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Dependence of Anomalous REG Performance on Elemental Binary Probability

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Abstract—Most experiments to study the anomalous interactions of human operators with electronic random event generators (REGs) utilize devices configured to produce output digital strings having individual binary probabilities of precisely 0.5000, which concatenate to well-behaved Gaussian distributions for statistical reference. Such studies thus leave unanswered the possible sensitivity of operator performance to other settings of the binary probability. Following a rudimentary analysis of the statistical expectations for the output behavior of such REG variants, we constructed a modification of our standard microREG electronics that allows binary probability settings of 0.0625, 0.5000, and 0.9375. We also established a protocol for a proof-of-concept experiment (POCX) that allowed each of five operators to generate datasets of 2500 × 200–bit trials under pre-stated High, Low, and Baseline intentions for each of these three binary settings. The results, displayed in detail graphically and in tabular formats in this paper, were bemusing in two respects that precluded unequivocal responses to the basic question addressed. First, although the experiment differed only marginally from our standard microREG technology, feedback modalities, and operator protocols, it did not yield anomalous effect sizes, comparable to those achieved in our prior experiments, even for the 0.5000 probability setting. Second, much of the data displayed severe non-independence that could not be attributed unequivocally to the modified REG device, ***per se***. Thus, these empirical confounds not only limit comparisons among the binary probability values, but also add another generation of complications to the interpretation of anomalous REG effects in general.

Keywords: binary probabilities—human/machine anomalies—random event generator (REG)

I. Background

In an earlier study[1] we explored the possibility that the anomalous effect sizes or, equivalently, the apparent shifts in the individual bit probability, Δp, achieved by operators of a random event generator (REG) might evolve over the course of an experimental run, and that the pattern of this evolution could give some hint about the fundamental mechanism underlying the phenomenon.

Unfortunately, retrospective examinations of even our largest collective and individual databases were unconvincing in distinguishing any such patterns from constant Δp models, with the possible exception of some suggestive internal structure correlations that are currently under further analysis.

The purpose of this report is to address an alternative possibility, namely that anomalous REG performance might display a parametric dependence on the nominal design value of the binary probability, p, itself. To pursue this, we envisage an REG whose a priori probability is not fixed at precisely 0.5, as is the usual case, but can be changed over the range of $0 < p < 1.0$ by some control setting. Elementary binary statistics offers the following pertinent relations:*

$$\mu = p\mathrm{N} \tag{1}$$

$$\sigma = \sqrt{(p-p^2)\mathrm{N}} = \mathcal{P}\sqrt{\mathrm{N}} \tag{2}$$

$$\sigma/\mu = \frac{\sqrt{p-p^2}}{p\sqrt{\mathrm{N}}} = \frac{\mathcal{P}}{p\sqrt{\mathrm{N}}} \tag{3}$$

$$\Delta\mu = \mathrm{N}\Delta p \tag{4}$$

$$Z = \Delta\mu/\sigma = \frac{1}{\sqrt{p-p^2}}\sqrt{\mathrm{N}}\,\Delta p = \frac{\sqrt{\mathrm{N}}\,\Delta p}{\mathcal{P}} \tag{5}$$

$$\mathcal{E}_\mu = \Delta\mu/\mu = \Delta p/p \tag{6}$$

$$\mathcal{E}_Z = Z/\sqrt{\mathrm{N}} = \Delta\mu/\sigma\sqrt{\mathrm{N}} = \Delta p/\mathcal{P} \tag{7}$$

where N denotes the number of bits processed per trial; μ the mean count of bits conforming to a predefined filter imposed by the experimental equipment; a the standard deviation of μ; $\Delta\mu$ and Δp the deviations in μ and p imposed by the operator's effort; and Z the trial-level statistical 2-score thereof. The quantity $\mathcal{P} = \sqrt{p-p^2}$, introduced for parsimony of notation, actually plays the role of **a** generalized probability function for all of the $p \neq 0.5$ cases, where $(p/\mathcal{P})^2 = p/(1-\mathrm{p})$, *i.e.*, the ratio of successes to failures in the alignment of the bit stream with operator intention. The ratio σ/μ was suggested in the prior paper as an appropriate measure of the noise-to-signal ratio in the REG output, possibly relevant to the operator's capacity to achieve some Δp. $\mathcal{E}_\mu$ denotes a dimensionless or normalized mean shift or effect size, *i.e.,* bits altered per mean bit count. $\mathcal{E}_Z$ is the conventional 2-score denoting the decimal fractions of standard deviations of the output distributions entailed by the mean shifts. Note that for the usual case of $p = 0.5$, $\mathcal{E}_Z = \mathcal{E}_\mu = 2$ Ap. For any other case, $\mathcal{E}_Z = (p/\mathcal{P})\ \mathcal{E}_\mu$.

The theoretical sensitivity of these statistical indicators to the a *priori* binary probability follows from simple differentiation:

* Note: From this point on, for parsimony of notation in the text, we shall use only the minimum significant figures in specifying the a ***priori*** probabilities, *e.g.* ***p = 0.5, etc.***

$$\mathrm{d}\mu/\mathrm{d}p = \mathrm{N} \tag{8}$$

$$\mathrm{d}\sigma/\mathrm{d}p = \frac{(1-2p)}{2\mathcal{P}}\sqrt{\mathrm{N}} \tag{9}$$

$$\frac{\mathrm{d}}{\mathrm{d}p}(\sigma/\mu) = -\frac{1}{2p\mathcal{P}\sqrt{\mathrm{N}}} \tag{10}$$

$$\frac{\mathrm{d}Z}{\mathrm{d}p} = -\frac{(1-2p)}{\mathcal{P}^3}\sqrt{\mathrm{N}}\,\Delta p \tag{11}$$

$$\frac{\mathrm{d}(\Delta\mu)}{\mathrm{d}p} = 0 \tag{12}$$

$$\frac{\mathrm{d}\mathcal{E}_\mu}{\mathrm{d}p} = -\frac{\Delta p}{p^2} \tag{13}$$

$$\frac{\mathrm{d}\mathcal{E}_Z}{\mathrm{d}p} = -\frac{(1-2p)}{\mathcal{P}^3}\Delta p \tag{14}$$

Pertinently reconfigured forms of these relations are tabulated in Appendix Table A-1 for various incremental values of p, with N and Ap carried as parameters, presumed fixed for any given experiment. The bracketed values below each entry are those corresponding to N = 200, which conforms to the number of bits sampled per trial in virtually all of our previous benchmark experiments. Figure 1 displays the dependencies of μ, a, and alp on the prevailing nominal p-value for the N = 200 case. The principal features to be noted are that whereas μ increases linearly with p, a has a maximum at p = 0.5, and falls in proportion to $\mathcal{P} = \sqrt{p - p^2}$ symmetrically in both directions, reflecting the decreasing uncertainty in the count values as p approaches 0 or 1. Consequently, the "noise-to-signal" ratio, alp, decays steeply as $\mathcal{P}/p = \sqrt{p - p^2}/p$ from an infinite singularity at p = 0, to zero at p = 1. It follows that in any given experiment wherein the operator achieves a constant shift of binary probability, Ap, the corresponding mean shift is simply proportional to Ap, independent of p, whereas the most common statistical figure of merit, $Z = \Delta\mu/\sigma$, scales as $\Delta p/\mathcal{P} = \Delta p/\sqrt{p - p^2}$, an inverted symmetrical function with its minimum at p = 0.5 and infinite singularities at p = 0 and 1, and the normalized mean shift, $\mathcal{E}_\mu = \Delta\mu/\mu = \Delta p/p$, decays monotonically as $1/p$ from infinity at p = 0, to 1 at p = 1. All of which suggests that if Ap is indeed independent of p, experiments conducted at nominal probabilities near p = 0 or p = 1 should display stark differences in Z, $\mathcal{E}_\mu$ and $\mathcal{E}_Z$ results from those of the usual p = 0.5 settings. Moreover, symmetrically poised low-p and high-p devices should produce equivalent Z and $\mathcal{E}_Z$ results, but widely different $\mathcal{E}_\mu$ results. Thus, such experiments should help to discriminate whether a uniform shift in binary probability is indeed the fundamental achievement of the operator, or whether some more complex mechanism is involved.

