This contagious error voids Bell·1964, CHSH·1969, etc.

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Abstract Elementary instance-tracking identifies a contagious error in Bell (1964). To wit, and against his own advice: in failing to match instances, Bell voids his own conclusions. The contagion extends to Aspect, Griffiths, Levanto, Motl, Peres and each of CHSH.

1. Introduction

1.1. Bell (1964) and Watson 2018J—freely available, see ¶5-References—provide the preamble to this note. So our context is still the program to provide a more complete specification of EPRB; while 2018J shows that Bell's famous inequality is seriously infected: its upper bound of 1 being readily breached, peaking at $\frac{3}{2}$. So we now reveal the source of the problem: the instance-matching error in both Bell (1964) and CHSH (1969) that is contagiously false wrt the number of writers who, failing to detect the infection, continue its spread.

1.2. Next, the housekeeping: (i) After Bell 1964:(14), we label the unnumbered math-expressions (14a)-(14c). (ii) We put the *crucial* line[1] that precedes Bell 1964:(1) into a convenient mathematical form. Thus, consistent with fn.1:

> The result A_i is determined by a and $\boldsymbol{\lambda}_i$, so $A_i = A(a, \boldsymbol{\lambda}_i) = \pm 1$. And the *paired result* B_i [ie*, the result obtained in the same instance*] is determined by b and $-\boldsymbol{\lambda}_i$. So $B_i = B(b, -\boldsymbol{\lambda}_i) = \pm 1 = -A(b, \boldsymbol{\lambda}_i)$ as in Bell 1964:(13). Thus:[2]
>
> $$A_iB_i : i = 1, 2, .., n.\ A_jC_j : j = n+1, .., 2n.\ B_kC_k : k = 2n+1, .., 3n. \tag{1}$$
>
> $$\therefore A_iA_i = B_iB_i = 1; A_iB_j = \pm 1; B_iB_j = \pm 1; E(a, b) \doteq \frac{1}{n}\sum_{i=1}^{n} A_iB_i; \text{ etc.} \tag{2}$$

1.3. So we tag each instance by a different subscript *instance-identifier*—see (1)—without implying uniqueness. Consistent with Bell's integrals, the subscripts denote the representative instances that appear in our formalisms, and not necessarily discreteness. (Thus the same tag may be used to identify each instantiated particle-pair, and each $\boldsymbol{\lambda}$, without implying uniqueness.)

1.4. In sum: (i) an EPRB instance is defined by a paired-result. In the context of expectations: (ii) no EPRB instance can be constructed by combining results from different instances; (iii) the expectation over such constructions is zero (since the averaging is over random pairs of uncorrelated results, each ± 1). (iv) And since our focus is EPRB: non-EPRB settings—in which Bellian inequalities hold—are not relevant here.

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[1] *Crucial* because EPRB correlations and expectations only arise from paired-results obtained in *the same instance*: not at all by pairing two results from two *different instances*. For now, let's call this latter practice *instance-faking.*

[2] nb: we sometimes use n discrete tests per test-setting—over the setting (a, b), say—for analytical convenience: but we always require n to be such that the sample mean is an adequate representation of the expectation (the population mean). Which we suggest is not a problem, since we can derive the expectation from first principles.

2. Analysis

2.1. Under EPRB—and in the context of Bell seeking (p.195) to provide a more complete specification of EPRB by means of parameter $\boldsymbol{\lambda}$—we begin with 2018J:(6)&(7) respectively, and implications:

$$\text{Irrefutably from us: } [|E(a,b)-E(a,c)|-1 \leq -E(a,b)E(a,c)] \quad \Rightarrow \quad \{A_iB_i\}, \{A_jC_j\}. \tag{3}$$

$$\text{Via Bell's famed inequality: } [|E(a,b)-E(a,c)|-1 \leq E(b,c)] \quad \Rightarrow \quad \{A_iB_i\}, \{A_jC_j\}, \{B_kC_k\}? \tag{4}$$

2.2. But (4)—based as it is on Bell's inequality—is misleading: for the seemingly valid (on the evidence) implication to $\{B_kC_k\}$ is not supported. Instead, per irrefutable (3): (i) the inequalities in (3)-(4) have a common LHS with common instance-sets; (ii) this common LHS is independent of $\{B_kC_k\}$. (iii) And from 2018J, due to $E(b,c)$, the inequality in (4) is often false. (iv) Thus, from the instance-audit in (4), $\{B_kC_k\}$ must be related to that weakness: as we now confirm.

