THE EFFECTS OF AUDIENCE SIZE: A FIELD RNG EXPERIMENT IN BALLPARKS IN JAPAN

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Recent studies using a field random-event generator (REG) and a random-number generator (RNG) have reported that field consciousness affected RNG output during large events or when news was broadcast worldwide (Nelson et al., 1998; Nelson, 2001; Radin, 2002). At the same time, however, RNG behavior remains unclear, and field consciousness can involve many psychological factors including group emotion, attention, coherence, and focus on an event. On the basis of results demonstrating that RNG outputs in movie theaters with larger audiences were associated with more biased RNG outputs (Shimizu & Ishikawa, 2010), we hypothesized that audience size would have an important effect on RNG output. However, the audience sizes of movie theaters do not vary greatly and are much smaller than those that have been used in other field RNG studies. Therefore, we designed a large-scale study that met specific conditions. First, we selected a Japanese professional baseball stadium as the field because baseball is the most popular sport in Japan. We initially selected the Tokyo Dome stadium, one of the major ballparks in the country, due its large audience capacity (a maximum of 55,000) that accommodates audiences of various sizes throughout the season. Second, to effectively detect RNG signals, we conducted many repetitive measurements of RNGs under both field and control conditions. We hypothesized that not only true random numbers but also pseudo random numbers (PRNG) could be affected with field consciousness.

Method

Experimenters attended 10 baseball games at the Tokyo Dome, the Seibu Dome, and the Chiba Marine stadiums from September 2010 to March 2011 to generate random numbers (additional venues were added because all the remaining games at the Tokyo Dome were cancelled after the earthquake in Japan). Average audience size at fields was 34084±7883.1 SD (N=10). We also generated random numbers under control conditions at Tokorozawa (Waseda University) and Musashi-Murayama fields in Tokyo. They were conducted at the same time as the baseball games. Distances from the ballpark field were recorded independently. Average distance was 30.8±22.8SD which was calculated by software application, which used information of latitude and longitude of two geometrical points, based on geocoding (http://www.geocoding.jp/). Although there were 12 (=4 *3) possible combinations of server location and ballparks, 8 patterns were actually observed.

[Instruments] We primarily used the Rpg102 and Rpg105 machines (FDK Corporation) to generate random numbers, but also relied on the Psyleron REG-1 to generate additional numbers. Rpg105 hardware can generate 32 truly independent random numbers. We used these first 32 random numbers, which were the mechanical equivalents of those generated by Rpg102. The software was re-developed to simultaneously generate two kinds of true random numbers (Rpg102 and Psyleron REG-1) and two kinds of pseudo-random numbers.

[Analysis] RNG (and PRNG) generate 512 bits 1/0 outputs per second. Then expected value of monobit counted was 256 and its expected variance was 128, from binominal distribution. Z-score of counted bits ‘x’ can be calculated as follows:

$$z_{raw} = \frac{x - 256}{\sqrt{128}}$$

Using baseball game as field event, from game start to end, z-score were accumulated,

$$Accumulated\ Chisquare = \sum_{t=1}^{n} \frac{(z_{raw} - 1)^2}{2n}$$

where n was total time of ballgame. This accumulated chi-square score was calculated in each game. Total 10 games were used in the current study.

Accumulated *chi*-square values during the entire game (from about 3 hours to 5 hours) were calculated for the dependent variables in the same way under the experimental and control conditions. All *chi*-square values were converted into *z*-scores to analyze the results, and the average *z*-scores were also calculated.

Results

The outputs of the RNGs, pseudo-random-number generators (PRNGs), and the integration of the two showed $z = -1.580$ (Mean = -0.422, $N = 14$, $p = 0.114$), $z = -1.535$ (Mean = -0.543, $N = 8$, $p = 0.125$), and $z = -2.186$ (Mean = -0.466, $N = 22$, $p = 0.029$), respectively, under the experimental condition. Under the control condition, the respective findings were $z = 1.830$ (Mean = 0.528, $N = 12$, $p = 0.067$), $z = -0.185$ (Mean = -0.041, $N = 20$, $p = 0.853$), and $z = 0.974$ (Mean = 0.172, $N = 32$, $p = 0.330$). Pearson's correlation coefficient (r) was calculated for the relationship between audience size and *z*-scores. The outputs of the RNGs, PRNGs, and their integration were as follows: $r = 0.451$ ($N = 14$, $p = 0.101$), $r = 0.341$ ($N = 8$, $p = 0.401$), and $r = 0.413$ ($N = 22$, $p = 0.056$), respectively. This data suggested that larger audience sizes were associated with more biased RNG outputs, although this association did not reach significance. And field consciousness could affect not only RNG but also PRNG at field.

The correlation between the distance from the actual playing field and the *z*-scores was calculated. The outputs of the RNGs, PRNGs, and their integration showed $r = 0.433$ ($N = 26$, $p = 0.027$), $r = 0.218$ ($N = 28$, $p = 0.265$), and $r = 0.303$ ($N = 54$, $p = 0.026$), respectively.

Discussion

Positive *r*-values were obtained in the current analysis. Although our sample was small, the results may imply the effect of audience size if this tendency were to be replicated. However, it should be noted that the effect seemed to be derived from the relative rather than the absolute size of the audience in the experiment. Strangely, distance from the field showed a significant positive effect, presumably because the outputs of the RNGs in the ballpark showed low (near-zero) *z*-scores. Future studies should explore the similarities in PRNGs and RNGs when *z*-scores are analyzed, as was demonstrated by Shimizu & Ishikawa (2010).

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