II. Experimental Design

As a first attempt at a proof-of-concept experiment (POCX), we designed a "ProbREG" device that essentially replaces the usual +, –, +, –,... binary filter of the standard MicroREG circuit, by one requiring alignment of four successive bits with a pre-set digital mask to yield one positive output bit (*cf.* Appendix 2). Thus, the unit presents a nominal p of 0.0625 (or 0.9375), to be compared with a p = 0.5 value obtained if only two of the four bits are required to match. The corresponding expected output characteristics and statistical indices are listed in Table 1. Note that for any operator-induced (constant) Δp, the Z and $\mathcal{E}_Z$ values should span symmetrically by a factor of about 2, while the $\mathcal{E}_\mu$ values should span asymmetrically by a factor of about 15. Conversely, if the experiment yields a $\Delta\mu$ independent of p, we may conclude that Ap is also independent of p, while if $\mathcal{E}_\mu = \Delta\mu/\mu$ is independent of p, it would follow that Ap is scaling as p. As a third possibility, if $\mathcal{E}_Z = Z/\sqrt{N}$ is constant over this range of p, Ap must be scaling as $\mathcal{P}$. Table 2 summarizes various potentially discriminating expectations.

III. Calibrations

The pre-stated protocol for this POCX required each of five anonymous operators to generate 25 balanced series, each comprising 100 trials per intention (High, Low, Baseline) for each of the set p-values (0.0625, 0.5, 0.9375). These were normally accumulated in 50-trial runs, with session lengths and feedback options (digital, graphic, none) left to the operator's discretion. At completion of any session, a full series of calibration data were automatically collected. In addition, much larger blocks of calibration data were accumulated from unattended continuous operation of the device over nights and weekends. All told, over 12 million calibration trials were performed, with the results summarized in Table 3. From these we conclude that the unit functions essentially as designed, with the slight exceptions that the empirical bit probabilities differ from their design values of 0.0625, 0.5, and 0.9375 by –.00010, +.00005, and +.00012, respectively. Since these translate to differences in the mean values that are comparable to those typically achieved in active REG experiments, we henceforth will compare the experimental means with the calibration values, rather than with the theoretical expectations (even though our standard tri-polar protocol should yield essentially untainted High – Low differences). The deviations of the calibration values of the three trial-level standard deviations are small enough not to affect significantly any pertinent statistical calculations. In short, for proof of concept purposes, the ProbREG unit seems more than adequate to proceed with analysis of the operator-generated data.

Table I: Theoretical REG Output Characteristics for p = 0.0625, 0.5, and 0.9375							
p	$\mathcal{P}$	μ	σ	σ/μ	$Z/\Delta p$	$\mathcal{E}_\mu/\Delta p$	$\mathcal{E}_Z/\Delta p$
0.0625	.2421	12.5	3.423	.2738	58.41	16	4.131
0.5	.5	100	7.071	.07071	28.28	2	2
0.9375	.2421	187.5	3.423	.01826	58.41	1.067	4.131

Table 2: Anticipated Responses of ProbREG POCX . to Various Ap Dependencies on p			
Ap model	$\Delta\mu$	$\Delta\mu/\mu$	z
Ap constant	constant	$\propto 1/p$	$\propto 1/\mathcal{P}$
$\Delta p \propto p$	$\propto p$	constant	$\propto p/\mathcal{P}$
$\Delta p \propto$ ***llp***	$\propto 1/p$	$\propto 1/p^2$	$\propto 1/p\mathcal{P}$
Ap– $\mathcal{P}$	$\propto \mathcal{P}$	$\propto \mathcal{P}/p$	constant
$\Delta p \propto 1/\mathcal{P}$	$\propto 1/\mathcal{P}$	$\propto 1/p$	$\propto 1/\mathcal{P}^2$

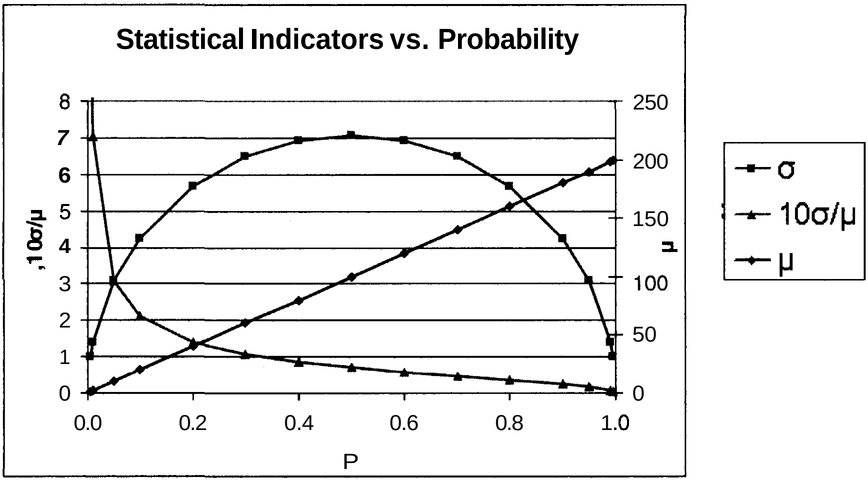

Fig. 1. Theoretical dependence of mean, standard deviation, and their ratio on the nominal p-value for N = 200.

Table 3: ProbREG Calibration Performance

Po	N_C	Po	μ_C	$\delta\mu$	σ_0	σ_C	$\delta\sigma$	p_C	δp
0.0625	1,517,450	12.5	12.4805	–.0195	3.4232	3.4176	–.0056	0.06240	–.00010
0.5000	1,517,700	100.0	100.0098	+.0098	7.0711	7.0676	–.0035	0.50005	+.00005
0.9375	1,517,700	187.5	187.5233	+.0233	3.4232	3.4200	–.0032	0.93762	+.00012

KEY

p_0 = design binary probability

N_C = number of calibration trials

μ_0 = design trial mean

μ_C = calibration trial mean

$\delta\mu = \mu_C - \mu_0$

σ_0 = design trial level standard deviation

O, = calibration trial-level standard deviation

$\delta\sigma$ = a, $-\sigma_0$

p_C = calibration binary probability

$\delta p = p_C - Po$

IV. Empirical Data

Numerical tabulations of the POCX data and the statistical figures of merit derived therefrom are presented in Tables A-2 to A-7 of the Appendix. More illuminating graphical representations follow in this text as Figures 2 through 9, which plot the $\Delta\mu$, $\Delta\mu/\mu_C$, Z, and Z^2 values for all five operators, three intentions, and three *a* priori binary probability settings, in two alternative formats. Most immediately apparent from even casual examination is that the overall data display no remarkable anomalous mean shift patterns comparable to those found in the earlier "benchmark" REG studies,[(2)] *even* for *the* p = *0.5 setting.* More specifically, in the p = 0.5 case (Figures 2 & 6), the mean shifts achieved by the individual operators scatter in such a fashion to combine to a composite High – Low value well below that obtained overall in our benchmark experiments (.02), and indeed in the direction opposite to intention. Of the five operators, only B reaches an interesting High – Low difference (.35), which for this small database is only marginally significant (p = 0.04, one-tailed).

