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

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. Watson 2018J provides the preamble here, for from there we know that Bell's famous 1964 inequality is seriously infected: its upper bound of 1, readily breached algebraically, peaks at $\frac{3}{2}$. So in this note—as a preamble to 2018L, where we explain Aspect's 2004 experiment and refute Bell's theorem in the context of Einstein-classicality—we reveal the source of Bell's problems: instance-matching errors in both Bell (1964) and CHSH (1969) are contagiously false wrt the number of writers who, failing to detect the infection, continue its spread.

1.2. Now (of course), our arguments are not general objections to researching alternative physical systems. Rather: our arguments refute the use of Bell's defective (and infective) analysis in so-called *entangled* systems; eg, in experiments like EPRB (Bell 1964) and Aspect (2004) where Bellians fail and we succeed in providing more complete specifications. So our hygienic practices continue:

1.3. (i) After Bell 1964:(14), we label the three unnumbered math-expressions (14a)-(14c). (ii) We put the *crucial* line[2] that precedes Bell 1964:(1) into a convenient form. Thus, consistent with fn.2:

> Result A is determined by a and $\boldsymbol{\lambda}$ via the function $A = A(a, \boldsymbol{\lambda}) = \pm 1$. And the *paired result* B [*the result obtained in the same instance*] is determined by $B = B(b, \boldsymbol{\lambda}) = \pm 1$. So—not yet using Bell 1964:(14); see ¶2.4—the related expectation, as in Bell 1964:(2), is

$$E(a,b) = \int d\boldsymbol{\lambda}\rho(\boldsymbol{\lambda})A(a,\boldsymbol{\lambda})B(b,\boldsymbol{\lambda}) \text{: However, in Bell 1964:(14a) we now need} \tag{1}$$

$$E(a,b) - E(a,c) = \int d\lambda\, \rho(\boldsymbol{\lambda})\left[A_i(a,\boldsymbol{\lambda})B_i(b,\boldsymbol{\lambda}) - A_j(a,\boldsymbol{\lambda})C_j(c,\boldsymbol{\lambda})\right] \tag{2}$$

$$\because\ A_iA_i = B_iB_i = 1; \langle B_iB_i\rangle = 1; A_iA_j = \pm 1; B_iC_j = \pm 1; \langle B_iC_j\rangle = 0; \text{ etc.} \tag{3}$$

1.4. That is, taking Bell 1964:(2) to be clearer than his (14) here: when *representative instances* appear together in aggregated formalisms, we tag each by a different subscript *instance-identifier*. Thus subscripts, as in (2), track different instances. With $\langle ...\rangle$ denoting an average in (3): we seek to avoid the contagion of instance-faking in EPR-settings and—see (7)—its attendant errors.

1.5. In sum: (i) an EPRB instance is defined by a paired-result. (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-style settings—in which Bellian inequalities hold—are not relevant here.

1.6. Wrt ¶1.5(ii), note that there is no difficulty in combining results from different instances appropriately. Thus with β denoting EPRB (honoring Bohm)—and with $A = 1 = A^+; A = -1 = A^-$; etc—an appropriate combination follows:

[1] The author is as close as an email: eprb@me.com Subject line: 2018K.v3.

[2] *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*. Let's call this latter practice *instance-faking*.

$$E(a,b|\beta) = P(A^+|\beta)[P(B^+|\beta,A^+) - P(B^-|\beta,A^+)] - P(A^-|\beta)[P(B^+|\beta,A^-) - P(B^-|\beta,A^-)]. \quad (4)$$

1.7. Alas, confusing nonlocal influences with logical implication, (4) is *not* what Bell uses; see Watson 2018L:¶4.1. For, contrarily and falsely, Bell typically concludes (2004:153) that "the quantum correlations are locally inexplicable". This we refute in 2018L. Here, next, we reveal Bell's contagion.

