On the truth-conduciveness of coherence

William Roche
Department of Philosophy, Texas Christian University, Fort Worth, TX, USA, e-mail: w.roche@tcu.edu

ABSTRACT: I argue that *coherence* is *truth-conducive* in that coherence implies an *increase* in the probability of truth. Central to my argument is a certain principle for *transitivity* in *probabilistic support*. I then address a question concerning the truth-conduciveness of coherence as it relates to (something else I argue for) the truth-conduciveness of *consistency*, and consider how the truth-conduciveness of coherence bears on coherentist theories of justification.

1 Introduction

I aim to show that *coherence* is *truth-conducive* in that coherence implies an *increase* in the probability of truth. Central to my argument is a certain principle for transitivity in probabilistic support. In section 2, I clarify my thesis. In section 3, I give my argument. Next, in section 4, I address a question concerning the truth-conduciveness of coherence as it relates to (something else I aim to show) the truth-conduciveness of *consistency*, and consider how the truth-conduciveness of coherence bears on coherentist theories of justification. Last, in section 5, I conclude.

2 The thesis

Several clarifications are in order. I begin with the notion of truth-conduciveness.

2.1 Truth-conduciveness

I aim to establish the truth-conduciveness thesis that coherence implies an *increase* in the probability of truth. This thesis is distinct from the considerably stronger truth-conduciveness thesis that (a) coherence implies a *high* probability of truth,[1] and from the recently much discussed truth-conduciveness thesis that (b) *ceteris paribus greater* coherence implies a *greater* probability of truth.[2] Nothing in what I argue is meant to establish, or render plausible, (a) or (b).

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[1] For relevant discussion, see BonJour (1985, Ch. 8), Davidson (2000), Haack (1993, pp. 26-27), and Olsson (2005a, Part I).

[2] See Angere (2007, 2008), Bovens and Hartmann (2003a, 2003b, 2005, 2006), Bovens and Olsson (2000, 2002), Cross (1999), Huemer (1997, 2007, 2011), Klein and Warfield (1994,

2.2 Coherence

I assume that *consistency* is *necessary* but *insufficient* for coherence. Suppose, to illustrate, $S_1 = \{p, q, r, \neg p\}$ and $S_2 = \{p, q, r\}$, where:

p	=	This chair is brown;
q	=	Electrons are negatively charged;
r	=	Today is Thursday.[3]

S_1 is inconsistent, hence, it seems, not coherent; p, q, r, and $\neg p$ do not "hang together" or "mutually support each other" in the requisite sense. S_2, unlike S_1, is consistent, but, as with the members of S_1, the members of S_2 fail to hang together or mutually support each other in the requisite sense. So S_2 is not coherent.

I do not assume any particular theory of coherence. It is worth noting, though, that at least some of the leading extant *probabilistic* theories of coherence imply that consistency is necessary but insufficient for coherence. Consider, for example, Tomoji Shogenji's (1999) probabilistic theory of coherence. Let $S = \{p_1, \ldots, p_n\}$. Then, on Shogenji's theory the degree to which S is coherent, "C(S)," is given by:

$$C(S) = \frac{\Pr(p_1 \wedge \ldots \wedge p_n)}{\Pr(p_1) \times \ldots \times \Pr(p_n)}.$$ [4]

If $C(S) < 1$, S is incoherent. If $C(S) = 1$, S is neither coherent nor incoherent. If $C(S) > 1$, S is coherent. The minimum value for C(S) is 0. There is no maximum value for C(S). Consider S_1 and S_2 from above. Suppose $1 > \Pr(p) > 0$, $\Pr(q) > 0$, and $\Pr(r) > 0$. Then, since S_1 is inconsistent, hence $\Pr(p \wedge q \wedge r \wedge \neg p) = 0$, and since $[\Pr(p) \times \Pr(q) \times \Pr(r) \times \Pr(\neg p)] > 0$, it follows that:

$$C(S_1) = \frac{\Pr(p \wedge q \wedge r \wedge \neg p)}{\Pr(p) \times \Pr(q) \times \Pr(r) \times \Pr(\neg p)} = 0.$$

