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RESEARCH ARTICLE

Audience Size Effects in Field RNG Experiments: The Case of Japanese Professional Baseball Games

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Abstract—This study examined the association between the outputs of a true random number generator (RNG) and audience size during Japanese professional baseball games. We regarded the RNG as a signal detector of field consciousness and hypothesized that the number of signal sources may increase the ability of an RNG to detect signals. Experimenters and our assistants voluntarily obtained 76 samples from a total of 78 baseball games during the 2010–2011 baseball season. The effects of audience size at the stadium (M = 38970 ± 6058 SD, N = 78) and TV audience ratings (M = 7.07 ± 2.32 SD, N = 23) were examined in relation to the measurements of multiple Random Streamer and Psyleron RNG devices. RNGs set at remote locations ran simultaneously during the games. Our results showed a positive correlation between accumulated chi-squared statistics by Random Streamer and audience size at the stadium. Unexpectedly, identical RNG devices showed strong negative correlations between different machines, which suggested that their outputs canceled each other out. Finally, some future tasks are discussed.

Keywords: baseball stadium—MMI—PK—Rpg102—Rpg105—Tokyo Dome

Introduction

A random number/event generator (RNG/REG) creates a physical random source in itself, and its output is essentially unpredictable and different from pseudo random numbers (PRNG), which require an initial seed. Recent field RNG/REG studies have reported that field consciousness affects RNG output during large events or when news is broadcasted worldwide (Nelson 2001, Nelson et al. 1996, 1998, 2002, Radin 1997, 2002, 2006).

Field consciousness seems to involve many psychological factors, including group emotion, focused group energy (Rowe 1998), and a coherent mind (Radin 2006). From the results of previous studies, it is possible to assume that an RNG would be a signal detector despite its noisy outputs, whereas field consciousness would be regarded as the source of signals during events. In accordance with this assumption, it can be hypothesized that statistical biases are more detectable when strong signals, such as coherent group emotion, exist in the field (Shimizu & Ishikawa 2010, 2011). In contrast, it could be hypothesized that a large number of signal sources makes it easy for an RNG to detect biases as signals, even though each signal is weak. This possibility is suggested by the results of Radin (2006), who reported, based on analysis of data from midnight of Y2K and all New Year's Eve data from 1999 to 2005, that the anomalistic behavior of RNGs was observed by a "mass-coherent mind." As external variables such as audience size have no relationship to RNG outputs, audience size effects, if they exist, could no longer be an issue of RNG output qualities, and it might be concluded that it is simply an anomaly that an RNG detects field consciousness.

To date, however, there exists little systematic field research and few experiments that have directly investigated audience size effects. This is related to methodological issues confronting field RNG studies. It is difficult for researchers to control huge events or worldwide news and to determine exact audience size and the possibility that other factors might be involved.

Field RNG Experiment

The current study focused on how signal quantity or audience size affects the outputs of an RNG. It was expected that the larger the audience is, the greater the statistical bias would be in the outputs of an RNG. To examine this hypothesis, a field experiment with a fixed event that enables us to measure audience size would be required. Additionally, the event must have particular locations and start and end times, in contrast to events such as broadcasted news, which pose difficulties in determining the endpoints. Recently, these kinds of field RNG experiments have been conducted by several researchers (Varvoglis 2006, Lumsden-Cook 2005a, 2005b, Shimizu & Ishikawa 2010).

It is important for a large-scale study to meet the following conditions. First, the event must be repetitive. Second, the audience size must be countable and must vary. This will allow an estimation of how RNG outputs and audience size are associated. Ideally, audience size always maintains a particular size. A large-scale repetitive sporting event fulfills these conditions.

Sporting events could be regarded as a way to detect field consciousness, considering that RNG outputs of some sporting events, such as soccer games showing statistical biases (Bierman 1996, Hagel & Tschapke 2004) and American football games, which tend to produce chance results (Nelson et al. 1998, Radin 1997), have already been analyzed and reported.

For this purpose, we selected Japanese professional baseball games for our field RNG experiment because baseball is the most popular sport in Japan and typically has a large audience. The Tokyo Dome has a large audience capacity (a maximum of about 47,000), and audience sizes vary throughout each season. The game is also repetitive. Generally, about 70 games (half the number of total games in the season) are held at the home field during a regular season. It is predicted that RNGs run at the stadium during baseball games would show statistically biased outputs. The main hypothesis of this study is that outputs will reveal positive effects corresponding to the audience size at the stadium.

TV Audience Ratings as a Second Factor

Because Japanese professional baseball games are occasionally broadcast nationwide on a ground-based system, we can also consider TV audience ratings as a second factor indicating focus–attention quantity, assuming that the TV audience rating is related to and corresponds to the quantity of total nationwide focus attention or interest of many people.

