A Comment on *Can Our Mind Emit Light at 7300 km Distance?*

Hartmut Grote

ABSTRACT

The paper titled 'Can Our Minds Emit Light at 7300 km Distance? A Pre-Registered Confirmatory Experiment of Mental Entanglement with a Photomultiplier', published in *NeuroQuantology* in September 2016, claims a significant effect for mental action at a distance (or something similar) onto a physical system. This author re-analyzed the experimental data with a Monte-Carlo method estimating the background distribution from random permutations of the experimental data. While the authors of find a Bayes factor of $9.6x10^{10}$ for one of their main results, this author finds the result of the Monte-Carlo simulation to be not significant: The probability to find the data (or more extreme data) as observed (under a null hypothesis of no mental influence) is p=0.074 and p=0.30 for two pre-specified conditions, respectively. The error in the claiming of the high significance in probably stems from the assumption that the statistics of the data is binomial distributed, which, as will be argued, seems to be an incorrect assumption.

Key Words: mind-matter; entanglement; data-analysis

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Introduction

In the work reported in (Tressoldi *et al.,* 2016) the authors conduct an experiment where the output of a photomultiplier tube is recorded for three distinct conditions. The conditions are called *Pre-ME*, *ME*, and *Control*. During the ME condition, 'mental intention' is applied by humans to the photomultiplier from a remote location. In both other conditions no such 'mental intention' is applied, and these conditions serve as controls.

Every half second the number of detected photons (over the last half second) is sampled, and according to the pre-specified protocol in (Tressoldi *et al.,* 2016), only the number of photons in samples with more than 10 photons are counted for the analysis. The number of *occurances of samples* with more than 10 photons (called *bursts > 10* in Tressoldi *et al.,* 2016) is used for a post-hoc analysis in (Tressoldi *et al.,* 2016), but is not analyzed in this comment.

For each of the three conditions, 10 sessions have been performed, each lasting 40 minutes, as described in (Tressoldi *et al.,* 2016), and thus each resulting in 4800 samples. The observed photon numbers (again, only counting photons in samples with more than 10 photons) summed over 40 minutes for each session are shown in Table 1 below.

	Session Nr.										
Condition	1	2	3	4	5	6	7	8	9	10	**Sum**
Pre-ME	112	66	61	127	171	78	90	54	49	79	**887**
ME	130	104	53	178	127	103	108	133	100	128	**1164**
Control	107	71	72	116	87	87	36	124	123	237	**1060**

Corresponding author: H. Grote
Address: Max-Planck-Institut für Gravitationsphysik (Albert Einstein Institut) und Leibniz Universität Hannover, Callinstr. 38, 30167 Hannover, Germany. **e-mail** ✉ hrg@mpq.mpg.de
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Table 1. Experimentally obtained data of the study (Tressoldi *et al.,* 2016) for three different conditions. The numbers represent the total number of photons in bursts with more than 10 photons for the 10 sessions for each condition. For illustration: The photon counts of 112 for the first session of the Pre-ME condition is the result of 9 (out of 4800) samples that have more than 10 photons:

$$4\times 11 photons + 2\times 12 photons + 1\times 13 photons + 1\times 14 photons + 1\times 17 photons = 112 photons.$$

The data for the individual sessions is not given in (Tressoldi *et al.,* 2016), and was downloaded from the raw data repository cited in (Tressoldi *et al.,* 2016) for each condition, which correspond to the column labeled 'photons' in Table 2 of (Tressoldi *et al.,* 2016).

The sum of these photons of the 10 sessions is shown in the last column for each condition. These sum values correspond to the column labeled 'photons' in Table 2 of (Tressoldi *et al.,* 2016). The sum of photons for the ME condition (1164) is found to be larger than the sum for the Pre-ME (887) and the Control (1060) conditions, which was the main prediction under test in (Tressoldi *et al.,* 2016).

However, the main analysis question is to what degree these differences (of ME vs. PRE-ME and ME vs. Control) are statistically significant.