S_1 is thus not coherent, in fact, is maximally incoherent. Next, suppose $\Pr(p) > 0$, $\Pr(q) > 0$, $\Pr(r) > 0$, $\Pr(q \mid p) = \Pr(q)$ and $\Pr(r \mid p \wedge q) = \Pr(r)$. Then, it follows that:

1996), Meijs and Douven (2007), Merricks (1995), Olsson (2001, 2002, 2005a, 2005b), Olsson and Shogenji (2004), Roche (2010, 2012b), Schubert and Olsson (2012), Schupbach (2008), Shogenji (1999, 2001b, 2005, 2007, 2013), van Cleve (2005, 2011), and Wheeler (2009, 2012).

[3] This case is adapted from BonJour (1985, pp. 95-96).

[4] Shogenji spells out his theory in terms of sets of *beliefs*, not in terms of sets of *claims*. But for my purposes nothing of importance hinges on this difference.

$$
\begin{aligned}
C(S_2) &= \frac{\Pr(p \wedge q \wedge r)}{\Pr(p) \times \Pr(q) \times \Pr(r)} \\
&= \frac{\Pr(p) \times \Pr(q \mid p) \times \Pr(r \mid p \wedge q)}{\Pr(p) \times \Pr(q) \times \Pr(r)} \\
&= 1.
\end{aligned}
$$

So, though S_2 is consistent, S_2 is not coherent.[5]

The thesis that coherence implies an increase in the probability of truth is meant to be restricted to *doxastic* coherence—the coherence of a set of *beliefs*. Nothing in what I argue is meant to show that *propositional* coherence—the coherence of a set of *propositions*—implies an increase in the probability of truth.[6]

2.3 Probability

By "probability" I have in mind *evidential* probability where $\Pr(h \mid e)$ specifies the degree to which hypothesis h is supported by evidence e. If e entails h, this is the best e can do for h, so $\Pr(h \mid e) = 1$. If e entails $\neg h$, this is the worst e can do for h, thus $\Pr(h \mid e) = 0$. Otherwise $0 < \Pr(h \mid e) < 1$. Suppose, for example, a card is randomly drawn from a standard deck of cards. Let h be the claim "The card drawn is a Red" and e be the claim "The card drawn is a Diamond." Then, since e entails h, $\Pr(h \mid e) = 1$. I assume (as is standard) that if $\Pr(e) = 0$,[7] then $\Pr(h \mid e)$ is undefined. I do not assume any particular theory of evidential probability.[8]

I mean for Pr to be understood so that the background information k codified in Pr includes just the claim that S believes p. k does not include a claim about the *reliability* of S's processes, or about the reliability of the processes of other cognizers. k does not include a claim about the *independence* of S's beliefs (that is, about the extent to which S's beliefs were formed independently of each other), or about the independence of the beliefs of other cognizers. k does

[5] For general discussion of the elements of coherence, see BonJour (1985, Ch. 5). For discussion of *probabilistic* theories of coherence, see Akiba (2000), Bovens and Hartmann (2003a), Douven and Meijs (2007), Fitelson (2003, 2004), Glass (2005), Meijs (2006), Olsson (2002, 2005a), Roche (2013), Schupbach (2011), Shogenji (1999, 2001b), Siebel (2004, 2005, 2011), and Siebel and Wolff (2008). For discussion of *nonprobabilistic* theories of coherence, see Eliasmith and Thagard (1997), Thagard (1989a, 1989b, 1992, 2000, 2004, 2012), Thagard and Nowak (1988), and Thagard and Verbeurgt (1998).

[6] For discussion of *propositional* versus *doxastic* truth-conduciveness, see Bovens and Olsson (2002), Cross (1999), and Olsson (2001, 2002, 2005a, 2005b).