It should be noted that the TV audience is distant from the stadium. As non-locality in psi phenomena has already been reported (Hagel & Tschapke 2004, Dunne & Jahn 1992, and the Global Consciousness Project), some might expect that an RNG can detect field consciousness without being influenced by distance. However, distance-dependent properties of RNGs have also been reported such that deviations in RNG outputs decrease with distance from the Institute of Noetic Science laboratory, where the RNG machines are located (Radin 2006). These findings are not inconsistent when we assume that non-local psi phenomena exist but are not completely free from distance effects.

One can rather assume that the TV audience is very large. In 2011, about 120 million people were living in Japan, and 42 million people live in the Kanto Area where the current study collected information. If the TV rating is 10%, then 4.2 million people in the Kanto Area will be focusing on the same program simultaneously (12 million in nationwide Japan). This size corresponds to 100 times the audience size at the stadium. It was expected that the TV audience rating may have sufficient influence on the RNG output due to its huge size, despite distance.

To examine these two kinds of audience effects, we set up RNGs at the ballpark and at locations remote from baseball stadiums, and we made them generate random numbers continuously. If the effects of audience size are dependent on distance, it would be expected that the effects of the stadium audience could affect RNG outputs at the stadium while having small-sized effects on the remote RNGs. Additionally, TV audience rating effects, if observed, would have small effect sizes on all RNG outputs regardless of their location. If a huge TV audience size could make up for the increase in distance, all RNG output conditions would be affected by the TV audience ratings. The ratings were expected to directly affect not only experimental RNG outputs located at the stadium but also those located far from the stadium. In any case, it was expected that the audience size at the stadium would have positive effects on the RNGs located at the stadium.

Using Multiple RNG Devices

In the current experiment, multiple RNG devices were used to generate random numbers, based on the assumption that all the RNGs at the same location would be affected equally by field consciousness (or other potential factors). If so, the outputs of multiple RNG devices would be positively correlated, and an experiment with multiple RNG devices would have some advantages, as it could increase the chance of finding output biases from the viewpoint of signal detection.

Methods

RNG Hardware

Five “Psyleron (REG-1)” and five “Random Streamer” devices were used as physical random number generators. Both types of RNG devices generated true random numbers with the physical sources.

The random source was a Psyleron device based on a field-effect transistor (FET), which has reverse-biased diodes with 10-nm doped gaps for electron tunneling, so that current flows opposite to the normal direction and forces electrons against the solid-state junction barrier. Electron tunneling allows a small current to develop past the barrier, and this is sampled to provide the random bits used in the experiments.

The Random Streamer[1] complies with Federal Information Processing Standardization (FIPS 140-2) regulations, using thermal noise as a random source. The IC tip has a pair of sensors, each of which is constructed by combining two FETs: one for a source of thermal noise and another as a noise amplifier. Next, the two signals from the sensors are modulated by other thermal noise. Two clock signals are put into delay flip-flop, which compares their time difference. Bit output (1 or 0) is decided based on whether one is faster than another. With these mechanisms, the device is not affected by environmental parameters such as external temperature or noise.

We have two types of Random Streamers, Rpg102 (four devices), and Rpg105 (one device). The Rpg102 has one random source, whereas the Rpg105 has 32 independent RNG sources that can generate outputs simultaneously. All Rpg105 outputs are bitwise-XORed (exclusive-OR) with a mask provided by RNG 33. However, we should note that the first

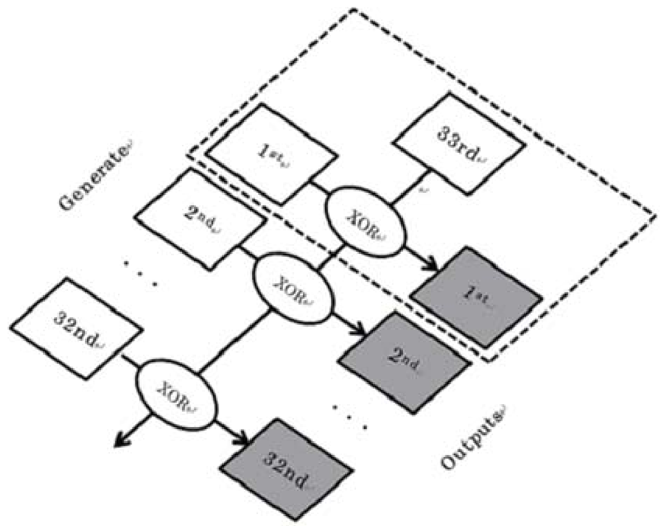

Figure 1. Random number generation structure by Rpg105 (whole figure) and Rpg102 (within dashed closed line).
Each random number generator (RPG100B) is represented by white rectangles in the figure. Gray rectangles are their outputs. Rpg105 has 32 independent RPG100B systems, which generate outputs of bits (1s or 0s), and the 33rd one is used only for XOR (exclusive or) between outputs by 32 RPG100B. Items shown within the dotted line are the same as the mechanism of the Rpg102.

part of its output is systematically the same as the Rpg102 (Figure 1). To analyze all the data from the Random Streamer equally, only the first outputs of the Rpg105 were used.