2.3. From Watson 2018J we know that Bell's famous inequality—Bell 1964:(15)—is false. And, since Bell 1964:(15) is correctly derived from Bell 1964:(14b), we consequently know that (14b) is false. Thus, since Bell 1964:(14a) is true (by definition), it follows (by logic alone, and with certainty) that:

$$\text{Bell 1964:(14b)} \quad \neq \quad \text{Bell 1964:(14a)}. \tag{5}$$

2.4. Then, since Bell arrives at (14b) using his 1964:(1), it follows (again, with certainty) that Bell's usage of his (1) is the sole source of his error. Indeed, comparing (14b) with (14a)—and understanding ¶1.2(ii)—we see that Bell makes this transition by using 1964:(1) absurdly.[3] A fact that is now reinforced by instance-tagging Bell's analysis via (1)-(2):

$$\begin{aligned}
\text{Bell 1964:(14a)} \quad &\equiv \quad E(a,b)-E(a,c) && (6)\\
&\equiv \quad -\int d\lambda\, \rho(\boldsymbol{\lambda})\, [A_i(a,\boldsymbol{\lambda})A_i(b,\boldsymbol{\lambda}) - A_j(a,\boldsymbol{\lambda})A_j(c,\boldsymbol{\lambda})] && (7)\\
&= \quad \int d\lambda\, \rho(\boldsymbol{\lambda}) A_i(a,\boldsymbol{\lambda})A_i(b,\boldsymbol{\lambda})[A_j(b,\boldsymbol{\lambda})A_j(c,\boldsymbol{\lambda})-1] = \text{Bell 1964:(14b):[sic]}\blacktriangle && (8)\\
&\qquad \text{Bell using 1964:(1) and } A_i(b,\boldsymbol{\lambda})A_j(b,\boldsymbol{\lambda}) = 1, \text{ contrary to our (2).}\ \blacktriangle && (9)
\end{aligned}$$

2.5. That is: Bell's move from valid (7) to (8) is absurd: for the correlation that Bell employs is only available *via outcomes obtained in the same instance*; see (2). To show this, we base our rebuttal[4] on the same (6)-(7): but respecting our subscript instance-identifiers, per (1)-(2).

$$\begin{aligned}
\text{Bell 1964:(14a)} \quad &\equiv \quad E(a,b)-E(a,c) && (10)\\
&\equiv \quad -\int d\lambda\, \rho(\boldsymbol{\lambda})\, [A_i(a,\boldsymbol{\lambda}_i)A_i(b,\boldsymbol{\lambda}_i) - A_j(a,\boldsymbol{\lambda}_j)A_j(c,\boldsymbol{\lambda}_j)] && (11)\\
&= \quad \int d\lambda\, \rho(\boldsymbol{\lambda}) A_i(a,\boldsymbol{\lambda}_i)A_i(b,\boldsymbol{\lambda}_i)[A_i(a,\boldsymbol{\lambda}_i)A_i(b,\boldsymbol{\lambda}_i)A_j(b,\boldsymbol{\lambda}_j)A_j(c,\boldsymbol{\lambda}_j)-1] && (12)\\
\therefore |E(a,b)-E(a,c)| \quad &\leq \quad \int d\lambda\, \rho(\boldsymbol{\lambda})[1 - A_i(a,\boldsymbol{\lambda}_i)A_i(b,\boldsymbol{\lambda}_i)A_j(b,\boldsymbol{\lambda}_j)A_j(c,\boldsymbol{\lambda}_j)] && (13)\\
&\qquad\qquad \because \int d\lambda\, \rho(\boldsymbol{\lambda})A_i(a,\boldsymbol{\lambda}_i)A_i(b,\boldsymbol{\lambda}_i) \leq 1 && (14)\\
&\leq \quad 1 - E(a,b)E(a,c) = \text{2018J:(6), our inequality (as it should)}:\ \blacksquare && (15)
\end{aligned}$$

for the expectation over the product of $[A_i(a,\boldsymbol{\lambda}_i)A_i(b,\boldsymbol{\lambda}_i)]$ and $[A_j(b,\boldsymbol{\lambda}_j)A_j(c,\boldsymbol{\lambda}_j)]$—two independent and uncorrelated random variables; representing two sets of systematically tagged instances, per (1)—is the product of their individual expectations. Hence the utility of our subscript instance-identifiers in reproducing irrefutable (15).