[7] $\Pr(e)$ is the "prior" probability of e—the probability of e given the background information k (perhaps tautological) codified in Pr.

[8] See Carnap (1962), Franklin (2001), Hawthorne (2005), Keynes (1921), Maher (2006), Plantinga (1993), Swinburne (1973), and Williamson (2000).

not include a claim about the *ratio of true to total beliefs* in *S*'s belief system, or about the ratio of true to total beliefs in the belief systems of other cognizers, or about the ratio of true to total beliefs in *coherent* belief systems, or about the ratio of true to total beliefs in *consistent* belief systems. And so on. The issue is whether, given just the background information that *S* believes *p*, the probability of *p* given *S*'s belief system is coherent is greater than the probability of *p*.

I do not mean to suggest that it is of no interest or importance whether coherence implies an increase in the probability of truth when *k* includes, say, a claim about the reliability of *S*'s processes. I am simply concerned with a different issue.[9]

Let "Coh_S" stand for the claim that *S*'s belief system is coherent. The aim is to show that coherence increases the probability of truth in that, when *k* includes just the claim that *S* believes *p*, and thus includes no claims about reliability, independence, etc., $\Pr(p \mid Coh_S) > \Pr(p)$.

2.4 Scope and assumptions

I do *not* aim to show that for *any* claim *p*, $\Pr(p \mid Coh_S) > \Pr(p)$. When *p* is the claim that *S* does not believe *p*, or the claim that $\neg Coh_S$, it follows that $\Pr(p \mid Coh_S) = 0$,[10] in which case $\Pr(p \mid Coh_S) \leq \Pr(p)$. Likewise, when *p* is the claim that *S* has no beliefs, or the claim that *S* has no mental states, or the claim that *S* does not exist, etc., it follows that $\Pr(p \mid Coh_S) = 0$, thus $\Pr(p \mid Coh_S) \leq \Pr(p)$. I assume, then, that *p* is *not* the claim that *S* does not believe *p*, and *not* the claim that $\neg Coh_S$, and *not* the claim that *S* has no beliefs, etc.

Consider the conditions:

(c1) $0 < \Pr(p) < 1$;
(c2) $0 < \Pr(Coh_S)$.

When either (c1) or (c2) fails to hold, it is not the case that $\Pr(p \mid Coh_S) > \Pr(p)$. If (c2) fails to hold, $\Pr(p \mid Coh_S)$ is undefined. If (c2) holds but (c1) does not, $\Pr(p \mid Coh_S) = \Pr(p)$; if $\Pr(p) = 1$, $\Pr(p \mid Coh_S) = 1 = \Pr(p)$, and if $\Pr(p) = 0$, $\Pr(p \mid Coh_S) = 0 = \Pr(p)$. So I assume that (c1) and (c2) hold.

If *p* is the claim that *S* has some beliefs, or the claim that *S* has some mental states, or the claim that *S* exists, etc., then $\Pr(p) = 1$, hence (c1) fails to hold. Thus I assume that *p* is *not* the claim that *S* has some beliefs, and *not* the claim that *S* has some mental states, and so on.

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[9] Cf. Bovens and Olsson (2000), Huemer (1997, 2007), Olsson (2002, 2005a), Olsson and Shogenji (2004), and Shogenji (2005). Cf. Fitelson and Hawthorne (2010, p. 252) on "Nicod's condition" and the "background corpus" presupposed therein. Note that since *k* includes the claim that *S* believes *p*, it follows that $\Pr(S \text{ believes } p) = 1$, hence $\Pr(p \mid S \text{ believes } p) = \Pr(p)$. *S* thus has "no individual credibility" with respect to *p*.

[10] More precisely, it follows that $\Pr(p \mid Coh_S) = 0$ *if* $\Pr(Coh_S) > 0$. If $\Pr(Coh_S) = 0$, then $\Pr(p \mid Coh_S)$ is undefined.

