Comparison Testing Protocol for Anomalous Cognition or Effects and Mind-Matter Interaction

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Abstract: We present a detailed protocol for comparison testing of systems responsive to anomalous cognition, anomalous effects (A.C.E.) and mind-matter interaction (MMI), focusing on the random generator design and data processing algorithm, aiming to advance the development of more responsive systems. The procedure involves simultaneous testing of two generators or two alternative processing techniques with statistical analysis of their results. The protocol also addresses the nuances of initiated and continuous trials, and offers guidelines to enhance tester performance.

Keywords: Anomalous Cognition, Anomalous Effects (together, A.C.E.), Mind-Matter Interaction (MMI), Comparison Testing, Random Number Generators, Initiated Trials, Continuous Trials, Testing Protocol; Alternative Processing Methods.

Introduction

Systems responsive to mental influence, such as anomalous cognition or effects (A.C.E.), or mind-matter interaction (MMI), primarily depend on two elements: the random generator (especially the physical entropy source and sampling circuitry), and the data processing algorithm, which translates generator data into an observation or trial result. To accelerate the development of more responsive systems, it is essential to directly compare different generator designs or processing methods. However, these measurements depend on the mental efforts of a tester that can vary significantly over time and can be strongly influenced by a preference or bias favoring a specific generator type or processing method. These issues are overcome by keeping the tester blind to the specifics of the comparison and not revealing test results until the testing is completed.

Experimental setup

In the experimental setup, two generators of different design are connected to a computer, which reads and processes the data and provides trial-by-trial feedback. The variability of tester focus and mental effort can be significant. To enable accurate comparisons, data from the two generators must be captured simultaneously rather than testing them sequentially. The most insightful results are obtained when the effect sizes are at their peak, thus an experienced tester known to produce strong results should be chosen. The same processing algorithm and number of bits per trial should be used to ensure the generator design is the sole variable. The tester should ideally be blind to the specifics of the generators being tested, including visually concealing them. To familiarize the tester with the process and enable optimal results, a brief

[1] President at Core Invention, Inc.

warm-up period before recording comparison data is recommended. The tester should be comfortable and undistracted.

In each trial, one generator is randomly selected to provide tester feedback and is designated as the "active generator". Data is collected and processed for each trial, regardless of which generator is active, and trial results produced by each generator are placed in separate files for active and inactive results. To equalize the number of trials for each generator, a randomized list of 100 – 1s and 100 – 2s (for 200 trials) is created [see CALCULATIONS]. Each number in the randomized list designates which generator is active for each trial: a 1 or a 2 selects the corresponding generator. It is recommended that each test series consists of 200 trials, giving n = 100 for each generator.

Optimum results are achieved when good feedback is provided. Feedback must be provided in real time, immediately after each trial completes. At a minimum, feedback should be a plot of the count of 1s and 0s produced by the active generator: increment the count for each 1 result and decrement for each 0. Monitors have a variety of resolutions so the number of pixels updated per trial should be scaled so the results more or less fill the screen during the series. Divide the horizontal resolution into 200 trials and divide the vertical resolution into 400 times the maximum expected hit rate counts. Other feedback mechanisms can include auditory cues (a high tone for a 1 and a lower tone for a 0); visual cues (a flash or small object displayed above the center of the screen for a 1 and below center for a 0); and cumulative statistics displayed on the left of the screen including hit rate and probability of chance occurrence corresponding to all active trials.

When the series of trials is completed, the results for each generator, both active and inactive, are displayed. If the results for the active generators are not different at the desired level of significance, more data will need to be gathered and combined until the comparison becomes significant. Equations for calculating probabilities for each generator and for comparing results are given in the CALCULATIONS section below.

Initiated versus Continuous Trials

Trials can either be initiated or continuous. Each initiated trial lasts about 200ms and is started with a keypress or mouse click. In contrast, a continuous trial lasts one second. Once initiated, it runs continuously until the desired number of trials is reached. The active generator is randomly selected and the active and inactive generator data are processed the same way for initiated and continuous trials. The tester must maintain good focus during the entire 200 seconds for a 200-trial continuous series, making continuous trials more challenging than initiated trials to achieve high hit rates, where the tester has the ability to pause, refocus and synchronize maximum mental effort with each trial.

The tester's goal is to achieve the highest hit rate during the test series. A target value, 1 or 0, will be selected and disclosed prior to the beginning of the series along with the testing mode, initiated or continuous. There is no time limit for completing an initiated trial series, but a 200 trials series (100 for each active generator) will take about three to five minutes to complete. Achieving significant results allows valid comparisons more quickly A line or envelope representing a 5% probability at each trial number provides additional incentive for the tester to achieve the best results.

Comparison Testing for Alternative Processing Methods.

Comparing different processing methods involves the same methodology as comparing generator designs. However, in the setup, only one generator is connected to the computer and two processing methods will be compared at a time, both running continuously. Always use the best-performing generator design as this will reduce the number of trials needed to achieve significance in comparing the results. One of the processing methods is randomly selected as the active method, analogous to selecting the active generator in generator comparison testing. All data gathering, tester feedback, and data processing will proceed as with generator comparison testing.

Use the same number of raw bits for each processing method and ensure the outputs from the different methods occur very close in time. This approach ensures consistency and reduces the likelihood of timing-related variables affecting the results.

Independence is assured when comparing two generators, but comparing processing methods using the same source generator may cause some correlation between the processed trial results. The two sample proportion test assumes independence between sequences, which may be less accurate for comparison testing of processing methods.