2. Analysis

2.1. Under EPRB—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 their implications:

$$\text{Irrefutably from us: } [|E(a,b) - E(a,c)| - 1 \leq -E(a,b)E(a,c)] \quad \Rightarrow \quad \{A_iB_i\}, \{A_jC_j\}. \quad (5)$$

$$\text{Via Bell's famed inequality: } [|E(a,b) - E(a,c)| - 1 \leq E(b,c)] \quad \Rightarrow \quad \{A_iB_i\}, \{A_jC_j\}, \{B_kC_k\}? \quad (6)$$

2.2. But (6)—based as it is on Bell's inequality—is misleading: for the seemingly valid inference to $\{B_kC_k\}$ —via $E(b,c)$— is not supported. Instead, per irrefutable (5): (i) the inequalities in (5)-(6) have a common LHS with common instance-sets; (ii) this common LHS is independent of $E(b,c)$, and thus of $\{B_kC_k\}$. (iii) And from 2018J, due to $E(b,c)$, the inequality in (6) is often false. (iv) Thus, from the instance-audit in (6), $\{B_kC_k\}$ 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:

$$\text{Bell 1964:(14b)} \quad \neq \quad \text{Bell 1964:(14a)}. \quad (7)$$

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 ¶1.3(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)-(3); now using $E(a,b)$ as in Bell 1964:(14), etc.[4]

$$\text{Bell 1964:(14a)} \quad \equiv \quad E(a,b) - E(a,c) \quad (8)$$

$$\equiv \quad -\int d\lambda\, \rho(\boldsymbol{\lambda})\, [A_i(a,\boldsymbol{\lambda})A_i(b,\boldsymbol{\lambda}) - A_j(a,\boldsymbol{\lambda})A_j(c,\boldsymbol{\lambda})] \quad (9)$$

$$= \quad \int d\lambda\, \rho(\boldsymbol{\lambda}) A_i(a,\boldsymbol{\lambda})A_i(b,\boldsymbol{\lambda})[A_j(b,\boldsymbol{\lambda})A_j(c,\boldsymbol{\lambda}) - 1] = \text{Bell 1964:(14b):[sic]}\blacktriangle \quad (10)$$

Bell using 1964:(1) and $A_i(b,\boldsymbol{\lambda})A_j(b,\boldsymbol{\lambda}) = 1$, contrary to our (2). ▲ (11)

2.5. That is: Bell's move from valid (9) to (10) is absurd: for the correlation that Bell employs is only available *via outcomes obtained in the same instance*; see (3). To show this, we next base our rebuttal[5] on the same (8)-(9): but respecting our subscript instance-identifiers, per (1)-(3).

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[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 QM, EPRB and elementary algebra): which leads to other Bellian errors; see Watson 2018J:¶1.2 and Watson 2018L.

[4] nb: when it comes to instance-tracking, we believe that Bell 1964:(2)—as used in our (1)-(3)—provides a clearer analysis. But we now use Bell 1964:(14) here to minimize departures from Bell's well-known and widely copied analysis: defective though it be, as we show.

[5] 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.

$$\begin{aligned}
\text{Bell 1964:(14a)} &\equiv E(a,b)-E(a,c) && (12)\\
&\equiv -\int d\lambda\, \rho(\boldsymbol{\lambda})\, [A_i(a,\boldsymbol{\lambda}_i)A_i(b,\boldsymbol{\lambda}_i) - A_j(a,\boldsymbol{\lambda}_j)A_j(c,\boldsymbol{\lambda}_j)] && (13)\\
&= \int d\lambda\, \rho(\boldsymbol{\lambda}) A_i(a,\boldsymbol{\lambda}_i)A_i(b,\boldsymbol{\lambda}_i)[A_i(a,\boldsymbol{\lambda}_i)A_i(b,\boldsymbol{\lambda}_i)A_j(b,\boldsymbol{\lambda}_j)A_j(c,\boldsymbol{\lambda}_j)-1] && (14)\\
\therefore |E(a,b)-E(a,c)| &\leq \int d\lambda\, \rho(\boldsymbol{\lambda})[1 - A_i(a,\boldsymbol{\lambda}_i)A_i(b,\boldsymbol{\lambda}_i)A_j(b,\boldsymbol{\lambda}_j)A_j(c,\boldsymbol{\lambda}_j)] && (15)\\
& \qquad\qquad \because \int d\lambda\, \rho(\boldsymbol{\lambda})A_i(a,\boldsymbol{\lambda}_i)A_i(b,\boldsymbol{\lambda}_i) \leq 1 && (16)\\
&\leq 1 - E(a,b)E(a,c) = \text{2018J:(6), our inequality (as it should)}: \blacksquare && (17)
\end{aligned}$$

