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# The effects of audience size and audience rating on field random number generator output: A case study of Japanese professional baseball

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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 an RNG as a signal detector of field consciousness and hypothesized that the number of signal sources might increase the ability of an RNG to detect signals.

Experimenters and assistants voluntarily obtained 76 samples from a total of 78 baseball games during the 2010–2011 baseball seasons. 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 show a positive correlation between accumulated chi-squared statistics by Random Streamer and audience size at the stadium. Unexpectedly, identical RNGs showed strong negative correlations between different machines, which suggests that their outputs cancelled each other out. Finally, some future tasks are discussed.

**Keywords:** baseball stadium, MMI, Rpg102, Rpg105, and multiple RNG.

## Introduction

A random number/random event generator (RNG/REG) creates a physical random source in itself, and its output is essentially unpredictable and different from pseudo random numbers (PRNGs), 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 broadcast worldwide (Nelson, 2001, 2002; 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 output, 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 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 be no longer an issue of RNG output qualities, and it might be concluded that it is simply an anomaly that RNGs detect 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 RNGs. It was expected that the larger the audience was, the greater the statistical bias would be in the outputs of RNGs. To examine this hypothesis, a field experiment with a fixed event that enabled us to measure audience size was required. Additionally, the event had to have particular locations and start and end times, in contrast to events such as broadcast news that 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 allows 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 can be regarded as a way to detect field consciousness, considering that the RNG outputs of some sporting events have already been analyzed and reported, such as soccer games that showed statistical biases (Bierman, 1996; Hagel and Tschapke, 2004) and American football games that tended to produce chance results (Nelson et al., 1998; Radin, 1997).

For this purpose, we selected Japanese professional baseball games for our field RNG experiments 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 total number of games in a season) are held at the home field during a regular season. It was predicted that RNGs run at the stadium during baseball games would show statistically biased outputs. The main hypothesis of this study was that outputs would 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 extent of total nationwide attention focus or the 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 RNGs to detect field consciousness without being influenced by distance. However, distance-dependent properties of RNGs have also been reported, such that deviations in RNG outputs decreased with increasing distance from the Institute of Noetic Science laboratory, where the RNG machines were 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 about 4.2 million people in the Kanto area will be focusing on the same program simultaneously (12 million in nationwide Japan). This corresponds to 100 times the audience size at the stadium. It was expected that the TV audience rating might influence RNG outputs 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 generated 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 effects on the remote RNGs. Additionally, TV audience rating effects, if observed, would have small effects on all RNG outputs regardless of their location. If a huge TV audience 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 RNGs 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 RNGs would be positively correlated, and an experiment with multiple RNGs would have some advantages, as it could increase the chance of finding output biases from the viewpoint of signal detection.

## (I) Field RNG Experiment

### Method

### RNG hardware

Five “Psyleron (REG-1)” and five “Random Streamer” devices were used as physical RNGs. Both RNGs 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 in the opposite direction 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:

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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]

one as a source of thermal noise and another as a noise amplifier. The two signals from the sensors are then 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 unaffected by environmental parameters such as external temperature or noise.

We have two types of Random Streamers, Rpg102s (four devices), and an 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 part of its output is systematically the same as that of 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 it is impossible to use Rpg102 and Rpg105 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; the numbers were automatically recorded into a csv text file at 2-min intervals after the PC 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, thereby preserving battery life. One notebook PC controlled the Rpg102 and Psyleron devices (Figure 2) once we obtained 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 mainly managed by the first author.

In total, 78 baseball games in the Kanto area were observed as experimental field events between September 2010 and October 2011. The experimenter and the assistants repeatedly attended 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 observer to relax, because there are no seats in front of or behind these seats, although sometimes the seats to the right were filled.

**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, the RNGs always generated random numbers even though the analyzed data were limited to the periods when the games were 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 trouble or software bugs. In another case, Psyleron could not be used because the experimenter discovered just before the game that the USB port had broken. As a result, the experimental condition included observations of 76 games (Random Streamer missed two games and Psyleron missed three).

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 assistants 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 shock to the RNG. The second reason was a freeze in data processing. This problem was related to the PCs and software application processing, and was solved by maintenance. The third reason was delays in the games, as reported by our assistants. They reported at least two instances of long delays to the game. However, 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 4), excluding the two games that were completely missed at the Tokyo Dome.

**Data processing and analysis**

To obtain information regarding audience sizes and the lengths of the baseball games, we referred to the NPB website (Japanese Professional Baseball) and the official website of the Yomiuri Giants. Average audience size was 38970.15 ± 6057.63 for the 78 games. The average length of all the games was 3.09 hours ± 0.40 SD (11141.8 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 ratings for satellite broadcasts, cable TV, and radio listeners were not included. 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 broadcasts, etc.), we integrated the two separate ratings into a whole rating using the weighted mean. The average of the 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 Dome, Marin Stadium, and Jingu, respectively. Those for Tsukuba were 53.9, 72.3, 49.8, and 58.5 km, and those 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 an RNG generated X bits per trial, where X totals 1 s, X was approximately binomially distributed, and standardized z-scores could be calculated from X. The Z-score based on chance was calculated as follows:

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

where $\pi$ 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

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

where T is game length (the number of trials; mean = 11141.82 sec ±1445.0 SD).