It will help to introduce three additional conditions:

(c3) $0 < \Pr(ABT_S) < 1$;
(c4) $0 < \Pr(Con_S) < 1$;
(c5) $\Pr(Coh_S) < 1$.

"ABT_S" stands for the claim that *all* of *S*'s *beliefs* are *true*. "Con_S" stands for the claim that *S*'s belief system is consistent. I assume (c3)-(c5) all hold.[11]

It seems clear that (c1)-(c5) are mutually consistent. This is verified below in 3.6 where I give a probability distribution on which (c1)-(c5) all hold.

One final word of caution is in order. It is not my view that there is no claim *q* such that $\Pr(p \mid Coh_S \wedge q) \leq \Pr(p)$. Clearly there is such a claim. Let *q* be the claim that $\neg p$. Then, $\Pr(p \mid Coh_S \wedge q) = 0$, therefore $\Pr(p \mid Coh_S \wedge q) \leq \Pr(p)$.[12]

3 The argument

The argument has four main steps and involves several theses labelled "(A)," "(B)," . . . , "(M)." In *Step One*, I argue that if *p* probabilistically supports Coh_S, then Coh_S probabilistically supports *p*:

Step One If $\Pr(Coh_S \mid p) > \Pr(Coh_S)$, then $\Pr(p \mid Coh_S) > \Pr(p)$.

In *Step Two*, I argue that *p* probabilistically supports ABT_S:

[11] The argument given below in section 3 could be run with the claim "All of *S*'s belief-forming processes are perfectly reliable," hereafter "$APPR_S$," in place of "ABT_S." (c3) would then be the condition: $0 < \Pr(APPR_S) < 1$. Note: The notion of perfect reliability should be understood so that even if all of *S*'s beliefs are true, it might be that not all of *S*'s processes are perfectly reliable (because one or more such processes produce some false beliefs in various nonactual possible worlds close to the actual world). But since, in part, it is clearer that $0 < \Pr(ABT_S)$ than it is that $0 < \Pr(APPR_S)$, I assume the condition that $0 < \Pr(ABT_S) < 1$ and not the condition that $0 < \Pr(APPR_S) < 1$. Thanks to an anonymous reviewer for suggesting that the argument be run in terms of truth rather than in terms of reliability.

[12] This point brings to light the fact that probabilistic support is nonmonotonic. It is not true in general, however, that when $\Pr(h \mid e) > \Pr(h)$, there is a claim e^* such that $\Pr(h \mid e \wedge e^*) \leq \Pr(h)$. Suppose *h* is *entailed* by *e*. Suppose $\Pr(h) < 1$. Then, for any claim e^* such that $\Pr(h \mid e \wedge e^*)$ is defined, it follows that $\Pr(h \mid e \wedge e^*) = 1 > \Pr(h)$. Hence, there is no claim e^* such that $\Pr(h \mid e \wedge e^*) \leq \Pr(h)$.

Step Two $\Pr(ABT_S \mid p) > \Pr(ABT_S)$.

Then, in *Step Three*, I argue in part by appeal to *Step Two* that p probabilistically supports Con_S:

Step Three $\Pr(Con_S \mid p) > \Pr(Con_S)$.

Last, in *Step Four*, I argue in part by way of *Step Three* that p probabilistically supports Coh_S:

Step Four $\Pr(Coh_S \mid p) > \Pr(Coh_S)$.

It then follows, given *Step One*, that Coh_S probabilistically supports p:

Conclusion $\Pr(p \mid Coh_S) > \Pr(p)$.

I provide a probability distribution on which (c1)-(c5) and (A)-(M) all hold. This serves to verify that, as it seems, (c1)-(c5) and (A)-(M) are mutually consistent.[13]

3.1 *Step One*

It is a theorem of the probability calculus that probabilistic support is *reciprocal* in that:

(RPS) For any e and h, $\Pr(h \mid e) > \Pr(h)$ if and only if $\Pr(e \mid h) > \Pr(e)$.[14]

(RPS) implies that:

(A) If $\Pr(Coh_S \mid p) > \Pr(Coh_S)$, then $\Pr(p \mid Coh_S) > \Pr(p)$.