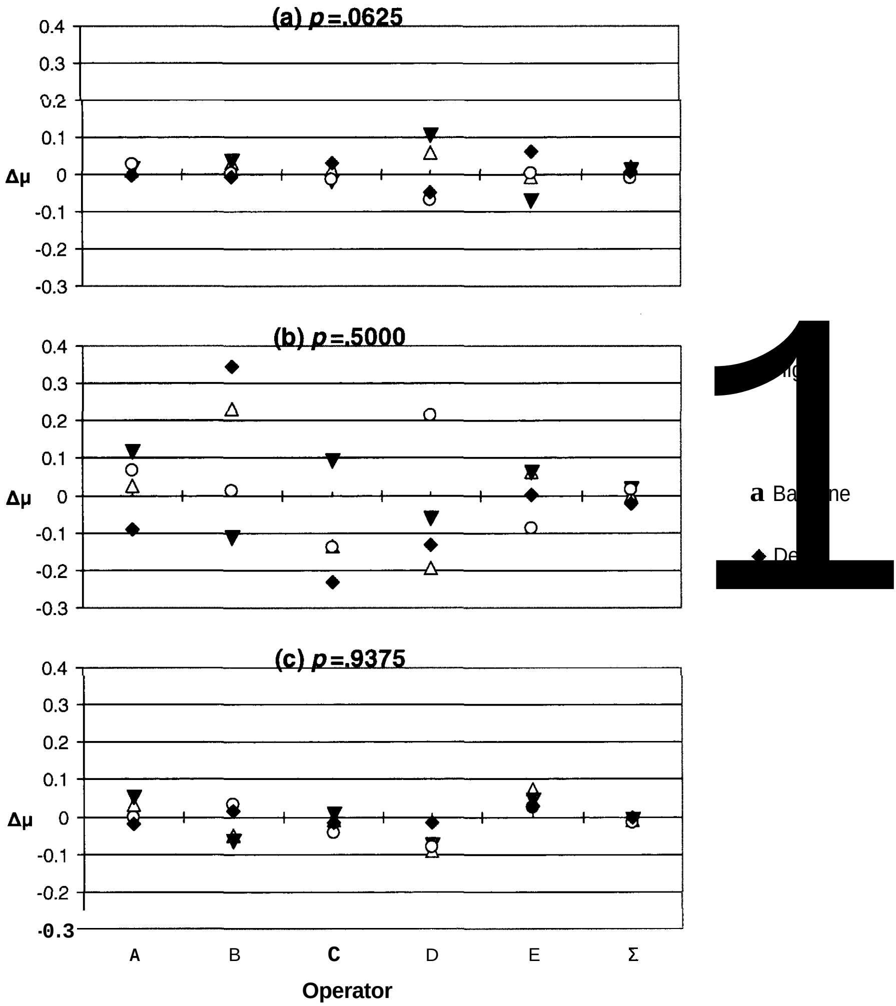

Fig. 2. Mean shifts achieved by five operators for three intentions and three binary probabilities: (a) $p = .0625$; (b) p = .5000; (c) p = .9375.

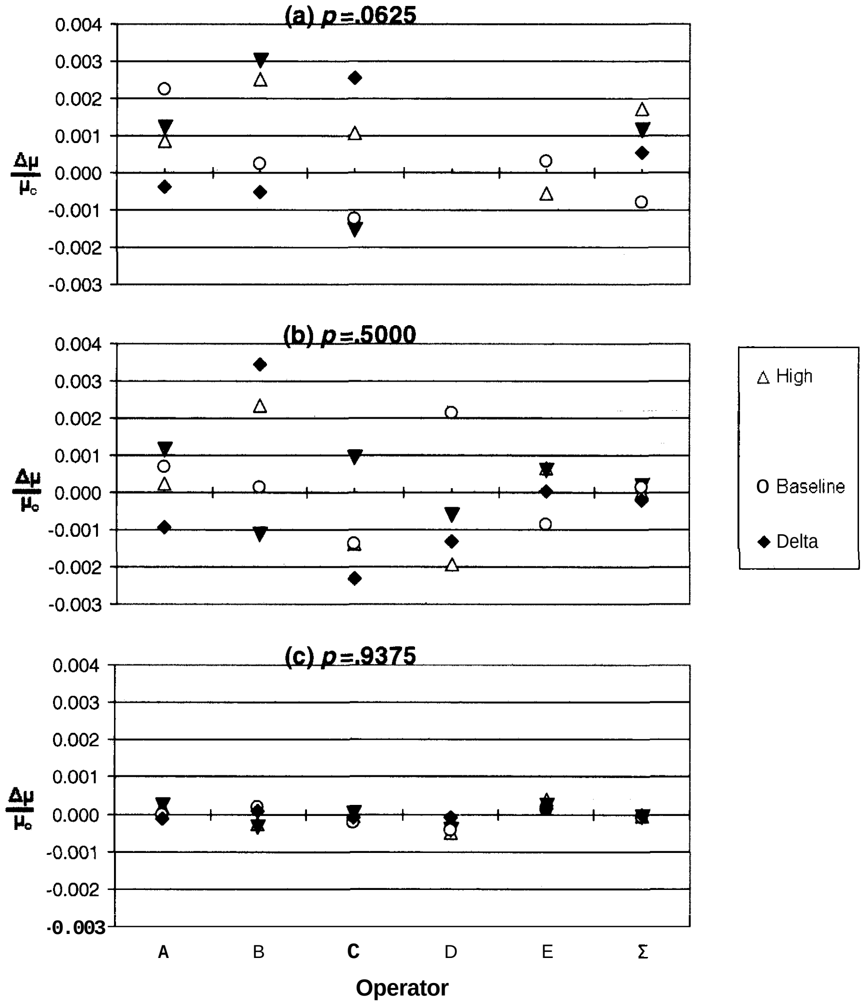

Fig. 3. Normalized mean shifts achieved by five operators for three intentions and three binary probabilities: (a) p = .0625; (b) p = .5000; (c) p = .9375.

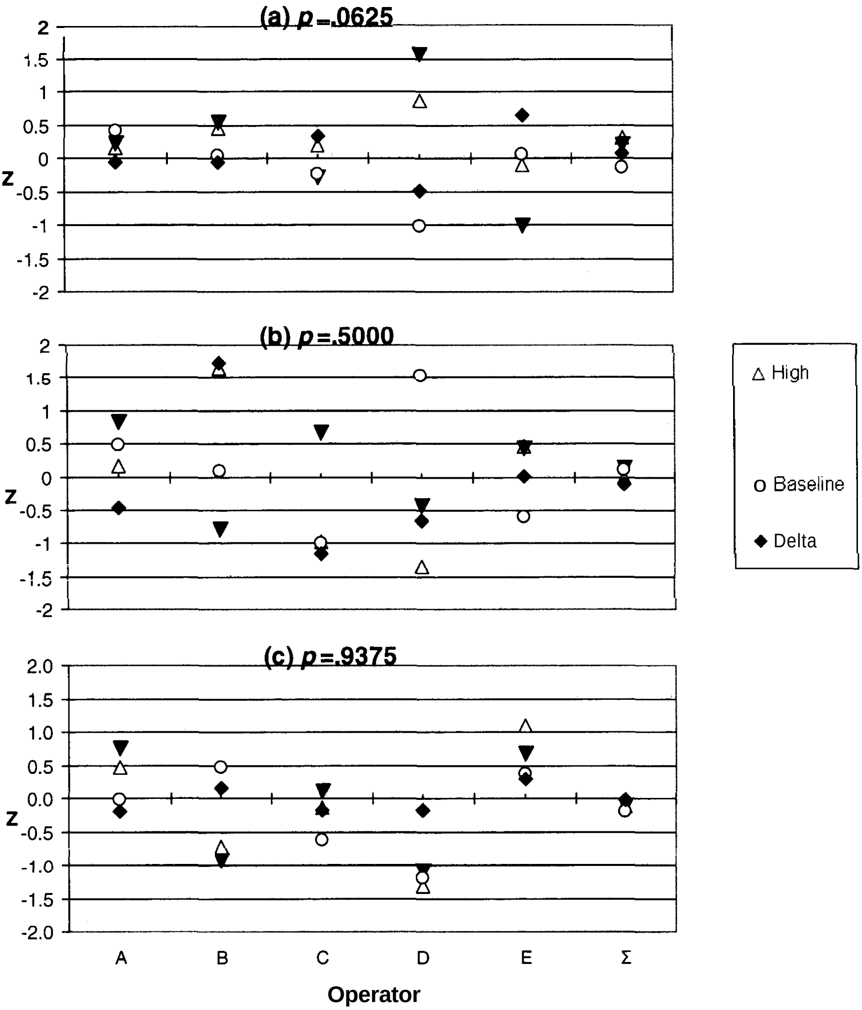

Fig. 4. Z-scores achieved by five operators for three intentions and three binary probabilities: (a) $p = .0625$; (b) $p = .5000$; (c) $p = .9375$.