With these statistics, total CZ through all the games was:

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

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

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

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

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 and Discussion

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 that 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 scatter plots and regression lines for the devices. SZ showed no significant results.

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

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

### 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 (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 the correlation coefficients. As we were most interested in the PC difference, we tested the above three conditions and the 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 show significant negative correlations between identical RNG devices using different PCs ($r = -.54,\ t\,(33) = -3.66,\ p = 0.0009$). This does not suggest the advantages of multiple measurements that we had assumed before the experiment. A positive correlation was found only for different kinds of

RNGs with a single PC, although it was not significant when correction for multiple testing was applied ($r = .21$, $N = 81$).

If these multiple devices had been affected by the experimental location equally, a positive correlation would be expected. The results shown in Table 4 suggest that CZ rather than SZ was totally sensitive to field consciousness. The results also show that different kinds of devices used with an identical PC had positive correlation coefficients (Table 4), which supports our prediction. This may result from the fact that the identical PC had the same location, CPU clock, and inner temperature. Some might suggest the possibility of a spurious correlation between CZ and the audience size, both of which might be influenced by any of these environmental parameters. For instance, increased temperature might have increased both variables simultaneously. However, this seems improbable, as RNG devices are not influenced by such external parameters.

Several unexpected results were found. First, the chi-square statistics for both devices show 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 cancelled that from another, at least during a 3-hour baseball game. Thus, a new issue to explore is how (and why) such cancelling-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 each other out. 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 cannot run together in such a way. This becomes one of our future tasks.

### (II) Reliability of multiple RNG

Field RNG (random number generator) studies have shown that a RNG can detect field consciousness during highly focused events. However, few studies have examined whether outputs of multiple RNGs coincide when they generate random numbers simultaneously. If multiple RNG devices are equally influenced by field consciousness, their outputs should resemble each other. This is associated with the issue of measurement reliability. In the case of typical psychological studies that develop psychological scales or achievement tests, not only the validity of test items or questions, but also reliability in measuring individual differences, must be confirmed. Of course, RNG originally was no more than a random number generator. Scale development studies have basically confirmed the general parent population (adequate number of participants at a particular scale) and the computational method of cumulative chi-squares in the case of field RNG studies. However, questions remain as to which conditions enhance (or lessen) the reliability of the RNG outputs. This study sought to determine the conditions that can cause measurement reliability to be high or low. If reliability is observed, this would suggest that RNG has some kind of function in relation to field consciousness.

Regarding signal detection, we assumed 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 reliability would also become positive. There are several indices to confirm reliability for multiple variables. One of the most well-known indices is Cronbach's alpha, which can be reliable even when there are more than three variables.

**Methods**

The RNG outputs were divided into three datasets (Table 5), to differentiate kind of RNG devices and to avoid overlap analysis. The first dataset consisted of Rpg105 outputs during 12 games (during eight of these games, single PCs were used, as has been reported by Shimizu and Ishikawa, 2012a). The second dataset consisted of 64games by Psyleron and Rpg102 devices at stadium. The second datasets were divided into three subsets; 46 games with single machine measurement (2-1) and 18 games with dual measurement by Rpg102 (2-2) and Psyleron with one game missing (2-3). The third dataset consisted of outputs in the remote condition (78 games). The number of the outputs was different among locations. After 9 outputs by Rpg105 at Tsukuba were excluded (see Shimizu & Ishikawa, 2012b), 330 RNG outputs by Psyleron and Random Streamer devices at the remote locations during 78 games were analyzed totally. The third datasets can be divided by two factors; RNG devices (3a) or remote locations (3b) (Table 5).

The variance-covariance matrixes of subsets were calculated by pairwise deletion, and reliability was estimated by Cronbach's alpha. An observed score (X) is composed of two latent independent components, a true score (T) and an error score (E). Then, the variance is expressed as $Var(X) = Var(T) + Var(E)$. Using covariance and total variance between k devices, Cronbach's alpha can be expressed as $\alpha = Var(T)/Var(X) = [k/(k-1)] \cdot [1 - \sum Var(x_i)/Var(X)]$(Millar, 1995). The expected alpha value for chance is zero because the multiple RNG devices were independent from each other. Using SPSS, two tailed F-tests were conducted for Cronbach's alpha coefficients, in which p-values would become less than .025 if positive reliability ($F > 1$) was obtained, or more than .975 when it was negative ($F < 1$).

## Results and Discussion

Cronbach's alpha was calculated from the variance-covariance matrix of each of the three datasets. Figure 6 showed results of F-test visually. Small p-value on the right side corresponds to positive and left side does negative reliability. Vertical dotted lines mean significant p-value with two-tailed distribution.

