Sham-experiments reveal a statistical error and the need for confirmatory research in the Radin Double-Slit experiment

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Background:

• Radin, 2008, Radin et al., 2012, Radin et al., 2013, Radin et al., 2015, Radin et al., 2016 reported significant effects of conscious attention on photon interference pattern in a double slit apparatus.

• A commissioned replication study conducted by Dean Radin for the Fetzer-Franklin-Fund found a significant effect only in a "sham condition", i.e. in the absence of any participants. (Walleczek and von Stillfried, 2019)

• This led to the question if the effects reported in the earlier publications by Radin et al. could also be false positives.

Aim:

An empirical investigation of the statistical analysis methods used in three of these studies

Material and Method:

• Dean Radin kindly provided a double-slit apparatus and a Matlab script for analysis of interference patterns

• The Matlab script contained three different outcome parameters which correspond closely to the different outcome parameters employed in three of the studies

- FV (Fringe Visibility) ≈ Radin et al., 2016

- dD (detrended Double-slit spectral power) ≈ Radin et al., 2013

- R (Ratio between single-slit and double-slit spectral power ≈ Radin et al., 2012)

• We conducted sham-experiments, i.e. mimicking the experimental procedures but in the absence of any participants.

• 64 datasets were recorded from the double slit apparatus (eight times the amount of data produced in the commissioned study by Radin).

•This data was analyzed using each of the outcome parameters with the Matlab Script provided by Radin.

Results:

- The data analysis script provided by Radin produced a significantly above-chance number of statistical significances in the case of outcome criteria FV and R. (21 for FV, 22 for R, chance expectancy = p<0.000001, two-tailed binomial probability test). When a procedure called "trimming" was deactivated, the number of statistical significances conformed to chance expectancy. Note: All significances are false positives because they occurred in the absence of participants.

- The different outcome criteria developed by Radin give substantially different results when applied to the same datasets. The deactivation of "trimming" does not remedy this discrepancy. FV and R are more similar to each other than to dD but in only two datasets did FV and R produce a significant z-value whereas in six datasets only one of them led to a significant z-value result.

Z-values: resulting from analysis
- of 64 sham data-sets
- by 3 outcome criteria
- with / without "timming".

Positive and negative (one-tailed) significances marked.