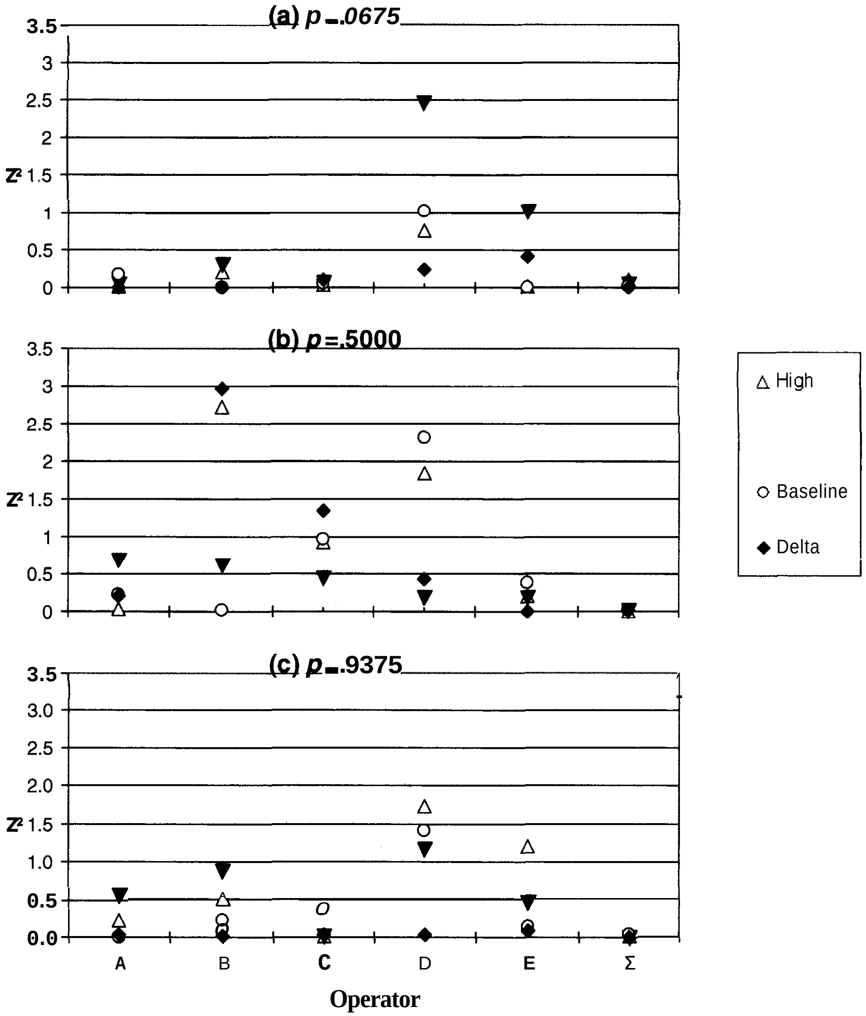

Fig. 5. Squares of Z-scores achieved by five operators for three intentions and three binary probabilities: (a) p = .0625; (b) *p* = .5000; (c) *p* = .9375.

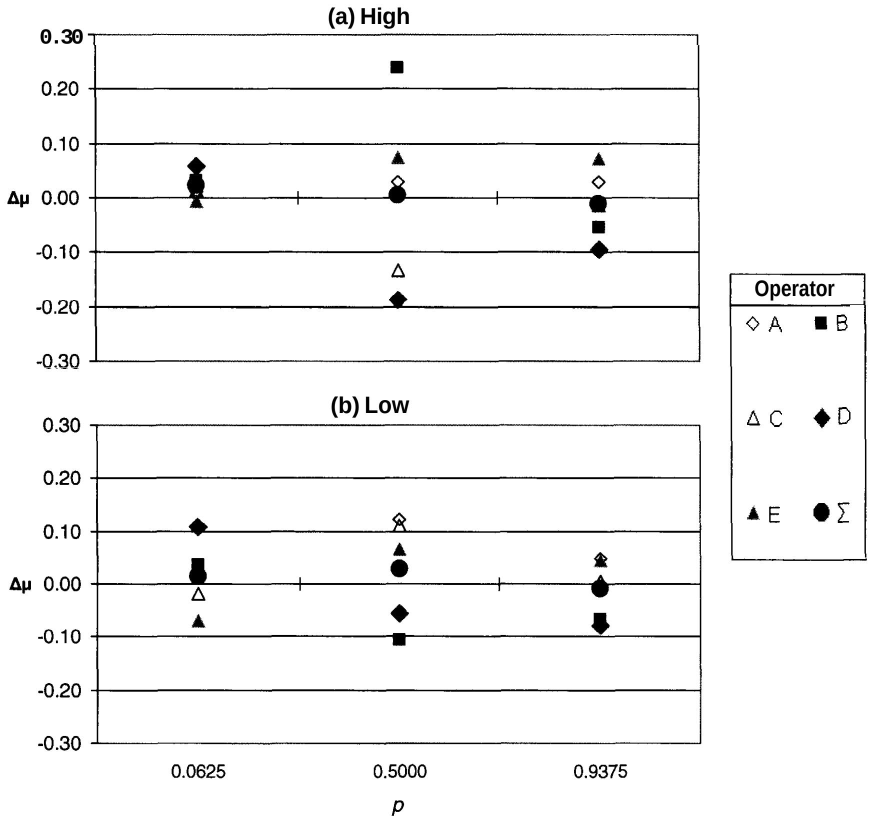

Fig. 6. Mean shifts achieved for three binary probabilities by five operators under three pre-stated intentions: (a) High, (b) Low, (c) Baseline, (d) High – Low **(A).**

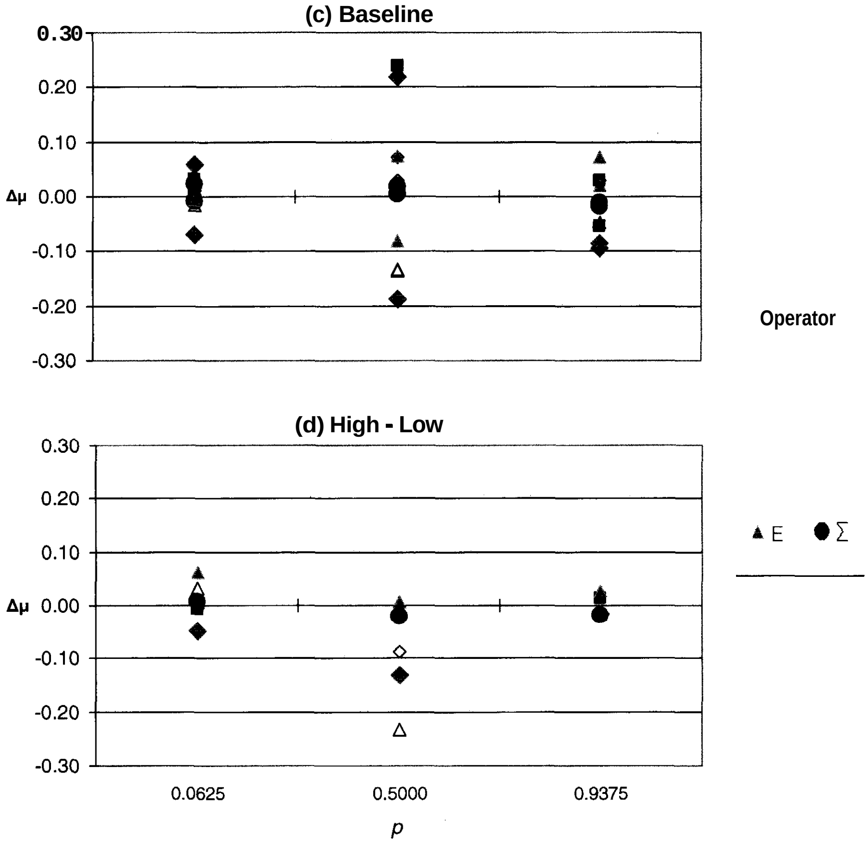

Fig. 6. (cont.): Mean shifts achieved for three binary probabilities by five operators under three pre-stated intentions: (a) High, (b) Low, (c) Baseline, (d) High – Low (Δ).

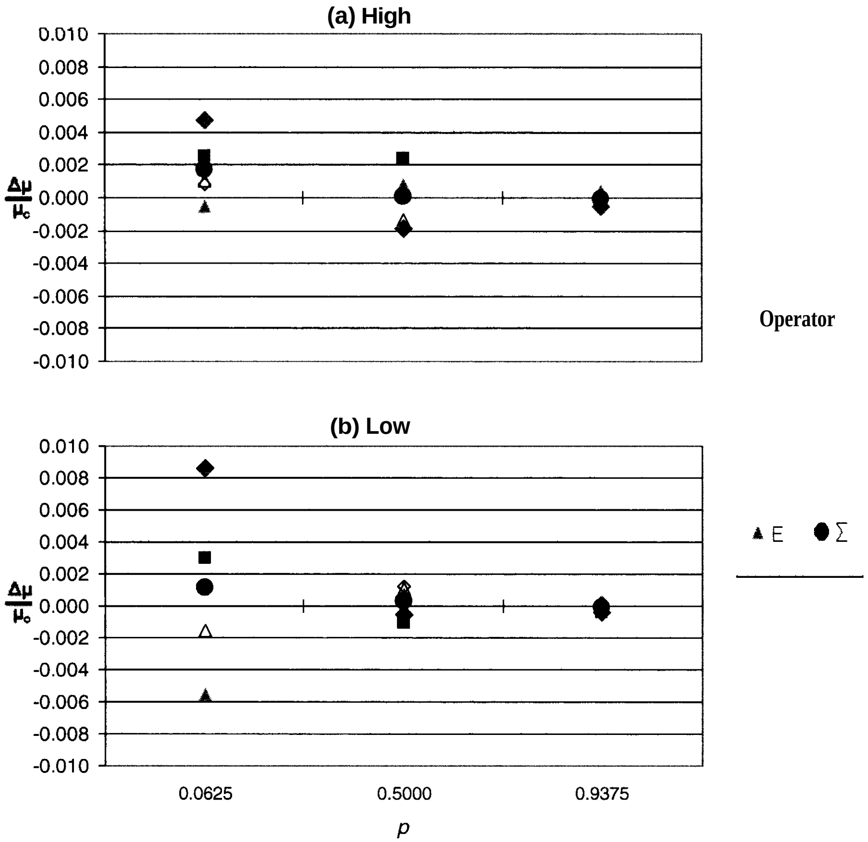

Fig. 7. Normalized mean shifts achieved for three binary probabilities by five operators under three pre-stated intentions: (a) High, (b) Low, (c) Baseline, (d) High − Low (A).