The results indicated that the first dataset of Rpg105 outputs showed no reliability $\alpha = 0.105$ $(N = 12, F(11{,}341) = 1.12, p = .346)$. The second dataset, during baseball games at the stadium, showed $\alpha = 0.293(N = 46, F(45{,}45) = 1.42, p = 0.124)$ between different device within identical PC and significant negative reliability, $\alpha - 2.320$ $(\mathrm{N} = 18, F(17{,}17) = .301, p = .991)$ for the Random Streamer devices and $\alpha = -2.439(N = 17, F(16{,}16) = .291, p = .991)$ for the Psyleron. In the 3rd dataset, Psyleron devices between different 3 locations showed $\alpha = -0.723(N = 35, F(34{,}68) = .580, p = .958)$ and Random Streamer devices showed $\alpha = .319(N = 21, F(20{,}40) = 1.469, p = .148)$. Since third dataset can be examined by location factor, we examined reliability by remote locations, additionally (Figure 1; 3b). For different RNG devices within the same location, results showed $\alpha = -0.339$ $(N = 63, F(62{,}62) = .747, p = .873)$ in Tsukuba, $\alpha = -0.153$ $(N = 34, F(33{,}33) = .867, p = .658)$ in Tokorozawa, and $\alpha = .195$ $(N = 53, F(52{,}52) = 1.242, p = .218)$ at Musashi-Murayama.

Our expectation was partially supported by the result that different devices within PCs showed moderate positive reliability in second dataset. In this condition, RNG devices could receive the same influence from field consciousness or other unknown factors. However, the multiple RNG devices did not cooperate with each other. In particular, the same RNG devices set up on different computers, in the second dataset, showed strong negative reliability both for Rpg102 and Psyleron devices. Our machines were located very near to one another during the baseball games. The negative correlation suggested that they behaved as if they were maintaining the sum of outputs (cumulative chi-squares) as constant. This approximates quantum effects. If so, random numbers generated at the same location might be entangled because of the same root. It becomes a future task to examine distance effect between RNGs. Noticeably, the RNG outputs including Rpg105 showed positive reliability which was probably caused by the structural mechanism of Rpg105. All 32 Rpg105 outputs were bitwise exclusive-or (XOR) as a result of a mask provided by the 33rd RNG. This XOR processing could make all the outputs independent. If the XOR mode were switched off, negative reliability would be shown. Our results suggest that measurement reliability could be one of the most useful indices to evaluate dependency between multiple RNG devices.

## General Discussion

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

### Audience effects

This result essentially resembles 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 the density of the audience at the experimental location, the average distance of each person from the RNG, or the strength of emotion evoked during the event.

In contrast, TV audience rates showed no effects on total RNG outputs, suggesting that a huge audience does not make up for an increase in distance. A larger size would be required to have sufficient influence on the RNG outputs. However, with respect to SZ 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 seem to exist between types of devices in detecting audience size effects. 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.

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

**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 cancelling effects between devices caused the absence of biases. However, this does not indicate a 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 for 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) suggested in his post hoc analysis that the period of the inning in which scores were recorded biased RNG outputs. The current study considered the period of one game in its entirety, which is about 3 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 measurements become. Since the outputs of RNGs 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 a trade-off, as we have to change the window size to take in the accumulation of bits from RNG outputs. In future studies, we must increase the total sample by further repetitions of the field experiment.

## References


Bierman, D. J. (1996). Exploring correlations between local emotional and global emotional events and the behavior of a random number generator, *Journal of Scientific Exploration*, **10**, 363–373.

Cohen, J. (1988). The significance of product moment r. In *Statistical power analysis for the behavioral sciences. Second Edition* (J, Cohen). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers. Pp 75.-107.

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

Hagel, J., & Tschapke, M. (2004). The local event detector (LED) – An experimental setup for an exploratory study of correlations between collective emotional events and random number sequences. Proceedings of Presented Papers: The Parapsychological Association 47th Annual Convention (pp. 379 - 388). Cary, NC: Parapsychological Association, Inc.

Hirukawa, T. & Ishikawa, M. (2004). Anomalous fluctuation of RNG Data in Nebuta: Summer Festival in Northeast Japan. *Proceedings of the 47th Annual Convention of the Parapsychological Association*. 389–397.

Ishikawa, M. (2004) Measurements and analyses of RNG data obtained in sports events, *The Japanese Journal of Parapsychology*, **9**, 40–46. (In Japanese)

Lumsden-Cook, J. J. (2005a). Mind–matter and emotion. *Journal of the Society for Psychical Research*, **69**, 1–17.

Lumsden-Cook, J. J. (2005b). Affect and random events: Examining the effects of induced emotion upon mind–matter interactions. *Journal of the Society for Psychical Research*, **69**, 128–142.

Miller, M. B. (1995) Coefficient alpha: A basic introduction from the perspectives of classical test theory and structural equation modeling, Structural Equation Modeling: A Multidisciplinary Journal, 2, 255-273.

Nelson, R. D. (2001). Correlation of global events with REG data: An Internet-based, nonlocal anomalies experiment. *Journal of Parapsychology*, **65**, 247–271.

Nelson, R. D. (2002). Coherent Consciousness and Reduced Randomness: Correlations on September 11, 2001. Journal of Scientific Exploration, 16, 549–570.