The aim now is to establish the antecedent of (A). It will then follow that $\Pr(p \mid Coh_S) >$ $\Pr(p)$.

[13] Thanks to an anonymous reviewer for impressing on me the importance of *showing* that the various main theses in my argument are mutually consistent.

[14] For helpful discussion of the theorem that probabilistic support is reciprocal, and of various additional theorems of the probability calculus, see Swinburne (1973, Ch. III). Also, see Shogenji (2001a), where the theorem that probabilistic support is reciprocal is discussed in relation to the role of coherence in justification.

3.2 *Step Two*

It is clear that:

(B) $\Pr(p \mid ABT_S) > \Pr(p)$.

The first probability is equal to 1, since, given that *k* includes the claim that *S* believes *p*, *p* is *entailed* by ABT_S. The second probability is less than 1; this follows from the assumption that (c1) holds.

(B) and (RPS) together entail that:

(C) $\Pr(ABT_S \mid p) > \Pr(ABT_S)$.

3.3 *Step Three*

Now consider the thesis:

(D) $\Pr(Cons_S \mid ABT_S) > \Pr(Cons_S)$.

The first probability is equal to 1. For, $Cons_S$ is entailed by ABT_S.[15] The second probability is less than 1; this follows from the assumption that (c4) holds. So, (D) holds.

It might seem that (C), which says that *p* probabilistically supports ABT_S, and (D), which says that ABT_S probabilistically supports $Cons_S$, together entail:

(E) $\Pr(Cons_S \mid p) > \Pr(Cons_S)$.

For, it might seem that probabilistic support is *transitive*:

(TPS) For any *x*, *y*, and *z*, if (i) $\Pr(y \mid x) > \Pr(y)$ and (ii) $\Pr(z \mid y) > \Pr(z)$, then $\Pr(z \mid x) > P(z)$.

It turns out, though, that (TPS) is false. Suppose a card is randomly drawn from a standard deck of cards. Let *x* be the claim that "The card drawn is a Heart," *y* be the claim "The card drawn is a Red," and *z* be the claim "The card drawn is a Diamond." Then, $\Pr(y \mid x) = 1 > \Pr(y)$ .5, $\Pr(z \mid y) = .5 > \Pr(z) = .25$, but $\Pr(z \mid x) = 0 < P(z) = .25$.[16]

[15] I am assuming there are no true contradictions. For discussion of the issue of whether there are true contradictions, see Priest, Beall, and Armour-Garb (2007).

[16] See, e.g., Eells and Sober (1983, pp. 43-44), Hanen (1971), Hesse (1970, pp. 50-51, 1974, Ch. 6, sec. II), and Shogenji (2003, p. 613).

Perhaps (TPS) is not needed. Consider:

(TPS*) For any x, y, and z, if (i) $\Pr(y \mid x) > \Pr(y)$, (ii) $\Pr(z \mid y) > \Pr(z)$, and (iii) y entails z, then $\Pr(z \mid x) > P(z)$.

(TPS*) says in effect that probabilistic support is transitive in the special case where y entails z.[17] Suppose (TPS*) is true. Then since by (C) $\Pr(ABT_S \mid p) > \Pr(ABT_S)$, by (D) $\Pr(Cons_S \mid ABT_S) > \Pr(Cons_S)$, and ABT_S entails $Cons_S$, it follows that, as (E) states, $\Pr(Cons_S \mid p) > \Pr(Cons_S)$. But (TPS*), like (TPS), is open to counterexample.[18] Imagine (adapting a case from Mackie 1969, p. 36) a deck of cards differing from a normal deck only in that Hearts has 4 Court cards (but still 13 total cards), and Diamonds has just 1 Court card (but still 13 total cards). Suppose a card is randomly drawn from the deck. Let x be the claim "The card drawn is a Court," y be the claim "The card drawn is Heart," and z be the claim "The card drawn is a Red." It follows that $\Pr(y \mid x) = 4/11 > \Pr(y)$ .25, $\Pr(z \mid y) = 1 > \Pr(z) = .5$, and y entails z. But $\Pr(z \mid x) = 5/11 < P(z) = .5$.[19]