Software Application

We developed two kinds of software to control the RNGs with the Visual Studio.NET framework version. The first application software was developed for Rpg105, and the other was designed to control Rpg102 and Psyleron at the same time. Since Rpg102 and Rpg105 were impossible to use simultaneously in one machine, these two applications could not be used in the same machine. Both of the applications were programmed to generate random numbers at 512 bits per second, automatically recording them into a csv text file at two-minute intervals after the PC is started.

Procedure and Baseball Games

The experimenter arrived at the stadium as long before the game as possible and started the notebook PCs attached to the RNGs before the start of each game. After starting the machines, he/she closed the covers to keep the monitors off to preserve the life of the batteries. One notebook PC controlled the Rpg102 and Psyleron devices (Figure 2) once we obtained

Figure 2. Two RNG devices, Random Streamer (Rpg 105 and Rpg102) and Psyleron (REG-1), are shown connected to the PC.

the Psyleron devices in early 2011. We used two notebooks simultaneously to generate as many random numbers as possible. Thus, two notebooks and four RNGs were used. The number of machines depended on the schedules of the 20 assistants who volunteered to take the PCs with RNGs to the stadiums. These time schedules were managed mainly by the first author.

A total of 78 baseball games in the Kanto area were observed as experimental field events from September 2010 to October 2011. The experimenter and our confederates went repeatedly to Japanese professional baseball games, including regular season games (67), the climax series (5), the Japan series (2), open games (2), and Eastern League games (2).

These games were held at the Tokyo Dome (70), Seibu Dome (3), Marin Stadium (2), and Meiji Jingu (3). Since two fixed season seats for the Giants were reserved throughout 2011, almost all of the observed games were at the Tokyo Dome. Both of the two season seats were bleacher seats located at the edge of the third floor behind the left pole (Figure 3), which allowed the watcher to relax, because there are no seats in front of or behind them, although sometimes the seats to the right were filled.

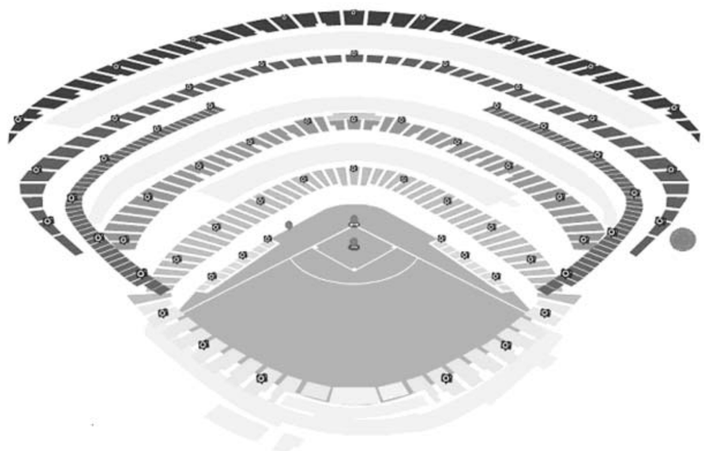

Figure 3. Location of season seats at the Tokyo Dome in 2011 (●).