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

Nelson, R. D. Jahn, R. G., Dunne, B. J., Dobyns, Y. H., & Bradish, G. J. (1998). Field REG II: Consciousness field effects: Replications and explorations. *Journal of Scientific Exploration*, **12**, 425–454.

Nelson, R. D., Radin, D. I., Shoup, R., & Bancel, P. A. (2002). Correlations of continuous random data with major world events. *Foundations of Physics Letters*, **15**, 537–550.

Radin, D. I., Rebman, J. M., & Cross, M. P. (1996). Anomalous organization of random events by group consciousness: Two exploratory experiments. Journal of Scientific Exploration, **10**, 143–168.

Radin, D. I. (1997). *The conscious universe*. San Francisco: Harper Edge.

Radin, D. I. (2002). Exploring relationships between random physical events and mass human attention: Asking for whom the bell tolls. *Journal of Scientific Exploration*, **16**, 533–548.

Radin, D. I. (2006). *Entangled Minds: Extrasensory experiences in a quantum reality*. Paraview Pocket Book, Simon & Schuster: New York.

Radin, D. I., & Atwater, F. H. (2009). Exploratory evidence for correlations between entrained mental coherence and random physical systems. *Journal of Scientific Exploration*, **23**, 263–272.

Rowe, W. D. (1998). Physical measurement of episodes of focused group energy. Journal *of Scientific Exploration*, **12**, 569-581.

Rowe, W. D. (1998). Physical measurement of episodes of focused group energy. Journal *of Scientific Exploration*, **12**, 569-581.

Shimizu, T. & Ishikawa, M. (2010) Field RNG data analysis, based on viewing the Japanese movie “Departures” (*Okuribito*). *Journal of Scientific Exploration*, **24**, 637–654.

Shimizu, T. & Ishikawa, M. (2011) A field RNG experiment using short movies: Effects of emotion. 7th Psi Meeting: Psi Research and Anomalistic Psychology Proceedings of Presented Papers. Curitiba, August.

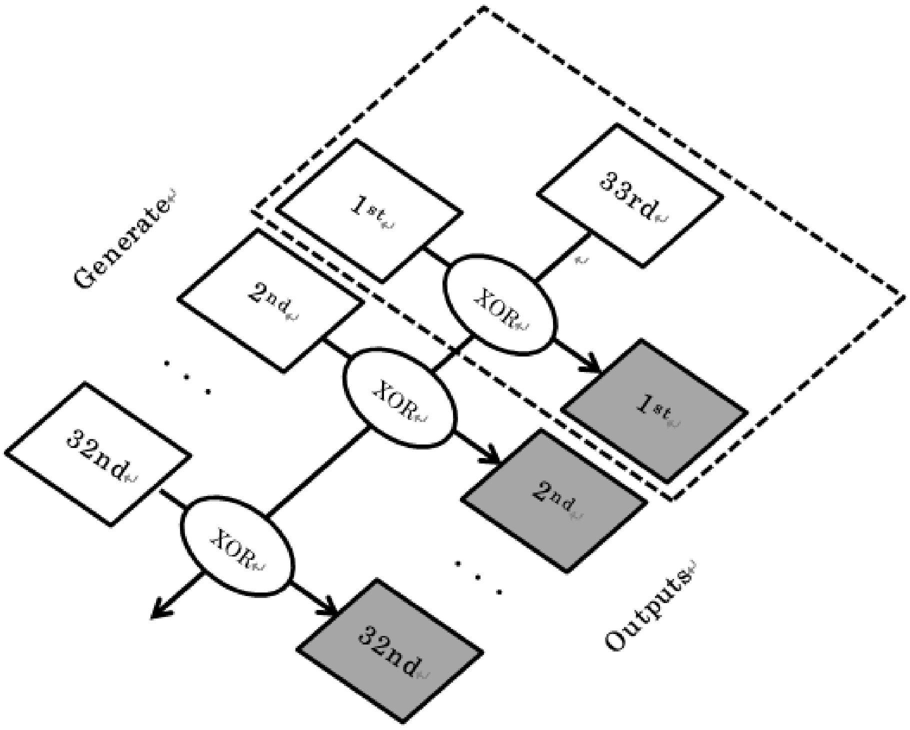
Shimizu, T. & Ishikawa, M. (2012a) Examination of Retroactive Effects in a Field RNG Experiment Using Prerecorded Files. *Journal of the International Society of Life Information Science*, 30, 5-16.

Shimizu, T. & Ishikawa, M. (2012b) Audience Size Effects in Field RNG Experiments: The Case of Japanese Professional Baseball Games. *Journal of Scientific Exploration,* 26(3), in press.

Varvoglis, M. (2006). The CinEgg research project final report: Assessing the relationship between group consciousness and random event generators. The Institut Metapsychique International, Project 140/14.