To test this, in this comment we make no a-priori assumption about the underlying distribution of the counted photons, but rather evaluate this distribution empirically from segmentation of the data. we start from a null hypothesis (of no mental interaction) and thus treat all 30 individual data points in Table 1 as equal, combining them in a set we call DATA. We then draw randomly 10 elements of DATA (draw without replacement) and compute their sum as A. We then draw another 10 elements of DATA (again without replacement) and compute their sum as B. We then calculate A-B and store the result in the array N. We repeat this procedure 100,000 times (starting always with the 30 data elements in DATA) and end up with an array N with 100,000 results, describing the target data distribution. Finally, we can compare our data of interest to the distribution of elements in N: The sum of the ME data minus the sum of the Pre-ME data (277) and the sum of the ME data minus the sum of the Control data (104). The results are shown in Figure 2.

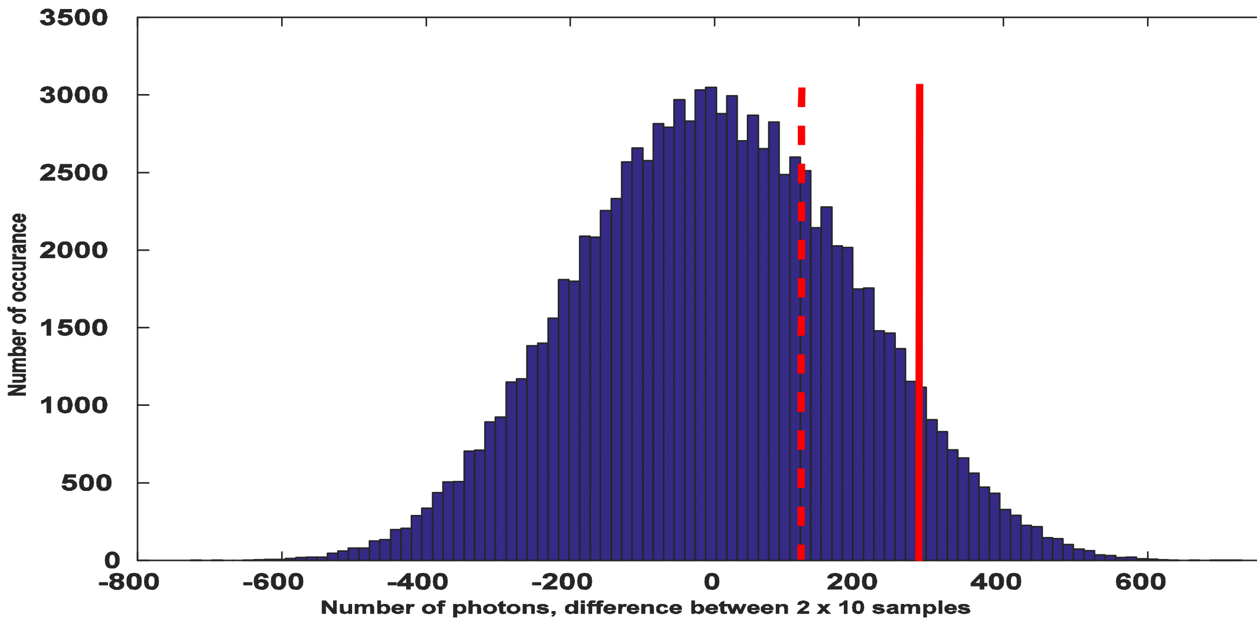

Table 2. Histogram of 100.000 permutations of the data presented in Table 1, evaluating the difference of the sum of two sets of 10 data points each. The vertical lines denote the position of the sum of ME data minus the sum of Pre-ME data (277, solid line) and the sum of ME minus the sum of Control (104, dashed line). The corresponding one-sided probabilities to find these results (or more extreme ones) by chance under a null hypothesis are p=0.074 (ME minus Pre-ME) and p=0.30 (ME minus Control).

We take from this simulation that the one-sided probabilities to find these experimental results (or more extreme ones) by chance under a null hypothesis are p=0.074 (ME minus Pre-ME) and p=0.30 (ME minus Control). (The MATLAB code used for this computation is given in the appendix.)

This result does not change much when the background distribution is estimated only from the Pre-ME and Control conditions, allowing for a less conservative analysis. In this case one obtains p=0.10 (ME minus Pre-ME) and p=0.33 (ME minus Control) that the data (or more extreme data) have been obtained by chance under a null hypothesis.