[3] Bellians may claim that this is Bell's way of providing 'the more complete specification of EPRB via parameters $\boldsymbol{\lambda}$' that he seeks (p.195). But this leaves Bell's false 1964:(15) remaining in play (when clearly ineligible under EPRB): which leads to other Bellian errors; see Watson 2018J:¶1.2 for now.

[4] For the record: this rebuttal is consistent with true local realism and our own more complete specification of EPRB: as drafted in Watson (2017d); and now being revamped in this series of short notes.

3. Replies (R) to questions (Q) and other (O), with thanks

3.1. **O1**: The CHSH (1969) inequality, $S \leq 2$, is more robust than Bell's and impossible to refute. **R1**: (i) Let's see, with $\langle \bullet \rangle$ denoting an expectation over the set of instances $\bullet$.

$$\text{CHSH}_{(\text{over instances})}: \quad S = |\langle A_i B_i \rangle + \langle B_j C_j \rangle + \langle C_k D_k \rangle - \langle D_k A_k \rangle| \quad \leq \quad 2\sqrt{2} : \text{ QED}; \tag{16}$$

for, via our proxies [Watson 2018J:¶2.4], or from QM, or derived independently [Watson 2017d:(24)]:

$$\langle A_i B_i \rangle = -\cos(a, b); \text{ etc.} \tag{17}$$

(ii) Studying CHSH—Peres 1995:(6.29)-(6.30) is helpful—you should see the clear difference between the one valid instance in CHSH (1969) and the three fakes. So the CHSH inequality—one of the clearest examples of instance-matching errors—is as false as Bell's. For four sets of subscripts (i, j, k, l) are required to conveniently track all the instances, as in (16); each set built from randomly generated particle-pairs. For now, see Watson 2017d:(34)-(41) to get the general idea.

3.2. **O2**: Bell prefers the CHSH inequality; see http://vixra.org/abs/1406.0027. **R2**: See ¶3.1 above. Regarding Bell's preference: via an educative *instance-deficiency-index*,[5] Bell's inequality rates 0.5 against CHSH at 3.0. So we prefer CHSH as well, because the errors are greater and clearer. However, to be unambiguous re our claim: all EPRB-based Bellian inequalities are false.

4. Conclusions

4.1. The basis for Bell's inequality (and his consequent false theorem)[6] is widely discussed up to the present day. In the context of EPRB, we show that there is no physically-significant basis for either.

4.2. For: (i) the instance-analysis leading to our (4) is impeccable; (ii) the related conclusion in ¶2.2(iv) is confirmed via (9); (iii) the logic leading to (5) is unassailable; (iv) Bell's work is faithfully reproduced in (6)-(9); (v) via our correction to that work in (10)-(15), Bell's famous inequality is refuted; (vi) and [as it should be] our irrefutable inequality from 2018J:(6) is independently confirmed, see (15).

4.3. It follows that neither Bell (1964), nor CHSH (1969), is a bar to our work[7]—our work being consistent with 'Einstein's arguments'—to make 'EPR correlations intelligible by completing the quantum mechanical account in a classical way,' after Bell (2004:86). For *grossly non-local structures* (Bell 1964:195) are characteristic of Bellian theory-voiding instance-faking: not a failure of the *vital* [locality] *assumption* below Bell 1964:(1).

4.4. Finally, we note the contagion associated with Bell's error in his moving from (7) to (8) via (9). Outbreaks, to name a few, include CHSH 1969:(first math expression; unnumbered), Clauser & Shimony 1978:(3.6b), Griffiths (1995:378), Peres 1995:(6.25)&(6.29), Aspect 2004:(17), Lubos Motl (2007:8),[8] Mikko Levanto (2016).

[5] In a Bellian inequality: the *instance-deficiency-index* is the ratio of fake-instances to valid-instances.
[6] Bell's theorem is the claimed impossibility in the line below Bell 1964:(3). It is refuted at Watson 2017d:(24).
[7] Drafted in Watson (2017d): now being revamped in this series of short notes.
[8] This example is from Lecture 36. Lubos Motl is not a Bellian.

5. References

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