**Figure 1**

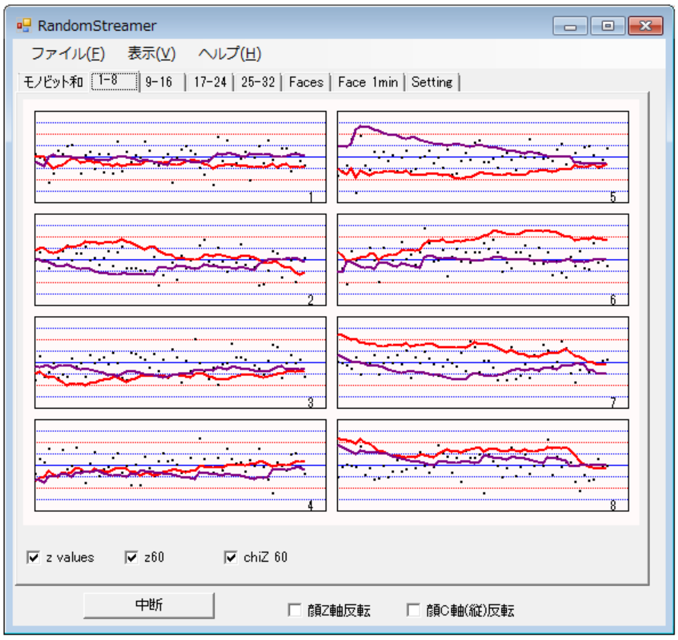
Random number generation structure by Rpg105 (whole figure) and Rpg102 (within dashed closed line)



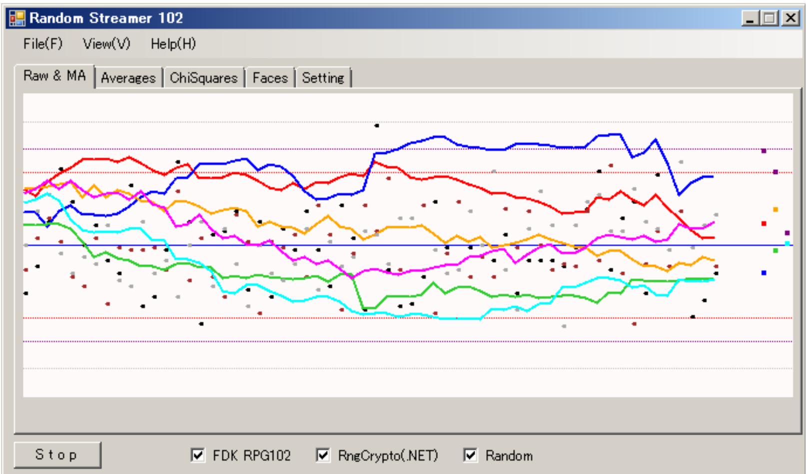

Each random number generator (RPG100B) is represented by white rectangles in the figure. Gray rectangles are their outputs. Rpg105 has 32 independent RPG100B systems, which generate outputs of bits (1s or 0s), and the 33rd one is used only for XOR (exclusive or) between outputs by 32 RPG100B. Items shown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

**Figure 2**

Two RNG devices, Rpg102 (Random Streamer) and Psyleron (REG-1), are shown connected to a PC