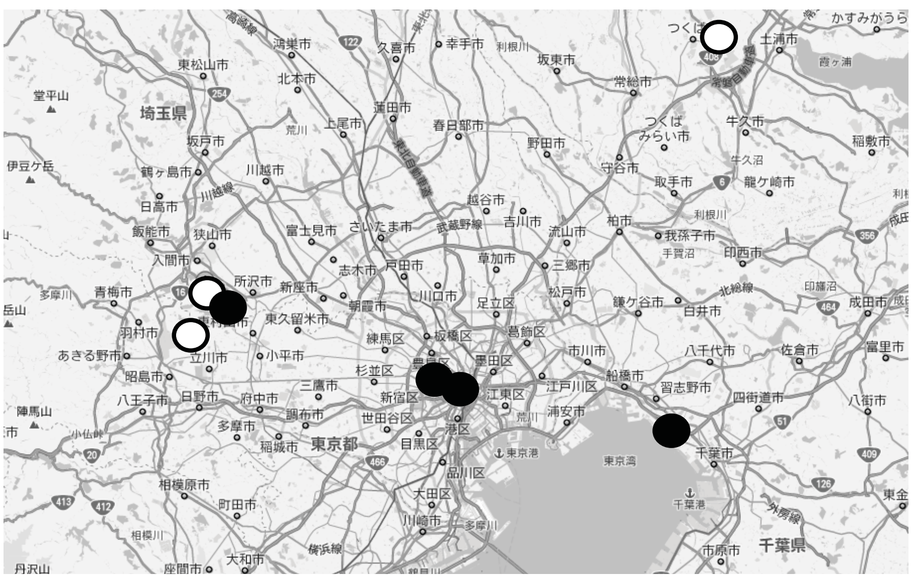

Figure 4. Location of baseball stadiums and remote PCs around Tokyo.
Black circles represent baseball stadiums, and white circles represent remote PCs.

Remote Client PCs and RNGs

For the remote condition, RNGs generated random numbers in Tokorozawa, Musashi-Murayama, and Tsukuba, all of which are in the Kanto area (Figure 4). At these remote PCs, RNGs always generated random numbers even though analyzed data were limited to the period when the game was in progress.

Missing Data

Unexpectedly, we completely failed to generate random numbers during the entire game period for two games at the Tokyo Dome. Both cases were because our application failed to work due to PC troubles or software bugs. In another case, Psyleron could not be used because the experimenter found

TABLE 1
Number of RNG Outputs Used in the Stadium and in Remote Locations in a Total of 78 Baseball Games

			Stadium		Remote Location		
Device	Generation	Number of Games Observed	First PC	Second PC	Musashi-Murayama	Tsukuba	Tokorozawa
Psyleron	single	46	25	21	67	64	35
	dual	21	17	21			
Random Streamer	single	55	34	21	57	64	43
	dual	21	21	18		9	
Number of RNG outputs			97	81	124	137	78
Total			178		339		
					517		

Sum of Psyleron RNG outputs at the stadium is 84 (25+21+17+21), sum of Random Streamer outputs is 94 (34+21+21+18).

TABLE 2
Estimated Pearson's Correlation Coefficients between Audience Size and *z*-Scores

Location	RNG	*CZ*					STOUFFER'S *Z* (*SZ*)					*N*
		Estimation	95% CI Lower	95% CI Upper	*t*-Score	*p*-Value	Estimation	95% CI Lower	95% CI Upper	*t*-Score	*p*-Value	
Stadium	Psyleron	−0.01	−0.22	0.21	−0.06	0.950	0.07	−0.14	0.28	0.67	0.507	84
	Random Str.	0.31	0.11	0.48	3.12	0.002*	−0.10	−0.30	0.10	−1.00	0.319	94
Remote Locations												
Musashi-Murayama	Psyleron	0.01	−0.23	0.25			0.11	−0.13	0.34			67
	Random Str.	0.00	−0.26	0.26			0.03	−0.23	0.29			57
Tsukuba	Psyleron	0.08	−0.17	0.32			0.26	0.02	0.48			64
	Random Str.	−0.02	−0.25	0.21			−0.05	−0.27	0.19			73
Tokorozawa	Psyleron	−0.01	−0.34	0.33			−0.02	0.31	−0.36			35
	Random Str.	0.12	0.41	−0.18			−0.03	−0.32	0.28			43
Combined	Psyleron	0.02	−0.11	0.14			0.12	0.00	0.24			250
	Random Str.	0.13	0.24	0.01			−0.05	−0.17	0.07			267

* Significance after correcting for multiple testing (0.05/4 = 0.0125).

that the USB port had broken just before the baseball game. As a result, the experimental condition included observations of 76 games (Random Streamer missed two and Psyleron missed three games). Using multiple RNGs, the number of RNG outputs collected at the stadium was greater than the total number of 76 games despite some missing data (Table 1). The experimental condition had a total of 178 independent RNG outputs, and the remote condition had 339 outputs from 78 games (Table 2).

However, the problem of missing data frequently occurred during games. We instructed our confederates to check the occasional blink of the Rpg102 devices to ensure that they were working so as to avoid stopping number generation due to unexpected issues. If they found that the devices had stopped during the game, the PC was restarted. The main reason for the machines to freeze seemed to be some kind of physical shocks to the RNGs. The second reason was a freeze in data processing. This is a problem related to the PCs and software application processing, and it was solved by maintenance. The third reason was delays in the games, as reported by our confederates. They reported at least two instances of long delays to the game. In addition, there were other occasions in which subtle delays occurred. One such reason was a dead battery.