While the authors of (Tressoldi *et al.,* 2016) claim a Bayes factor of 9.6×10^{10} (Lower Table 2S in the appendix of (Tressoldi *et al.,* 2016) for the condition of 'Control Pre-ME vs. ME') and thus an extremely significant result, we can only guess here where this error in (Tressoldi *et al.,* 2016) originates from: The authors claim that the data in their experiment would follow a Poisson distribution and show a figure do demonstrate this (Figure 1 in Tressoldi *et al.,* 2016). While the exact condition under which the data in this figure was obtained is not specified, it is denoted as `typical'. However, regardless of the question under which condition this data was taken, it is obvious that the distribution is not Poissonian, but has a significant tail towards higher photon counts. The authors refer to these outliers as '6 sigma' events, but fail to explain while such nominally rare events would occur so often if the data was really Poissonian distributed. Table 2 in (Tressoldi *et al.,* 2016) shows that even for the control conditions, where no mental influence is assumed, the number of times where more than 10 photons are registered in one sample is 66 and 78, respectively. A real Poissonian distribution with a mean expectation value of 1 photon count per sample does roughly reproduce the left part of Figure 1 in (Tressoldi *et al.,* 2016) for small photon numbers. However, the probability to get more than 10 photon counts in a real Poissonian distribution is of order $p=10^{-8}$ for a single sample. Even with the 48000 samples presumably underlying the data in Figure 1 in (Tressoldi *et al.,* 2016), the probability to obtain a sample with a photon count larger than 10 in this data is still smaller than p=0.001. So how tiny would the probability to get 66 or 78 such events be? Rather than answering this question, our conclusion here is that the data simply is *not* Poissonian distributed. Apparently, the photons must be correlated to a degree, in order to explain the high number of samples (bursts) with more than 10 photons. Considering the physical processes inside a photo-multiplier tube this may not come as a surprise since the number of generated electrons within the tube as well as the corresponding counting process can depend on several parameters. It is thus very hard or may be impossible to find an analytical a-priori description of the photon count statistics.

Now, for the Bayes factor calculation in the lower table 2S of (Tressoldi *et al.,* 2016), the authors use a web-based applet cited as Morey (2014) with an URL as repeated here (Morey, 2016). For this, only the sum data in Table 1 have been used by the authors of (Tressoldi *et al.,* 2016), which implies that an assumption of the underlying distribution has to be made, in order to be able to make a statistical assessment of the significance. The Morey applet (Morey, 2016) does in fact require a binomial distribution of the underlying data (Morey, 2016b). However, for the data here, to be binomial distributed, it would be required that each detected photon (in bursts of >10 photons) is statistically independent from each other photon. The conclusion from above strongly suggests otherwise. Since the Poissonian distribution is the limit of a binomial distribution, and accepting the conclusion from above, that the data is not Poissonian, it seems exceedingly unlikely that the data is binomial distributed.

If the `outliers' in the photon counts are just taken as they are, making no assumptions about the underlying distribution, and the statistical background is estimated as described in this comment, from segmentation of the actual data, then the results vanish to non-significance. Similarly, the extremely large Bayes factors presented in Table 3S in (Tressoldi *et al.,* 2016) probably stem from the same error as described above.

The main hypothesis as put forward in (Tressoldi *et al.,* 2016) was: *The percentage of photons in the bursts composed by at least 11 photons (corresponding to bursts exceeding 6Ïƒ the average count) detected by the PMT every half second during the 40 minutes of ME (...), will exceed those detected in the 40 min of the two Control periods.* While this hypothesis was confirmed, we conclude with the analysis presented here that it was confirmed only in a statistically non-significant way. The result may reasonably have been obtained due to chance alone.

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References

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Appendix

MATLAB code to calculate probabilities as described above:
clear all; N=100000; bp=zeros(1,N); p=[112 66 61 127 171 78 90 54 49 79 ... 130 104 53 178 127 103 108 133 100 128 ... 107 71 72 116 87 87 36 124 123 237]; for i=1:N cp = p(randperm(30)); bp(i) = sum(cp(1:10))-sum(cp(11:20)); end p1 = sum(bp>=277) / N p2 = sum(bp>=104) / N