Appearance of software application to control Rpg105




Appearance of software to control Psyleron and Rpg102

**Figure 3**

Locations of season seats at the Tokyo Dome in 2011

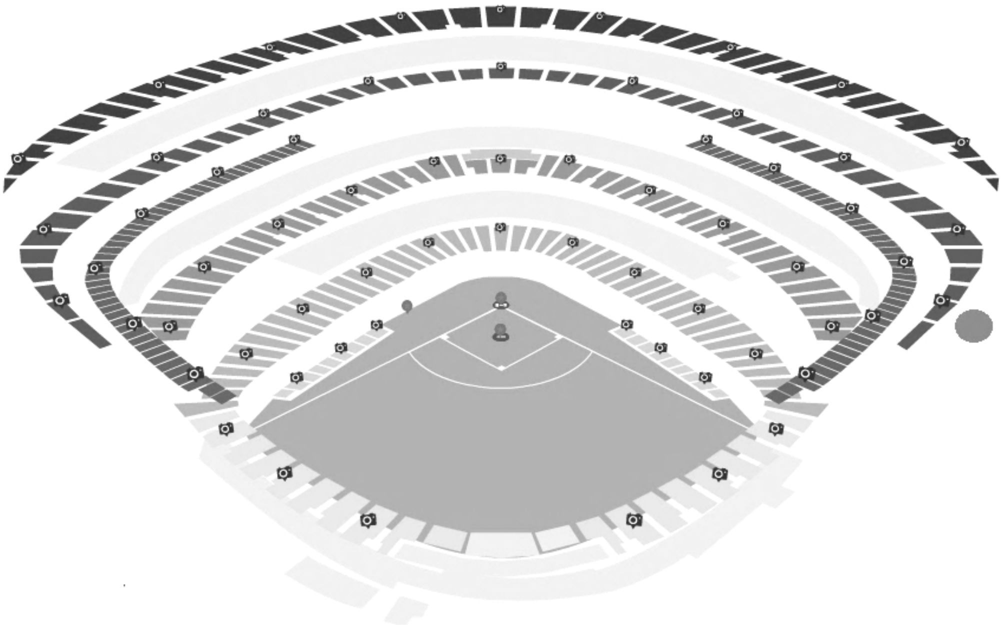
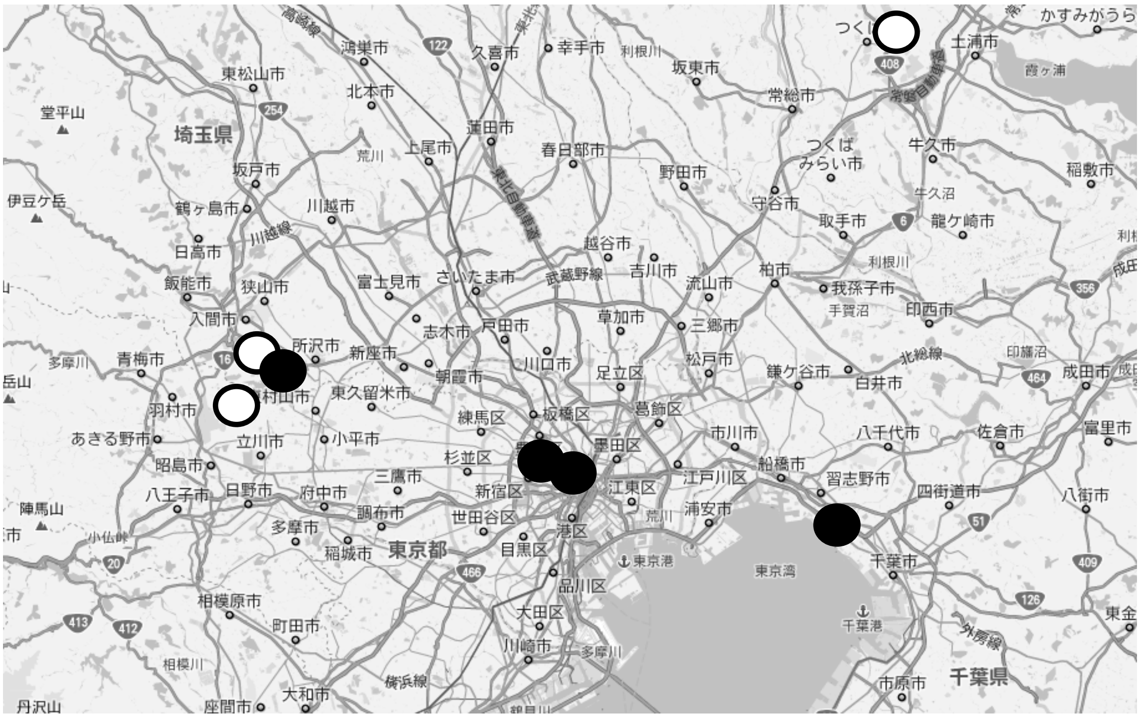


**Figure 3**

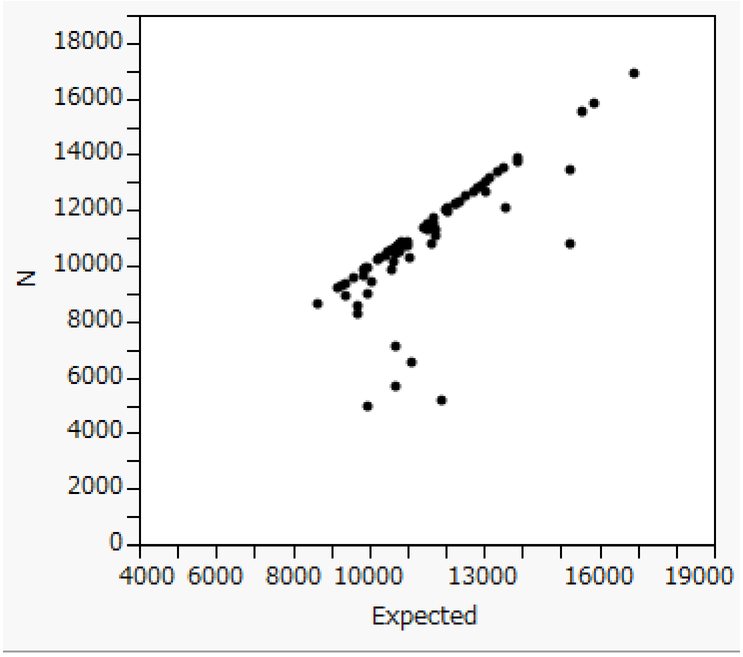
Locations of baseball stadiums and remote PCs around Tokyo