Data set #	with "trimming" outcome criterion			no "trimming" outcome criterion		
	FV	R	dD	FV	R	dD
1	-1,38	-1,42	0,97	-0,17	0,41	0,87
2	1,33	0,73	-0,98	0,03	-0,62	-0,58
3	0,91	0,51	-0,05	0,99	0,51	0,16
4	-0,38	-0,2	-1,6	-0,01	-1,01	-1,23
5	-4,8	-3,07	0,27	-2,7	-1,64	0,68
6	0,09	-0,89	-1,43	-1,27	-1,43	-1,27
7	-2,12	-2,27	-0,46	-0,37	0	-0,63
8	0,14	0,49	-0,76	-0,84	-0,67	-0,29
9	2,16	1,83	-3,15	1,34	0,98	-2,79
10	-0,17	0,81	0,12	0,33	0,36	0,16
11	0,35	-1,09	-0,18	-0,58	-0,9	-0,59
12	-0,94	-2,15	0,72	-1,32	-1,5	1,14
13	0,09	-2,61	-0,59	-0,23	-1,37	-0,16
14	1,23	2,3	-0,25	-0,41	-0,12	0,5
15	1,45	2,58	-1,25	0,82	0,76	-0,87
16	3,45	3,68	-0,56	1,3	1,12	-0,31
17	0,12	-1,21	-0,14	1,05	1,03	-0,61
18	-0,48	0,83	-0,04	0,9	1,03	0,55
19	-1,77	1,58	1,97	-1,35	0,56	0,89
20	-1,89	-1,58	0,15	-1,21	-0,24	0
21	-1,52	-0,64	-1,33	-0,3	0,07	-1,22
22	-0,69	-0,76	-0,83	0,77	0,7	-0,61
23	1,86	1,12	-2,01	1,26	0,89	-1,41
24	-0,8	-2,18	-1,03	0,82	1,12	-0,6
25	-1,37	-1,06	-0,69	-0,62	0,05	-0,38
26	-1,6	0,5	-0,62	-1,65	-0,19	-0,48
27	-0,17	1,81	-1,08	-0,82	-0,55	-0,79
28	-0,21	-1,11	-2,08	1,44	1,64	-1,44
29	-1,31	-0,01	0,15	1,48	1,81	0,19
30	1,8	1,16	-1,68	0,49	0,28	-1,46
31	-2,35	-4,09	-1,3	0,23	-0,6	-0,88
32	-0,41	1,33	0,24	0,07	0,2	-0,23
33	-0,34	-3,41	-0,38	-0,48	-1,04	-0,35
34	-1	-0,01	0,28	-0,68	-0,43	0,52
35	-0,53	-0,16	-0,38	-0,13	0,26	0,53
36	-1,79	-2,75	1,44	-1,47	-2,71	1,22
37	-1,07	-2,19	0,98	0,35	0,13	0,92
38	-0,76	-4,05	0,79	0,6	0,45	0,75
39	-0,92	-3,13	-0,44	-1,02	-1,31	0,26
40	1,33	-0,47	-0,99	-0,64	-0,72	-0,58
41	-2,82	-1,26	2,4	-1,75	-1,22	1,8
42	1,66	3,22	-0,36	1,1	1,32	-0,3
43	-0,32	1,25	0,84	0,98	1,6	0,57
44	-0,26	0,36	-0,72	-1,06	-0,89	-0,19
45	-0,23	-2,69	0,73	1,53	1,19	0,17
46	0,47	1,18	-0,38	-0,91	-0,99	-0,3
47	2,12	2,94	1,13	0,06	0,3	1,67
48	2,21	3,28	0,53	0,06	0,02	0,81
49	-0,43	0,8	0,03	-0,86	-0,66	0,29
50	2,17	-1,04	-0,75	2,56	1,64	-0,51
51	0,59	0,79	0,07	0,62	0,05	0,35
52	-1,35	-2,27	-1,08	-0,46	-2,22	-0,93
53	-1,12	-0,27	-0,42	0,34	0,68	-0,69
54	-1,73	-0,1	-2,22	0,04	0,69	-0,96
55	-1,74	0,68	1,55	-0,51	0,23	1,46
56	0,46	0,32	-1,18	0,24	0,52	-0,96
57	-2,79	0,24	-1,21	-1,38	-0,57	-0,7
58	-3,42	-0,46	1,2	-0,94	-0,02	1,03
59	-0,58	-1,15	0,96	-0,68	-0,98	0,57
60	-1,13	-0,04	-0,76	-1,26	-1,24	-0,65
61	0,72	0,12	1,32	-0,29	-0,5	1,18
62	1,66	-0,99	-0,38	-0,72	-0,93	-0,3
63	2,63	1,45	0,71	0,55	-0,01	0,71
64	0,96	1,93	-1,5	0,15	0,29	-0,06

Inferences:

- **The "trimming"-procedure which is used in Radin et al., 2016, can lead to false positives.** In fact, when trimming is deactivated, the data in Radin et al., 2016, no longer shows significant effects (Tremblay, 2019, pers.comm.).

- **The analysis methods used in Radin et al. 2013 were probably adjusted post hoc and should thus be considered exploratory research only.** Alternatively, since R and dD (corresponding closely to the ones used in Radin et al. 2012 and Radin et al. 2013) produce substantially different results in our sham data, it would have to be assumed that Radin et al. discovered two distinct effects of conscious attention on quantum interference. We consider this unlikely, in particular since no explanation for the change of analysis methods is given by the authors in the respective publications.

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