As a result, the average coverage of expected trials within a game was 95.5% for the Random Streamer and 96.0% for the Psyleron REG-1 (Figure 5), excluding the two games that were completely missed at the Tokyo Dome.

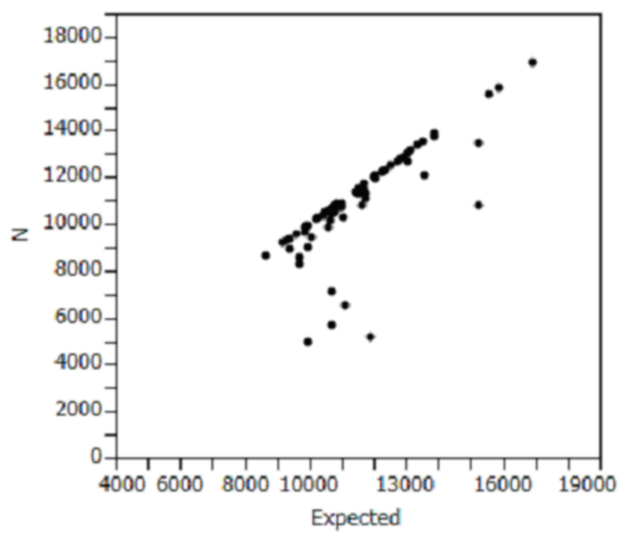

Figure 5. Expected trial numbers (sec) and actual numbers (sec) in games. Some games failed to generate random numbers or generated fewer than expected.

Data Processing and Analysis

To get information about audience sizes and lengths of the baseball games, we referred to the website of NPB (Japanese Professional Baseball) and the official website of the Yomiuri Giants. Average audience size was 38,970.15 ± 6,057.63 for the 78 games. The average length of all the games was 3.09 hours ± 0.40 SD (11,141.8 sec ± 1445.0 SD). The Video Research Corporation provided information on ground-wave TV ratings during baseball games in the Kanto area from 2010 to 2011. This rating information was regarded as a lower limit of ratings, as the rating of satellite broadcast, cable TV, and radio listeners was not counted. For the recorded TV ratings, we used 23 games in our analysis. As some games were broadcast separately because of interruptions by other programs (short news broadcast, etc.), we integrated the two separate ratings into a whole rating for a game using the weighted mean. The average of TV ratings was 7.07% ± 2.32 SD.

Distances between the baseball stadium and remote client PCs were calculated by latitude and longitude using Geocoding API. These distances for machines at Tokorozawa were 33.1, 2.71, 59.3, and 34.3 km from Tokyo Dome, Seibu Dom, Marin Stadium, and Jingu, respectively. Those for Tsukuba were 53.9, 72.3, 49.8, and 58.5 km, and distances for Musashi-Murayama were 31.7, 3.62, 57.7, and 32.1 km, respectively. The average distance of machines operating under the remote condition was 40.88 ± 11.40 SD km (total $N = 339$ in the remote condition).

Statistical Calculations

The RNG devices produce bits (1s or 0s) during real-time processing. All the outputs by the RNGs were converted into *z*-scores. When a RNG generated *X* bits per trial, where *X* is counted obtaining 1s, *X* was approximately binomially distributed, and standardized *z*-scores could be calculated from *X*. The *z*-score based on chance was calculated as follows:

$$Z_{raw} = (X - n\pi) / \sqrt{n\pi(1-\pi)} = (X - 256) / \sqrt{128}, \qquad (1)$$

where π was 0.5, the probability of obtaining 1s, *n* was the total number of bits per second generated by the RNG, and *X* was the sum of 512 bits in a second.

Using the Z_{raw} scores from the time of game start to the end, time-accumulated chi-squared statistics were available, and standardized scores for each game (*CZ* for short) were calculated by

$$CZ_{cumulative} = \sum_{t=start}^{end} (z_{raw}^2 - 1) / \sqrt{2T}, \qquad (2)$$

where T is game length (the number of trials; mean = 11,141.82 sec ± 1,445.0 SD). With these statistics, total CZ through all the games was:

$$Total\ CZ = \sum CZ_{cumulative} / \sqrt{G}, \tag{3}$$

where G means number of games observed. Additionally, Stouffer's z-scores (SZ for short) were calculated by:

$$Stouffers\ Z = \sum_{t=start}^{end} z_{raw}^2 / \sqrt{T}, \tag{4}$$

$$Total\ SZ = \sum Stouffers\ Z / \sqrt{G}. \tag{5}$$

All of the tests were two-tailed.