Black circles represent baseball stadiums, and white circles are remote PCs

**Figure 4**

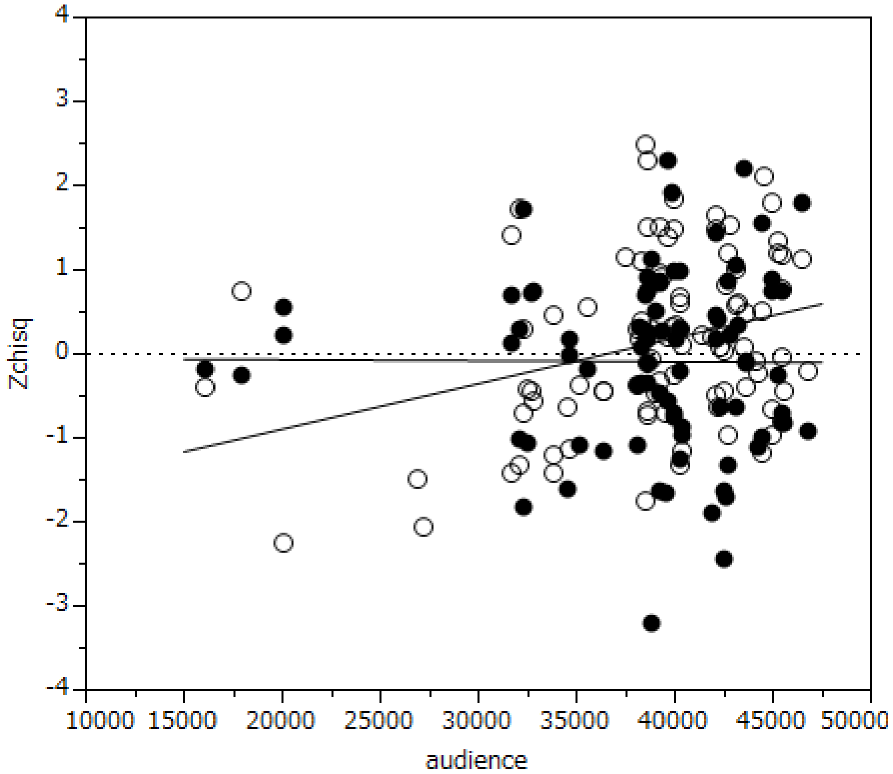
Expected trial numbers (sec) and actual numbers (sec) in games




Some games failed to generate random numbers or generated fewer than expected.

**Figure 5**

The effects of audience size on the *z*-scores of the accumulated chi-squares of outputs from RNGs




Dots are CZ, cumulative chi-squared statistics per game, standardized into *z*-scores. White dots are those of the Random Streamer. Black dots are those of Psyleron. Dotted line indicates chance level. Regression lines show a significant slope for the Random Streamer data, whereas that for Psyleron was not significant.

**Figure 6**

P-values in two-tailed F-test for Cronbach's alpha in the datasets

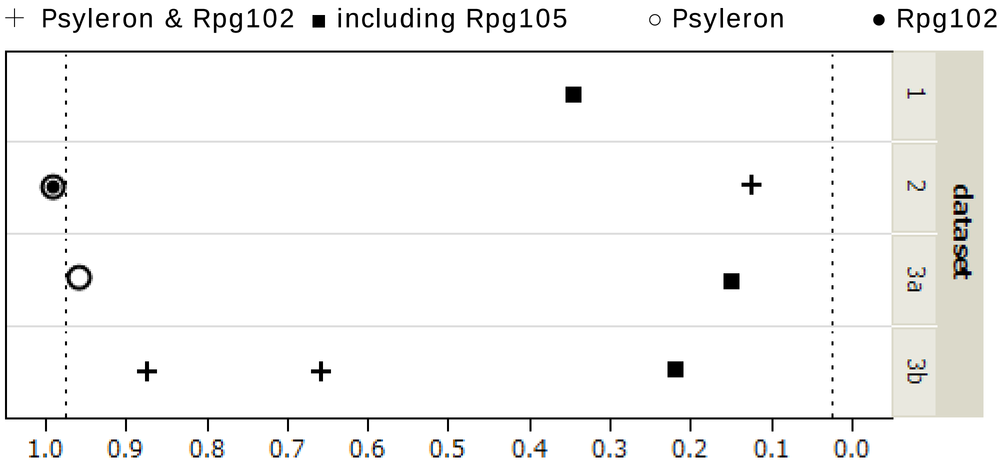


**Table 1 Number of RNGs used in the stadium and remote locations through a total of 78 baseball games**

| | | | | Stadium | | Remote Condition | | |
|---|---|---|---|---|---|---|---|---|
| Device | generation | Number of games observed | | 1st PC | 2nd PC | Musashi-Murayama | Tsukuba | Tokorozawa |
| Psyleron | single | 67 | 46 | 25 | 21 | 67 | 64 | 35 |
| | dual | | 21 | 17 | 21 | | | |
| Random Streamer | single | 76 | 55 | 34 | 21 | 57 | 64 | 43 |
| | dual | | 21 | 21 | 18 | | 9 | |
| | Number of RNGs outputs | | | 97 | 81 | 124 | 137 | 78 |
| | Total | | | 178 | | | 339 | |
| | | | | 517 | | | | |