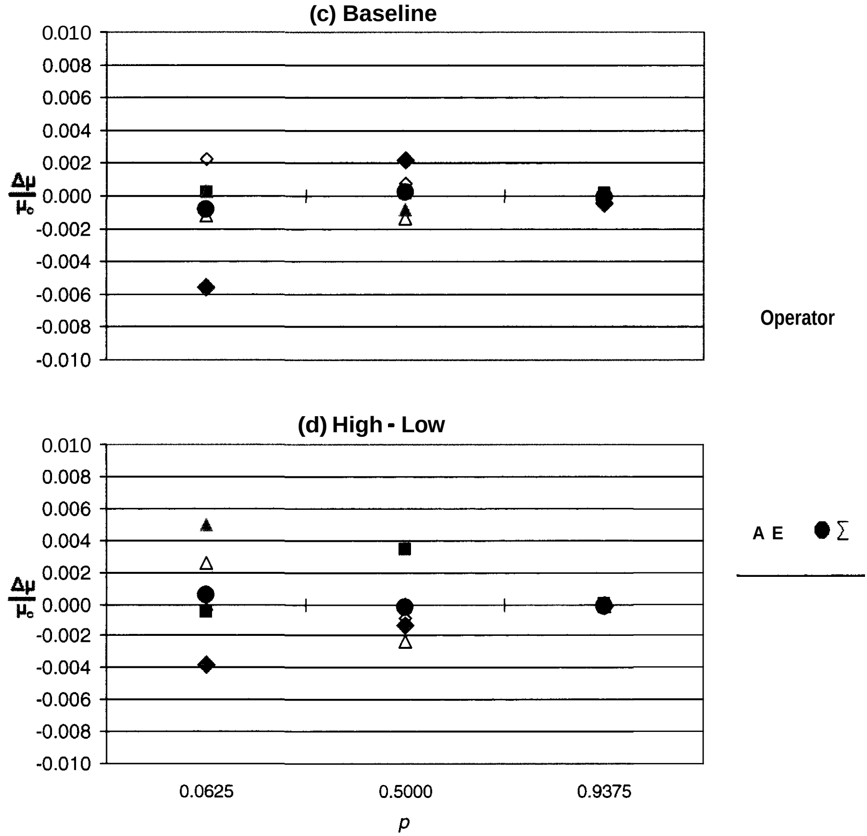

Fig. 7. (cont.): Normalized mean shifts achieved for three binary probabilities by five operators under three pre-stated intentions: (a) High, (b) Low, (c) Baseline, (d) High – Low (Δ).

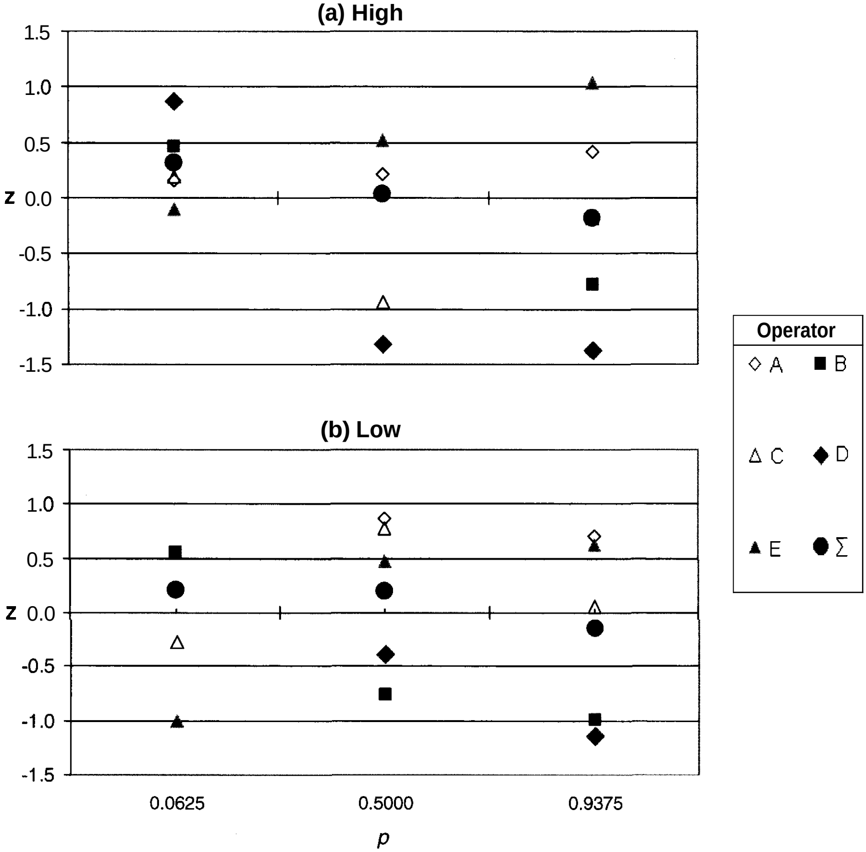

Fig. 8. *Z*-scores achieved for three binary probabilities by five operators under three pre-stated intentions: (a) High, (b) Low, (c) Baseline, (d) High – Low **(A).**

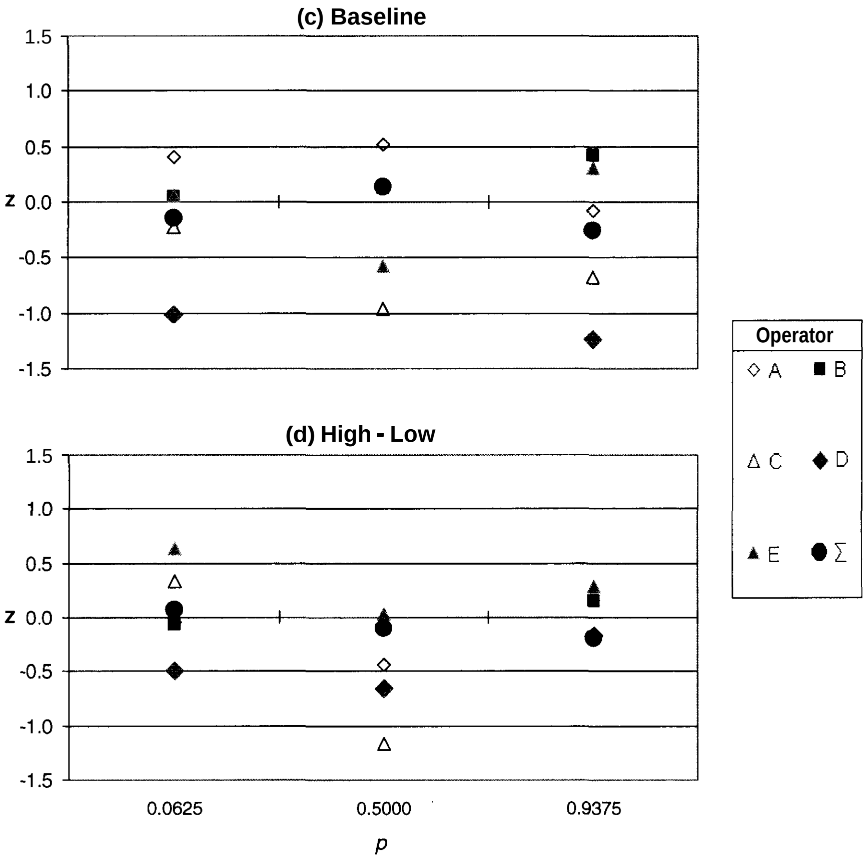

Fig. 8. (cont.): Z-scores achieved for three binary probabilities by five operators under three prestated intentions: (a) High, (b) Low, *(c)* Baseline, (d) High – Low **(A).**

