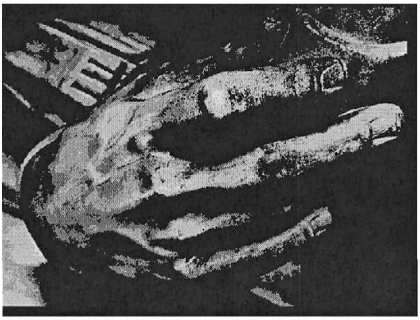


16. Horserug

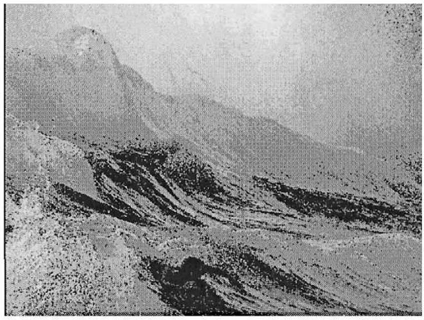
17. World



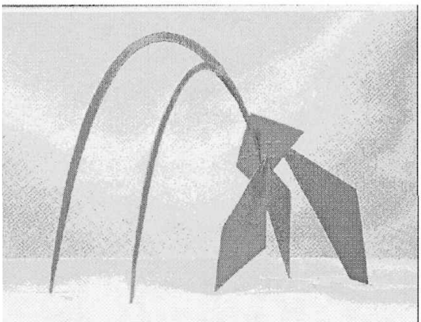
18. Acacia



19. Hand

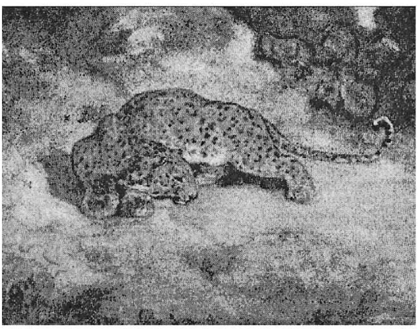


20. Surf

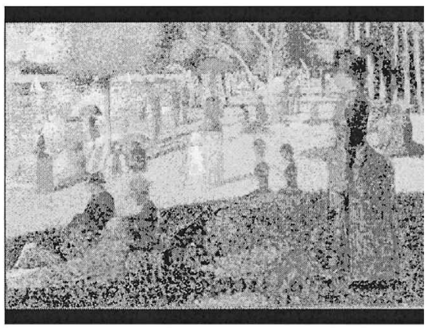


21. Calder

22. Japan



23. Leopard



24. Park

TABLE 10
ArtREG, Exploratory

Op.	N_S	H/L	S_S	N_R	S_R	μ	σ	Z
7	1	High	1	4	2	.0560	.2236	0.2504
		Low	0	4	1	–.1070	.2236	–0.4785
		Δ	0	8	3			–0.1613
10	16	High	10	64	37	.0736	.0559	1.3170
		Low	10	64	32	.0516	.0559	0.9235
		Δ	10	128	69			1.5843
21	1	High	1	4	2	.0880	.2236	0.3935
		Low	0	4	2	–.2000	.2236	–0.8944
		Δ	0	8	4			–0.3542
41	1	High	0	4	0	–.0670	.2236	–0.2996
		Low	0	4	2	–.0400	.2236	–0.1789
		Δ	0	8	2			–0.3384
78	3	High	1	12	4	–.0920	.1291	–0.7126
		Low	1	12	6	–.1400	.1291	–1.0844
		Δ	0	24	10			–1.2707
84	1	High	1	4	3	.2760	.2236	1.2343
		Low	1	4	3	.0280	.2236	0.1252
		Δ	1	8	6			0.9613
161	6	High	4	24	14	.1210	.0913	1.3255
		Low	1	24	13	–.0547	.0913	–0.5988
		Δ	5	48	27			0.5138
171	1	High	1	4	2	.0710	.2236	0.3175
		Low	1	4	3	.1850	.2236	0.8273
		Δ	1	8	5			0.8095
173	1	High	0	4	2	–.1210	.2236	–0.5411
		Low	1	4	3	.1400	.2236	0.6261
		Δ	1	8	5			0.0601
174	3	High	1	12	5	.0010	.1291	0.0077
		Low	1	12	7	.0287	.1291	0.2221
		Δ	2	24	12			0.1625
182	1	High	0	4	1	–.2970	.2236	–1.3282
		Low	0	4	1	–.1680	.2236	–0.7513
		Δ	0	8	2			–1.4705
406	1	High	0	4	1	–.1990	.2236	–0.8900
		Low	1	4	1	.0270	.2236	0.1207
		Δ	0	8	2			–0.5439
813	1	High	1	4	4	.2890	.2236	1.2924
		Low	0	4	0	–.2520	.2236	–1.1270
		Δ	1	8	4			0.1170
All	37	High	21	148	77	.0467	.0368	1.2697
		Low	17	148	74	–.0060	.0368	–0.1640
		Δ	21	296	151			0.7819

TABLE 10
Continued

Chi-squared tests:

	χ^2 (13 *df*)	P_χ
High	10.450	0.657
Low	6.439	0.929
Δ	8.736	0.793

Note: Op. = operator; N_S = number of series; H/L = high or low random-event-generator driver; S_S = number of successful series; N_R = number of runs; S_R = number of successful runs; μ = trial mean shift; σ = standard error; Z = Z score = μ/σ.

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