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

**Table 2 Estimated Pearson's correlation coefficients between audience size and z-scores**

| | | | 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 | | Psylron | -0.01 | -0.22 | 0.21 | -0.06 | 0.950 | | 0.07 | -0.14 | 0.28 | 0.67 | 0.507 | 84 |
| | | Random Streamer | 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 | Psylron | 0.01 | -0.23 | 0.25 | | | | 0.11 | -0.13 | 0.34 | | | 67 |
| | | Random Streamer | 0.00 | -0.26 | 0.26 | | | | 0.03 | -0.23 | 0.29 | | | 57 |
| | Tsukuba | Psylron | 0.08 | -0.17 | 0.32 | | | | 0.26 | 0.02 | 0.48 | | | 64 |
| | | Random Streamer | -0.02 | -0.25 | 0.21 | | | | -0.05 | -0.27 | 0.19 | | | 73 |
| | Tokorozawa | Psylron | -0.01 | -0.34 | 0.33 | | | | -0.02 | 0.31 | -0.36 | | | 35 |
| | | Random Streamer | 0.12 | 0.41 | -0.18 | | | | -0.03 | -0.32 | 0.28 | | | 43 |
| Whole | | Psylron | 0.02 | -0.11 | 0.14 | | | | 0.12 | 0.00 | 0.24 | | | 250 |
| | | Random Streamer | 0.13 | 0.24 | 0.01 | | | | -0.05 | -0.17 | 0.07 | | | 267 |

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

**Table 3 Estimated Pearson's correlation coefficients (*r*) for the TV audience ratings**

| | | | 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 | | Psyleon | −0.15 | −0.50 | 0.26 | | | −0.26 | −0.58 | 0.15 | | | 26 |
| | | Random Streamer | −0.16 | −0.50 | 0.22 | | | 0.27 | −0.10 | 0.58 | | | 29 |
| Remote locations | Musashi-Murayama | Psyleon | 0.22 | −0.21 | 0.58 | | | −0.38 | −0.69 | 0.03 | | | 23 |
| | | Random Streamer | −0.60 | −0.86 | −0.09 | | | 0.00 | −0.53 | 0.53 | | | 14 |
| | Tsukuba | Psyleon | −0.11 | −0.51 | 0.32 | | | −0.01 | −0.43 | 0.41 | | | 22 |
| | | Random Streamer | 0.08 | −0.30 | 0.44 | | | −0.07 | −0.43 | 0.32 | | | 28 |
| | Tokorozawa | Psyleon | 0.07 | −0.55 | 0.64 | | | −0.30 | −0.76 | 0.37 | | | 11 |
| | | Random Streamer | −0.12 | −0.67 | 0.52 | | | −0.49 | −0.84 | 0.16 | | | 11 |
| Whole | | Psyleon | −0.01 | −0.22 | 0.21 | −0.07 | 0.947 | −0.22 | −0.42 | −0.01 | −2.06 | 0.042 | 82 |
| | | Random Streamer | −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 condition**

| | | CZ | | | | | | Stouffer's Z (SZ) | | | | | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Estimation | 95% CI upper | 95% CI lower | t-score | p-value | | Estimation | 95% CI upper | 95% CI lower | t-score | p-value | |
| Different devices within PC (Psyleron and Random Streamer) | Total within PC | 0.21 | −0.01 | 0.41 | 1.90 | 0.061 | | 0.02 | −0.20 | 0.24 | 0.22 | 0.830 | 81 |
| | 1st | 0.12 | −0.19 | 0.41 | | | | −0.16 | −0.44 | 0.16 | | | 42 |
| | 2nd | 0.38 | 0.07 | 0.62 | | | | 0.24 | −0.08 | 0.52 | | | 39 |
| | Single PC | 0.19 | −0.10 | 0.46 | 1.31 | 0.198 | | 0.03 | 0.31 | 0.87 | 0.17 | 0.865 | 46 |
| | 1st | 0.13 | −0.28 | 0.50 | | | | −0.30 | −0.62 | 0.11 | | | 25 |
| | 2nd | 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 |
| | 1st | 0.23 | −0.28 | 0.64 | | | | 0.09 | −0.41 | 0.55 | | | 17 |
| | 2nd | 0.45 | −0.02 | 0.76 | | | | 0.01 | −0.46 | 0.48 | | | 18 |
| Between PCs (Dual) | 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 Streamer | −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

**Table 5**

Analyzed datasets and subsets during baseball game

| | dataset | N | | device | |
|---|---|---|---|---|---|
| | | games | ouputs | | |
| stadium | 1 | 12 /76 | 12*32 | Rpg105 | 32 RNGs within Rpg105 |
| | 2 | 46 /76 | 92 | Rpg102 & Psyleron | between two different RNGs within a PC |
| | | 18 /76 | 36 | Rpg102 | identical devices between PCs |
| | | 17 /76 | 34 | Psyleron | identical devices between PCs |
| remote | 3a | 21 /78 | 63 | Rpg102 & 105 | identical devices between 3 locations |
| | | 35 /78 | 105 | Psyleron | identical devices between 3 locations |
| | 3b | 63 /78 | 126 | Rpg102 & Psyleron | Tsukuba |
| | | 34 /78 | 68 | Rpg102 & Psyleron | Tokorozawa |
| | | 53 /78 | 106 | Rpg105 & Psyleron | Musashi-Murayama |