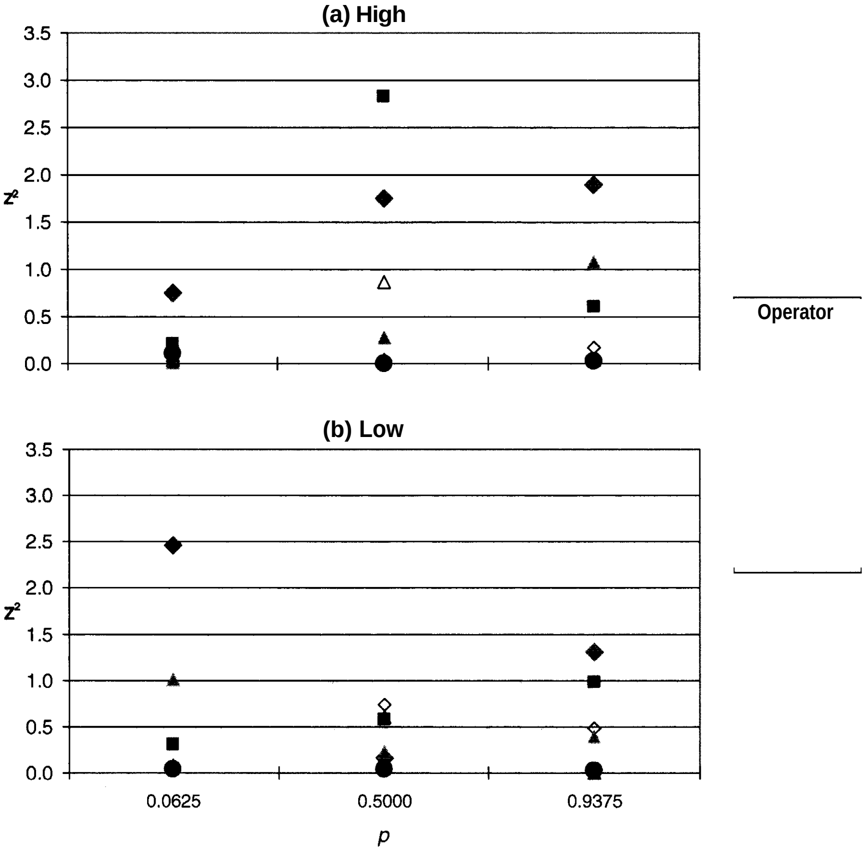

Fig. 9. Squares of Z-scores achieved for three binary probabilities by five operators under three pre-stated intentions: (a) High, (b) Low, (c) Baseline, (d) High – Low **(A).**

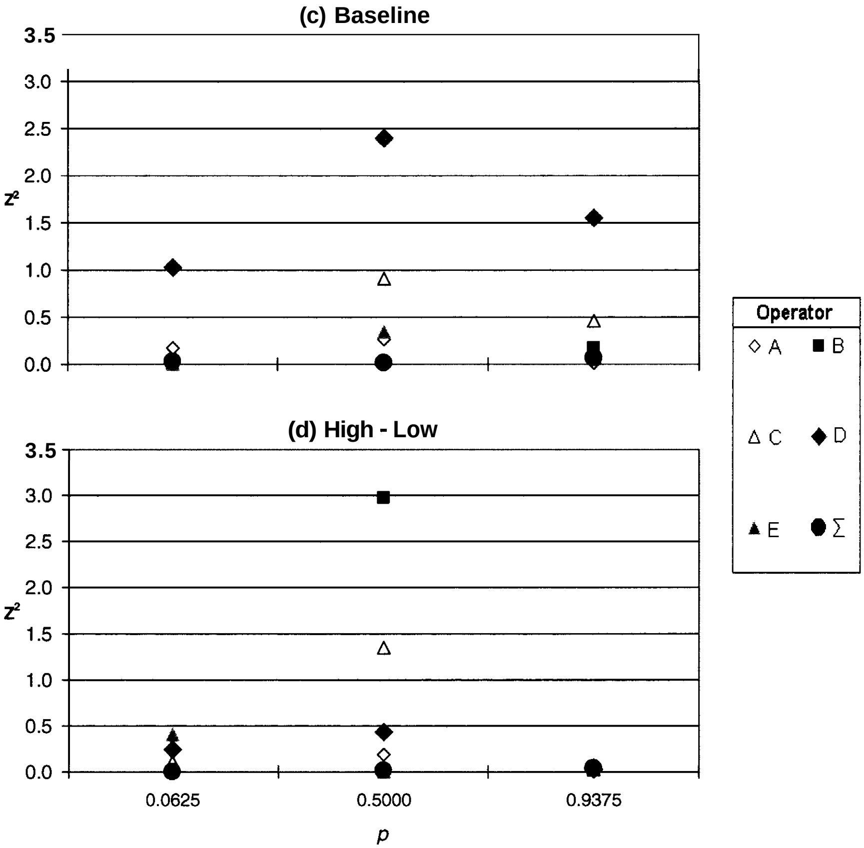

Fig. 9. (cont.): Squares of Z-scores achieved for three binary probabilities by five operators under three pre-stated intentions: (a) High, (b) Low, (c) Baseline, (d) High – Low **(A).**

V. Data Interpretation

This lack of replication of previously established effects has been encountered in a number of other contexts in our laboratory and elsewhere,[3,4] to the extent that it is widely regarded as an inescapable characteristic of the basic phenomena, the implications of which have been discussed in various theoretical contexts.[3,5,6,7] But in this particular study, it seriously confounds the search for empirical discriminators among the possible Δp mechanisms, given the inescapably large experimental and theoretical error bars on the empirical data. Notwithstanding this complication, since it has proven instructive in other situations to examine various subtler aspects of the data structure for alternative evidence of extra-chance behavior, we shall also pursue this strategy here.

In this spirit, next to be noted is that while the operator-segregated data of Figure 2 contain no other remarkable individual performances, they do display considerably more inter-operator variability in the $p = 0.5$ reference cases than in the $p = 0.0625$ and $p = 0.9375$ extremes, consistent with the elementary model predictions of the respective standard deviations. But, beyond this, the relatively weak variability of the inter-operator and inter-condition data raises statistical suspicions of a different kind, to be treated below. As expected from the basic statistical relations, non-dimensionalizing the mean shifts by the pertinent values of the calibration means, $\Delta\mu/\mu_C$ (Figures 3 & 7), explodes the 0.0625 values considerably, and constricts the 0.9375 values slightly, but offers little additional physical insight. More instructive are the corresponding Z-score patterns (Figures 4 & 8), which render the inter-operator variations into considerably more compatible comparisons. In fact, these essentially homogeneous arrays are totally non-significant, perhaps extraordinarily so, and thus tend to favor the Z-independent-of-p, *i.e.* $\Delta p \propto \mathcal{P}$ hypothesis alternative originally suggested in the design of the experiment. (This indication concurs with a similar result obtained in an earlier experiment using pre-recorded targets reported by Schmidt.[8])

In an attempt to quantify the $\Delta\mu$ and Z-score compactions, we may perform a standard chi-squared analysis, with the results shown in Figures 5 and 9. The upshot of these calculations is that the experimental values are indeed clustering around the chance mean to an extent approaching, and in some cases exceeding, statistical significance. This, of course, is tantamount to some sort of hidden correlation among the various components of the operator/intention/probability matrix, for which there is no evident physical or psychological basis. To validate this structural anomaly in the experimental data, we may resort to a Monte Carlo simulation technique we have employed in other contexts,[3] whereby many dummy data sets are constructed from the calibration data reservoir, of identical size and indexing to those of the experimental data. The distribution function of these dummy sets may then be used for estimating the extent of the departure of the experimental arrays from the chance expectations.

Table 4: Monte Carlo Data Simulations Based on Calibration Data

	$p = 0.0625$	$p = 0.5$	$p = 0.9375$
N_C	1,517,450	1,517,700	1,517,700
μ_C	12.480463	100.009847	187.52337
σ_C	3.417568	7.067636	3.41990
N_d	606	607	607
$\Delta\mu_d$	–.019537	+.0009847	+.02337
σ_d	.957454	.990361	1.000078

These simulation calculations were performed by assembling as many independent 2500-trial subsets of the available calibration data as possible (607) for each of the initial probability values and computing from the mean values and standard deviations thereof the corresponding dummy Z-scores and sums of Z^2 for all possible combinations of dummy operators, intentions, and a priori binary probabilities (45). The results are displayed in Table 4, where N_C denotes the number of calibration trials available, with μ_C and σ_C their respective trial-level means and standard deviations. N_d denotes the number of independent 2500-trial dummy sets utilized, $\Delta\mu_d$ the deviation of their trial means from expectation, and σ_d the standard deviations of their Z distribution.