Conclusion

This comparison testing protocol aims to provide a standardized approach to evaluate and compare generator designs and processing methods for use with anomalous cognition, anomalous effects and mind-matter interaction. Following this protocol should help researchers determine which designs and methods yield the most responsive and consistent results.

CALCULATIONS

Method for randomizing the order of items in a list:
Generate a uniformly distributed pseudorandom number for each item in the list. Most programming languages include a command to produce these numbers. Sort the list from low to high based on the value of the random numbers associated with each item in the original list. Discard the random numbers, and the original list is randomized. Make sure the pseudorandom generator is reseeded for each use so the randomized order is different each time.

Two Sample Proportion Test:[2]
The two-sample proportion test utilizes a z-score, which measures the number of standard deviations an element is from the mean. In the context of generator or processing method results, it provides a way to determine if the difference in hit rates is significant.

Definitions:

- n1 and n2 are the number of trials produced when generators 1 and 2 are active;
- x1 and x2 are the number of hits;
- hr1 and hr2 are the corresponding hit rates (number of hits/number of trials).

These values can be from a single series or the cumulative values from a number of series. SE is the standard error, z is the z-score of the test result and pdiff is the statistical probability that the two sequences are different.

$$\mathrm{SE} = \sqrt{\left(\frac{\mathrm{x1+x2}}{\mathrm{n1+n2}}\right)\left(1-\frac{\mathrm{x1+x2}}{\mathrm{n1+n2}}\right)\left(\frac{1}{\mathrm{n1}}+\frac{1}{\mathrm{n2}}\right)} \qquad 1.$$

$$\mathrm{z} = (\mathrm{hr1}-\mathrm{hr2})/\mathrm{SE} \qquad 2.$$

$$\mathrm{pdiff} = \mathrm{P}(\mathrm{X} \geq |\mathrm{z}|) \qquad 3.$$

Here, P(X > |z|) is the probability of a standard normal random variable X being greater than the absolute value of z. Absolute value is used because either hr1 > hr2 or vice versa, both of which are valid for the comparison. The generator with the higher hit rate is more responsive.

$$\mathrm{pdiff} = 1 - \mathrm{cnd}(|\mathrm{z}|) \qquad 4.$$

where cnd is the cumulative standard normal distribution; see equation below.

When the number of bits in each sequence is the same (n1 = n2 = n), the equation for the one-tailed test for proportions is simplified:

$$\mathrm{SE} = \sqrt{\frac{2(\overline{\mathrm{hr}})(1-\overline{\mathrm{hr}})}{\mathrm{n}}} \qquad 5.$$

Here $\overline{\mathrm{hr}}$ is the average of hr1 and hr2, $\overline{\mathrm{hr}} = (\mathrm{hr1}+\mathrm{hr2})/2$ 6.

[2] Hypothesis Testing (Lecture Notes 10) https://www.pnw.edu/wp-content/uploads/2020/03/lecturenotes10-10.pdf

$$z = (hr1 - hr2)/\sqrt{\frac{2(\overline{hr})(1-\overline{hr})}{n}} \qquad 7.$$

It is useful to estimate the number of trials for each test sequence, n, for a given critical value. Solving for n versus z from equation 7 gives:

$$n = \frac{2(\overline{hr})(1-\overline{hr})z^2}{(hr1-hr2)^2} \qquad 8.$$

For a 0.05 significance level, the critical value of z is 1.6449; for a 0.10 level, z is 1.2816.

Example calculations:
Suppose we have hr1 = 0.58 and hr2 = 0.54. To show these two sequences are different at a 5% significance level, we can use the formula for the two-sample proportion test.

Step 1: Calculate the average hit rate, $\overline{hr} = (hr1 + hr2)/2$. In this case, $\overline{hr}$ = (0.58+0.54)/2 = 0.56.
Step 2: Substitute the values into equation 8 to find the required number of trials n. For a 0.05 significance level (z = 1.6449), we find that n = (2(0.56)(1-0.56) * (1.6449)^2) / (0.58-0.54)^2 = 834.
Therefore, demonstrating these two sequences are different at a 5% significance level using n = 834 active trials for each sequence.

For hr1 = 0.58 and hr2 = 0.52, n = 372 and 226 for 5% and 10% significance levels respectively.

For comparison, in the first example the individual sequences are significant at the 5% level after only 106 and 423 trials.

To estimate the z-score from a series of trials of length n ≥ 100:

$$z = \sqrt{n}\ es = \frac{2x-n}{\sqrt{n}} \qquad 9.$$

where es is the effect size (2 hr – 1) and x is the number of hits in the series.
The probability of the null hypothesis is p ≈ P(X ≥ z) = 1 – cnd[z]. 10.
Example: for n = 100 and hr = 0.52 (es = .04), z = .4 and p = 0.3446. The binomial calculation gives the exact value, p = 0.3822. For n = 1000 and hr = 0.52, the estimated p = 0.1030 and the binomial p = 0.1087.

Following is a Mathematica program for estimating the cumulative normal distribution probability:

```
(* This function calculates the cumulative normal distribution *)
cnd[z_]:=                                                            11.
(* c1 to c7 are constants used in the formula *)
(c1 = 2.506628275;
c2 = .31938153;
```

```
c3 = -.356563782;
c4 = 1.781477937;
c5 = -1.821255978;
c6 = 1.330274429;
c7 = .2316419;
If[z >= 0, w = 1, w = -1];
t = 1. + c7*w*z;
y = 1./t;
cndout = 0.5 + w (0.5 - (c2 + (c6 + c5*t + c4*t^2 + c3*t^3)/t^4)/(c1*Exp[.5 z^2] t)))
```