Correlation Coefficients as Effect Size

To examine our hypothesis, correlation coefficients were calculated under each condition and used as an indicator of effect size. Small, medium, and large effect sizes were $r = 0.10$, 0.30, and 0.50, respectively. These values corresponded to $d = 0.20$, 0.50, and 0.80 (Cohen 1988). For the correlation coefficients, t-scores were calculated with G − 2 degrees of freedom.

Results

Unexpectedly, the total CZ and SZ scores during baseball games did not show significant biases for Random Streamer ($N = 94$, Total $CZ = 1.33$, Total $SZ = .40$) or Psyleron ($N = 84$, Total $CZ = -.80$, Total $SZ = .35$) devices. Statistics for both machines combined were also not significant ($N = 178$, Total $CZ = .41$, Total $SZ = .53$).

Audience Size Effects

Table 2 displays the outputs of the Random Streamers at the stadium, which showed medium-sized effects of audience size on CZ ($r = .31$, $N = 94$). As the z-scores of two devices and two kinds of statistics (CZ and SZ) were tested simultaneously, a corrected significance level in the multiple tests was $\alpha' = \alpha/4 = 0.05/4 = 0.0125$. The correlation coefficient $r = .31$ was significant ($t(92) = 3.12$, $p = 0.002$). No effects were found for the Psyleron CZ ($r = -.01$, $N = 84$; $t(82) = -0.06$, n.s.). Figure 6 shows scatterplots and regression lines for the devices. Stouffer's Z (SZ) showed no significant results.

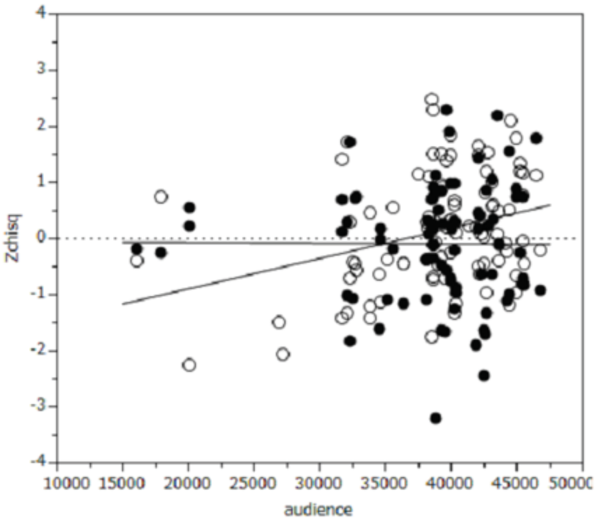

Figure 6. The effects of audience size on the *z*-scores of the accumulated chi-squares of outputs from RNGs.
Circles are *CZ*, cumulative chi-squared statistics per game, standardized into *z*-scores. White circles were those of the Random Streamer. Black circles were those of Psyleron. A dotted line indicates chance level. A regression line shows a significant slope for the Random Streamer data, whereas the one for Psyleron was not significant.

Table 3 shows the correlations between TV ratings and detectable differences between the devices. Corrected significance level was $\alpha' = 0.05/4 = 0.0125$. Stouffer's Z for the Psyleron showed negative correlation coefficients for the combined location (stadium and three three remote locations) ($r = -.22$, $N = 82$), despite the non--significant level ($t(80) = 2.06$), $p = 0.04 > 0.0125$.

Multiple-Devices Measurements

The current field RNG experiment tested the validity of multiple RNG measurements. Sometimes our field experiment used dual PCs simultaneously, although usually two different kinds of RNG devices were used with one PC. Therefore, correlation coefficients were calculated for these three conditions: (1) different devices with a single PC, (2) the same kind of RNG device used with different PCs, and (3) different devices used with different PCs. Table 4 displays these correlation coefficients. As we were not interested in the PC difference, we tested the above three conditions/ RNG device differences. The total number of tests was 14 (see Table 4). The corrected significance level was $\alpha' = 0.05/14 = 0.0036$. The results showed significant negative correlations between identical RNG devices using different PCs ($r = -.54$, $t(33) = 03.66$, $p = 0.0009$). This does not suggest the advantages of multiple measurements that we had assumed before the experiment. A positive correlation was only found for different kinds of RNGs with a single PC, although it was not significant when multiple testing ($r = .21$, $N = 81$).