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 (17).

3. Replies (R) to questions (Q), etc

3.1. **Q1**: 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 $\bullet$.

$$\text{CHSH}_{(\text{over instances})}: \quad S = |\langle A_iB_i\rangle + \langle B_jC_j\rangle + \langle C_kD_k\rangle - \langle D_kA_k\rangle| \quad \leq \quad 2\sqrt{2}: \text{ QED;} \tag{18}$$

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

$$\langle A_iB_i\rangle = -\cos(a,b);\ \text{etc.} \tag{19}$$

(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 (18); each set built from randomly generated particle-pairs. For now, see Watson 2017D:(34)-(41) to get the general idea.

3.2. **Q2**: 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*,[6] 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 EPR-based Bellian inequalities are false.

3.3. **Q3**: Can you point to an error in Shimony (1990)? **R3**: Yes: *outcome independence* (p.35) is false in all Bellian-settings, for the outcomes (eg, in EPRB, via $\boldsymbol{\lambda}$) are logically dependent.[7] That is, under EPRB $[\beta]$ via the general product rule in probability theory (Bayes Law):

$$\begin{aligned}
P(AB\,|\,\beta) = P(B\,|\,\beta)P(A\,|\,\beta B) &= P(A\,|\,\beta)P(B\,|\,\beta A): && (20)\\
\text{which reduces to outcome independence } P(AB\,|\,\beta) &= P(A\,|\,\beta)P(B\,|\,\beta) && (21)\\
\textbf{if and only if } A \text{ and } B \text{ are logically independent} &: \text{alas, under } \beta, \text{ they are not.} \blacksquare \text{ QED.} && (22)
\end{aligned}$$

[6] In a Bellian inequality: the *instance-deficiency-index* is the ratio of faked-instances to valid-instances.

[7] Whether causally or correlatively, outcomes $A\,\&\,B$ are logically dependent if $P(A\,|\,\beta B) \neq P(A\,|\,\beta)$. nb: given the $\boldsymbol{\lambda}$s in (1), EPRB is a typical case where the logical dependence in $P(A\,|\,\beta B)$ is correlative, not causal; etc.

4. Conclusions

4.1. The basis for Bell's inequality (and his consequent false theorem)[8] 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 (6) is impeccable; (ii) the related conclusion in ¶2.2(iv) is confirmed via (11); (iii) the logic leading to (7) is unassailable; (iv) Bell's work is faithfully reproduced in (8)-(11); (v) via our correction to that work in (12)-(17), Bell's famous inequality is refuted; (vi) and [as it should be] our irrefutable inequality from 2018J:(6) is independently confirmed, see (17).

4.3. It follows that neither Bell (1964), nor CHSH (1969), is a bar to our work[9]—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 (as above) from (9) to (10) via (11). 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),[10] Mikko Levanto (2016).

5. References

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[8] Bell's theorem is the claimed impossibility in the line below Bell 1964:(3). It is refuted at Watson 2017D:(24).
[9] Drafted in Watson (2017D): now being revamped in this series of short notes. See 2018L.
[10] Lubos Motl is not a Bellian. This example is from his Lecture 36.

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