Compounding the corresponding Z^2 values over the 45 degrees of freedom entailed by the five-operator, three-intention, three-probability matrix for the 40 independent simulations yields a distribution having a mean of 43.55 and a standard deviation of 8.68. The theoretical expectation for $\sum_{45} Z^2$ is, of course, 45, with a o of 9.49. Given the slightly smaller simulation values of σ_d tabulated, the corrected expectation would be 43.4653. The empirical value from the active experiments is 26.94, which differs from the theoretical expectation by −18.06, from the adjusted expectation by −14.24, and from the simulation mean by −13.91, having corresponding 2-scores and one-tailed probabilities of 2.01 ($p = 0.022$), 1.589 ($p = 0.056$), and 1.552 ($p = 0.060$), respectively, all marginal by conventional statistical standards, but possibly noteworthy.

VI. Discussion

We are thus left with a dilemma whether to attribute the compression of empirical Z-scores to an operator-induced structural anomaly akin to those we have identified in other experiments,[3] or to a technical auto-correlation non-ideality in the functioning of the POCX device. The slight narrowing of the standard deviations of the calibration mean distributions would seem to favor the latter interpretation, as would the ubiquitous appearance of Z and Z^2 congestion in virtually all of the conditions tested in the active experiment. On the other hand, the extensive Monte Carlo simulations of the 2-scores, based on the same empirical calibration data, in their close concurrence with theoretical expectations would seem to favor the former deduction. If these correlations are indeed some subtle form of operation-induced structural anomaly in the datasets, we face a difficult phenomenological interpretation. Namely, by what conceivable mechanisms can five different operators, utilizing their individual techniques to achieve anomalous High – Low separations of mean shifts from an experimental target configured to three widely disparate binary probabilities, unconsciously conspire to produce results that are substantially more correlated among themselves than should be expected by chance, even when they compound to statistically negligible primary effects? Bizarre as such secondary anomalies may appear, we have tended to encounter many forms of these in various other experimental contexts, leading us to speculations that such are intrinsic alternative expressions of the operator-induced anomalous behavior that will need to be accommodated in any comprehensive theoretical model of the phenomena.

All of this equivocation notwithstanding, we nevertheless can take away two useful insights from this POCX study. First, despite the small effect sizes, it appears that the best common denominator for various binary p experiments is the standard statistical 2-score, rather than the mean shifts, per se, normalized or not. This in turn predicates the deduction that the Δp that can be achieved scales as the prevailing generalized probability, $\mathcal{P} = \sqrt{p - p^2}$, rather than with p itself, or independent of it.

Second, from an operational perspective, we reluctantly concede that neither of the extreme initial probability settings has displayed sufficiently radical departure from the $p = 0.5$ data to encourage refinement of the device and collection of the order-of-magnitude–larger databases we would need to discriminate the original alternative hypotheses and structural features more authoritatively, let alone to attempt to exploit $p \neq 0.5$ technology to other research and application purposes.

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APPENDIX 1
Effect Sizes

Our REGs are characterized by a nominal binary probability, $0 < p < 1.0$, usually 0.5. Our protocols specify the total number of bits sampled, N, aggregated in some number of trials, runs, and series.[2] The primary measurable is the output mean, which has a theoretical chance expectation, $\mu_o = p\text{N}$, with a theoretical standard deviation, $\sigma = \mathcal{P}\sqrt{N}$, where $\mathcal{P} = \sqrt{p(1-p)}$.

In an operator-driven experiment, anomalous performance can be represented in various ways:

- Mean shift: $\Delta\mu = \mu - \mu_o = \text{N}\ \Delta p$
- Normalized mean shift: $\mathcal{E}_\mu = \Delta\mu/\mu_o = \Delta p/p$
- Z-score: $Z = \Delta\mu/\sigma = \text{N}\ \Delta p/\sqrt{\text{N}}\ \mathcal{P} = \sqrt{\text{N}}\ (\Delta p/\mathcal{P})$
- Z effect size: $\mathcal{E}_Z = Z/\sqrt{\text{N}} = \Delta\mu/\sigma\sqrt{\text{N}} = \Delta p/\mathcal{P}$

where Ap, the operator-induced change in the bit probability, is treated as the most fundamental empirical index of the anomalous effect.

The following Tables A-1 through **A-7,** described in detail in the text, presume these definitions.

Table A-1: Dependence of Various REG Output Characteristics on Nominal Binary Probability

	* (1)	$\sigma/\sqrt{N}$ (2)	$\frac{\sigma}{\mu}\bullet\sqrt{N}$ (3)	$Z/\sqrt{N}\,\Delta p$ (5)(7)	$\frac{\Delta\mu}{\mu}$ (1)(4)(6)	$\left(\frac{d\sigma}{dp}\right)/\sqrt{N}$ (9)	$\frac{d(\sigma/\mu)}{dp}\bullet\sqrt{N}$ (10)	$\left(\frac{dZ}{dp}\right)/\sqrt{N}\,\Delta p$ (11)	$\frac{d}{dp}\left(\frac{\Delta\mu}{\mu}\right)/\Delta p$ (13)
.01	.01	.0995	9.950	10.05	100.	4.925	– 502.5	–994.8	– 10000.
	[2]	[1.407]	[.7036]	[142.1]		[69.65]	[–35.531	[– 14068]	
.05	.05	.218	4.359	4.587	20.	2.064	– 45.87	– 86.87	– 400.
	[10]	[3.083]	[.3082]	[64.87]		[29.19]	[– 3.2431	[– 12291	
.1	.1	.3	3.	3.333	10.	1.333	– 16.67	– 29.62	– 100.
	[20]	[4.243]	[.2121]	[47.14]		[18.85]	[– 1.1791	[– 418.91	
.2	.2	.4	2.	2.5	5.	.75	– 6.	– 9.375	– 25.
	[40]	[5.657]	[.1414]	[35.36]		[10.61]	[– .4243]	[– 132.61	
.3	.3	.458	1.527	2.182	3.333	.437	– 3.64	–4.162	– 11.11
	[60]	[6.477]	[.1080]	[30.86]		[6.180]	[– .2574]	[– 58.821	
.4	.4	.490	.1225	2.041	2.5	.204	– 2.55	– 1.701	– 6.25
	[80]	[6.930]	[.08662]	[28.86]		[2.885]	[– .1803]	[– 24.061	
.5	.5	.5	1.	2.	2.	0	– 2.	0	– 4.
	[100]	[7.071]	[.07071]	[28.28]		[0]	[– .1414]	[0]	
.6	.6	.490	.817	2.041	1.667	– .204	– 1.7	1.701	– 2.778
	[120]	[6.930]	[.05777]	[28.86]		[– 2.8851	[– .1202]	[24.06]	
.7	.7	.458	.654	2.182	1.429	– .437	– 1.56	4.162	– 2.041
	[140]	[6.477]	[.04624]	[30.86]		[– 6.1801	[– .1103]	[58.82]	
.8	.8	.4	.5	2.5	1.25	– .75	– 1.56	9.375	– 1.563
	[160]	[5.657]	[.03536]	[35.36]		[– 10.611	[– .1103]	[132.6]	
.9	.9	.3	.333	3.333	1.111	– 1.333	– 1.85	29.62	– 1.235
	[180]	[4.243]	[.02355]	[47.14]		[– 18.851	[– .1308]	[418.91	
.95	.95	.218	.229	4.587	1.053	– 2.064	– 2.414	86.87	– 1.109
	[190]	[3.083]	[.01619]	[64.87]		[– 29.191	[– .1707]	[1229]	
.99	.99	.0995	.1005	10.05	1.010	–4.925	– 5.076	994.8	– 1.020
	[198]	[1.407]	[.00711]	[142.1]		[– 69.651	[– .3589]	[14068]	

* Circled numbers denote pertinent equations in text.