TABLE 3
Estimated Pearson's Correlation Coefficients (*r*) for the TV Audience Ratings

Location	RNG	CZ					STOUFFER'S *Z* (*SZ*)					*N*
		Estimation	95% CI Lower	95% CI Upper	*t*-Score	*p*-Value	Estimation	95% CI Lower	95% CI Upper	*t*-Score	*p*-Value	
Stadium	Psyleron	−0.15	−0.50	0.26			−0.26	−0.58	0.15			26
	Random Str.	−0.16	−0.50	0.22			0.27	−0.10	0.58			29
Remote Locations												
Musashi-Murayama	Psyleron	0.22	−0.21	0.58			−0.38	−0.69	0.03			23
	Random Str.	−0.60	−0.86	−0.09			0.00	−0.53	0.53			14
Tsukuba	Psyleron	−0.11	−0.51	0.32			−0.01	−0.43	0.41			22
	Random Str.	0.08	−0.30	0.44			−0.07	−0.43	0.32			28
Tokorozawa	Psyleron	0.07	−0.55	0.64			−0.30	−0.76	0.37			11
	Random Str.	−0.12	−0.67	0.52			−0.49	−0.84	0.16			11
Combined	Psyleron	−0.01	−0.22	0.21	−0.07	0.947	−0.22	−0.42	−0.01	−2.06	0.042	82
	Random Str.	−0.13	0.09	−0.34	−1.20	0.233	0.01	−0.20	0.23	0.13	0.898	82

TABLE 4
Estimated Pearson's Correlation Coefficients (*r*) for Each Device Combination

Devices		CZ					STOUFFER'S *Z* (*SZ*)					*N*
		Estimation	95% CI Lower	95% CI Upper	*t*-Score	*p*-Value	Estimation	95% CI Lower	95% CI Upper	*t*-Score	*p*-Value	
TOTAL WITHIN PC		0.21	−0.01	0.41	1.90	0.061	0.02	−0.20	0.24	0.22	0.830	81
	First	0.12	−0.19	0.41			−0.16	−0.44	0.16			42
	Second	0.38	0.07	0.62			0.24	−0.08	0.52			39
Different Devices within PC (Psyleron and Random Streamer)	Single PC	0.19	−0.10	0.46	1.31	0.198	0.03	0.31	0.87	0.17	0.865	46
	First	0.13	−0.28	0.50			−0.30	−0.62	0.11			25
	Second	0.30	−0.15	0.65			0.35	−0.09	0.68			21
	Dual PC	0.26	−0.08	0.55	1.58	0.124	0.02	−0.31	0.35	0.13	0.897	35
	First	0.23	−0.28	0.64			0.09	−0.41	0.55			17
	Second	0.45	−0.02	0.76			0.01	−0.46	0.48			18
BETWEEN 2 PCs												
Same Devices		−0.54	−0.74	−0.25	−3.66	0.001*	−0.16	−0.47	0.18	−0.93	0.357	35
	Psyleron	−0.55	−0.82	−0.10	−2.57	0.021	−0.39	−0.73	0.11	−1.63	0.124	17
	Random Str.	−0.54	−0.80	−0.09	−2.55	0.021	0.03	−0.44	0.49	0.12	0.906	18
Different Devices		−0.17	−0.48	0.17	−0.99	0.328	−0.19	−0.49	0.15	−1.11	0.276	35
	Pair 1	−0.55	−0.84	−0.03			0.09	−0.46	0.59			14
	Pair 2	0.02	−0.41	0.45			−0.38	−0.70	0.06			21

* Significance after correcting for multiple testing (0.05/14 = 0.0035).
Pair 1: First Random Streamer and second Psyleron. Pair 2: First Psyleron and second Random Streamer.

Discussion

The current study conducted field RNG experiments repeatedly at baseball stadiums. Although our initial hypotheses were partially supported by our results, we found several unexpected results.

Audience Effects

As expected, our results revealed that audience size had positive effects on the RNG outputs in *CZ* (cumulative chi-squares statistics) and no effects on the remote RNGs, which suggested some dependency of audience size effects on distance. When an RNG was run near the audience, the more signal sources there were, the more chances the RNGs had to receive signals.

This result essentially resembled that from a previous field RNG experiment at a movie theater using Rpg102 (Shimizu & Ishikawa 2010). However, the present audience size effect was quite small in comparison with that in the previous study, in which the number of people ranged from 19 to 70. It was suggested that *CZ* would be associated with density of audience at the experimental location, average distance of each person from the RNG, or strength of emotion evoked during the event.

In contrast, TV audience rates showed no effects on total RNG outputs, suggesting that the huge audience size did not make up for the decrease in distance. A larger size would be required to have sufficient influence on the RNG outputs. However, with respect to Stouffer's z-scores with the Psyleron, despite the small number of samples, it is possible that this would be significant if sample size were increased in the future. Some confirmation is required in the future using *SZ* scores from Psyleron outputs.

Unaccountably, qualitative differences between types of device in detecting audience size effects seem to exist. The Random Streamer was sensitive to audience size, whereas the Psyleron could detect TV ratings, suggesting that random bit sequences are physically dependent on the RNG bit-generation method. As mentioned above, the Psyleron is based on FET, whereas the Random Streamer uses thermal noise as a source.

Given that information on the audience was taken independently from the outputs of the RNGs, these significant correlations suggest that RNG could surely detect field consciousness. This is not a matter concerning the quality of the RNG outputs, but rather anomalistic phenomena caused by field consciousness.

Multiple RNG Measurements

In the current field experiment, random numbers were generated with multiple devices simultaneously. If these multiple devices had been affected by the experimental location equally, a positive correlation would be expected.

The results shown in Table 4 suggested that *CZ* rather than *SZ* was totally sensitive to field consciousness. It was also shown that different kinds of devices used with an identical PC have positive correlation coefficients (Table 4), which supports our prediction. This may result from the identical PC, which had the same location, CPU clock, and inner temperature. Some might indicate a possibility of spurious correlation between *CZ* and the audience size, both of which would be influenced by one of these environmental parameters. For instance, temperature might have positively increased them simultaneously. Of course, this seems improbable since RNG devices aren't influenced by such external parameters.

Several unexpected results were found. First, the chi-squared statistics for both devices showed a negative correlation between different machines that were the same kind of RNG (Table 4). The value of $r = .50$ corresponds to a large effect size of $d = .80$ (Cohen 1988). Importantly, when the signals became strong, the signals were not distributed equally among devices, but rather output from one machine canceled that from another, at least during a three-hour baseball game. Thus, a new issue to explore is how (and why) such canceling-out phenomena occur over such a long time span. Second, different devices operating with different machines also showed moderate negative correlations in *CZ* scores. These results suggest that multiple devices were not simply additive, but rather acted to cancel out each other. To make it clear which factors have positive and negative effects on the multiple devices, ideally we should have observed the behavior of the same kind of devices with an identical PC, although currently the two kinds of hardware devices could not run together in such a way. This becomes one of our future tasks.

Some Features of Baseball Games

It was somewhat unexpected that neither the total *CZ* nor the total *SZ* showed significant results in the overall analysis. Possibly, the canceling effects between devices caused the absence of biases. However, this does not indicate the failure to detect field consciousness in the experiment for several reasons. First, this outcome is the same as the GCP results for football games in the World Cup championship in 2010, or American football games (Nelson et al. 1998, Radin 1997), which did not show significant results.

A possible reason is that sports events often evoke opposite emotions among audiences. Thus, baseball games might be an inappropriate venue to find biases in RNG outputs compared with something like movies, for which significant results have been found (Shimizu & Ishikawa 2010, Shimizu & Ishikawa 2011). Similar to baseball or football games, it seems that audiences would not have a common empathetic mindset in horse races, car races, and combat sports, etc., because all of these are competitive. However, in contrast, shared emotion for a national team could construct high homogeneity.

Another reason for this failure to find biases is that these sporting events are not always exciting, which would cause no biases. Some games might drag out without scoring. Ishikawa (2004) has suggested in his post hoc analysis that the period of the inning in which scores were recorded could bias outputs of the RNG. The current study considered the period of one game in its entirety, which is about three hours, as a sample in the analyses. However, these wide ranges could have a variety of different effects on field consciousness. This means that, from the viewpoint of signal detection, signals have low homogeneity. Therefore, it would be an important future task to divide and elaborate innings according to some other conditions.

However, this raises another problem. It should be considered that the fewer accumulated samples one gathers due to limitations of range, the lower the power and reliability of the measurement become. Since the outputs of RNG are noise itself, after the sample is divided, the signal-to-noise ratio in the RNG outputs becomes low, which causes decreased power of analysis and reduced reliability in the measurements. The issue is somewhat of a tradeoff, as we have to change the window size to take in the accumulation of bits from RNG outputs. In further studies, we must increase the total sample by further repetitions of the field experiment.

Note

[1] Catalog or test results of Random Streamer IC (RPG100) are on the website of the FDK Corporation. In 2012, Rpg105 and Rpg102 were not produced or for sale.
http://www.fdk.co.jp/whatsnew-e/release050930-e.html
http://www.fdk.co.jp/cyber-e/pi_ic_rpg100.htm
Random Streamer1M (Rpg105) and 24M(Rpg107): http://www.fdk.co.jp/whatsnew-j/release060608-j.html [in Japanese]
Rpg102: http://www.fdk.co.jp/whatsnew-j/release041005-j.html [in Japanese]

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