Table A-2: p = 0.5; by Operator						
Op. #	N	μ	$\Delta\mu = \mu - \mu_C$	$\Delta\mu / \mu_C$	$Z = \Delta\mu\sqrt{N} / \sigma_C$	Z^2
High Intentions						
A	2500	100.0348	,024953	.000250	.176444	,031133
B	2500	100.2432	.233353	,002333	1.650055	2.722681
C	2500	99.8729	–.136950	–.001370	–.968360	.937724
D	2500	99.8176	–.192250	–.001920	–1.359390	1.847945
E	2500	100.0744	.064553	.000645	.456459	.208354
All	12500	100.0086	–.001270	–.000013	–.008959	.000080 ([illegible] = 5.747837)
Low Intentions						
A	2500	100.1272	.117353	.001173	.829811	,688586
B	2500	99.8984	–.111450	–.001114	–.788049	.621022
C	2500	100.1050	.095153	.000951	.672833	.452705
D	2500	99.9496	–.060250	–000602	–.426011	.181485
E	2500	100.0724	,062553	,000625	.442317	,195644
All	12500	100.0305	,020673	.000207	.146180	.021369 (= 2.139442)
Baselines						
A	2500	100.0780	.068153	.000682	,481914	.232242
B	2500	100.0236	.013753	.000138	,097248	.009457
C	2500	99.8704	–.139447	–.001390	–.986039	,972273
D	2500	100.2246	.214753	.002147	1.518533	2.305943
E	2500	99.9236	–.086247	–.000860	–.609858	.371927
All	12500	100.0240	,014193	.000142	.100360	.010072 ([illegible] = 3.891842)

Table A-3: p = 0.5; High – Low Differences, by Operator					
Op. #	N	$\delta\mu$	$\delta\mu / \mu_C$	$Z_\delta = (Z_{HI} - Z_{LO}) / \sqrt{2}$	Z_δ^2
A	5000	–.0872	–.000870	–.462000	,213444
B	5000	.3448	.003448	1.724000	2.972176
C	5000	–.2321	–.002320	–1.160499	1.346757
D	5000	–.1320	–.001320	–.659999	.435598
E	5000	.0072	,000072	.010000	.000100
All	25000	–.0219	–.000219	–.109700	.012034 ([illegible] = 4.968075)

Table A-4: p = 0.0625; by Operator						
Op. #	N	μ	$\Delta\mu = \mu - \mu_C$	$\Delta\mu / \mu_C$	$Z = \Delta\mu\sqrt{N} / \sigma_C$	Z^2
High Intentions						
A	2500	12.4912	,010737	.000860	.156824	,024594
B	2500	12.5120	,031537	.002527	.460627	.212178
C	2500	12.4937	.013237	.001061	.193339	.037380
D	2500	12.5400	.059537	.004770	.869594	.756193
E	2500	12.4736	–.006860	–.000550	–.100241	,010048
All	12500	12.5021	.021637	.001734	.316029	.099874 (□ = 1.040393)
Low Intentions						
A	2500	12.4960	,015537	.001245	,226932	.051498
B	2500	12.5184	.037937	.003040	.554105	.307033
C	2500	12.4617	–.018763	–.001503	–.274051	.075104
D	2500	12.5880	.107537	.008616	1.570678	2.467031
E	2500	12.4116	–.068863	–.005518	–1.005808	1.011651
All	12500	12.4951	,014677	.001176	,214371	.045955 (□ = 3.912317)
Baselines						
A	2500	12.5084	.027937	.002238	,408046	,166502
B	2500	12.4836	.003137	.000251	.045819	.002099
C	2500	12.4650	–.015463	–.001239	–.225852	.051009
D	2500	12.4112	–.069263	–.005550	–1.011651	1.023437
E	2500	12.4844	.003937	.000315	,057504	,003307
All	12500	12.4705	–.009943	–.000797	–.145227	021091 (□ = 1.246354)

Table A-5: p = 0.0625; High – Low Differences, by Operator					
Op. #	N	$\delta\mu$	$\delta\mu / \mu_C$	$Z_\delta = (Z_{HI} - Z_{LO}) / \sqrt{2}$	Z_δ^2
A	5000	–.0048	–.000385	–.049574	.002458
B	5000	–.0064	–.000513	–.066099	.004369
C	5000	.0320	,002564	,330495	,109227
D	5000	–.0480	–.003846	–.495742	,245760
E	5000	.0620	.004968	.640333	,410027
All	25000	.0070	.000561	.071883	.005167 (□ = .771841)

Table A-6: p = 0.9375; by Operator

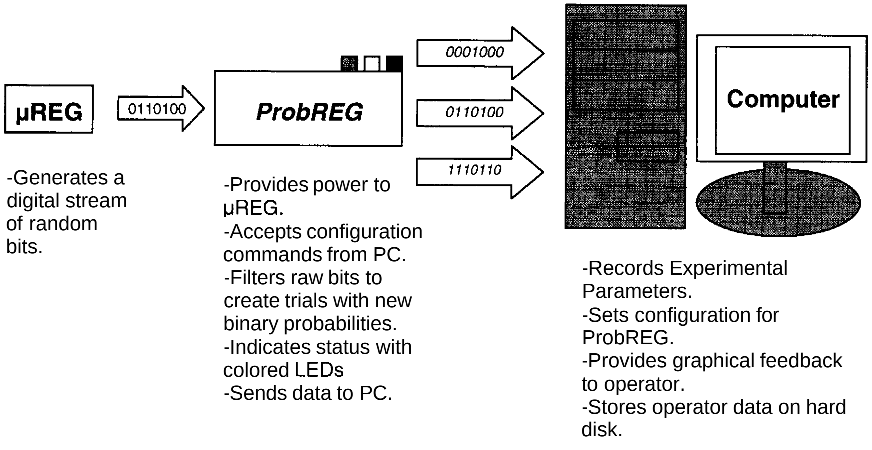
Op. #	N	μ	$\Delta\mu = \mu - \mu_C$	$\Delta\mu / \mu_C$	$Z = \Delta\mu\sqrt{N} / \sigma_C$	$\mathbf{Z}^2$
			High Intentions			
A	2500	187.5560	,032663	.000174	.477074	,227599
B	2500	187.4740	–.049336	–.000263	–.720613	.519283
C	2500	187.5146	–.008737	–.000047	–.127612	,016285
D	2500	187.4330	–.090337	–.000482	–1.319456	1.740965
E	2500	187.5984	.075063	.000400	1.096365	1.202017
All	12500	187.5152	–.008137	–.000043	–.118848	,014125(□ = 3.706149)
			Low Intentions			
A	2500	187.5752	,051863	.000277	.757508	,573818
B	2500	187.4596	–.063737	–.000340	–.930938	.866646
C	2500	187.5313	.007963	.000042	.116307	,013527
D	2500	187.4492	–.074137	–.000395	–1.082840	1.172543
E	2500	187.5700	,046663	.000249	.681557	.464520
All	12500	187.5171	–.006277	–.000033	–.091681	.008405 (□ = 3.091054)
			Baselines			
A	2500	187.5216	–.001737	–.000009	–.025371	.000644
B	2500	187.5560	.032663	.000174	.477074	.227599
C	2500	187.4808	–.042537	–.000227	–.621293	.386005
D	2500	187.4420	–.081337	–.000434	–1.188003	1.411351
E	2500	187.5484	.025063	.000134	.366069	.134006
All	12500	187.5098	–.013577	–.000072	–.198305	.039325 (□ = 2.159605)

Table A-7: p = 0.9375; High − Low Differences, by Operator

Op. #	N	$\delta\mu$	$\delta\mu / \mu_C$	$Z_\delta = (Z_{HI} - Z_{LO}) / \sqrt{2}$	Z_δ^2
A	5000	–.0192	–.000102	–.198297	.039322
B	5000	.0144	.000077	.148723	.022118
C	5000	–.0167	–.000089	–.172477	,029748
D	5000	–.0162	–.000086	–.167313	.027994
E	5000	.0284	.000151	.293314	.086033
All	25000	–.0193	–.000103	–.199330	.039732 (□ = .205215)

APPENDIX 2
Technical Design

Several options were considered for provision of the variable probability bit sources for the POCX ProbREG studies. As a compromise among precision of operation, simplicity of implementation, and similarity to our standard REG devices, we opted to interface one of our existing microREG units with a dedicated circuit utilizing an embedded microprocessor (PICI6F628), and its native RS232 interface. In addition to providing stabilized 5V power for the microREG, this circuit accumulated the individual bits from the output streams for filtering to the desired preset probabilities, as instructed by the PC controlling the experiment, and for downstream recording of the data. To accomplish the three binary probability options, a 4-bit mask was used in various configurations. For the .0625 case, only input bits matching one of the 16 possible combinations of template values produced a "1" output. For the .9375 case, all but one combination produced a "1" output. To recover the comparison .5000 case, eight of the combinations passed a "1" digit. In any situation, the bits were packaged into 200-bit trials and sent to the PC at a rate of approximately one trial per second.



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