[17] Assume each of x, y, and z has a nonextreme probability. Then (iii) in (TPS*) renders (ii) redundant, so that (TPS*) can be put: For any x, y, and z, if (i) $\Pr(y \mid x) > \Pr(y)$ and (ii) y entails z, then $\Pr(z \mid x) > P(z)$.

[18] (TPS*) is distinct from the principle: For any x, y, and z, if (i) $\Pr(y \mid x) > \mathbf{t}$, (ii) $\Pr(z \mid y) > \mathbf{t}$, and (iii) y entails z, then $\Pr(z \mid x) > \mathbf{t}$. The latter principle is correct. See Salmon (1965) for relevant discussion.

[19] Cases of "transmission-failure" (at least some of them), as discussed by Crispin Wright (1985, 2000a, 2000b, 2002, 2003, 2004, 2007, 2011) and many others (see Beebee 2001; Brown 2003, 2004; Cling 2002; Coliva 2011; Davies 1998, 2000, 2003, 2004; Dretske 2005a, 2005b; Ebert 2005; Hale 2000; Hawthorne 2005; Kotzen 2012, sec. 6; McKinsey 2003; McLaughlin 2003; Neta 2007; Peacocke 2004, Ch. 4, pp. 112-115; Pryor 2004; Sainsbury 2000; Schiffer 2004; Silins 2005, 2007; Smith 2009; Suarez 2000; Tucker 2010a, 2010b; White 2006, sec. 5) provide an important class of counterexamples to (TPS*). Suppose (adapting a case from Dretske 1970, pp. 1015-1016) Smith is visiting the local zoo. Let x be the claim "It appears to me (Smith) visually as if the animal in the pen before me is a zebra," y be the claim "The animal in the pen before me (Smith) is a zebra," and z be the claim "It is not the case that the animal in the pen before me (Smith) is a mule cleverly disguised to look like a zebra." x probabilistically supports y (at least on certain ways of filling in the details), and y probabilistically supports and entails z. But x fails to probabilistically support z. Indeed, given that $\Pr(x) < 1$, $\Pr(\neg z) > 0$, and $\neg z$ entails x (again at least on certain ways of filling in the details), it follows that x probabilistically supports $\neg z$. This sort of point is made in Chandler (2010, p. 337), Cohen (2005, pp. 424-425), Hawthorne (2004, pp. 73-75), Okasha (1999, sec. 9), Silins (2005, p. 85, 2007, pp. 123-125), and White (2006, sec. 5). For discussion of how to formalize the issue of transmission failure, see Chandler (2010), Moretti (2012) Moretti and Piazza (2011), and Okasha (2004). Cf. Pynn (2011).

Tomoji Shogenji (2003), though, establishes a condition for transitivity in probabilistic support. The condition is:

(SOC) $\Pr(z \mid x \wedge y) = \Pr(z \mid y)$ and $\Pr(z \mid x \wedge \neg y) = \Pr(z \mid \neg y)$.

(SOC) is a "screening-off" condition to the effect that y screens-off x from z. Shogenji thus establishes the principle:

(TPS**) For any x, y, and z, if (i) $\Pr(y \mid x) > \Pr(y)$, (ii) $\Pr(z \mid y) > \Pr(z)$, and (iii) (SOC) holds, then $\Pr(z \mid x) > P(z)$.

Consider the first card case from above. (i) and (ii) in (TPS**) are satisfied. But (iii) is not, since $\Pr(z \mid x \wedge y) = 0 < \Pr(z \mid y) = .5$, and $\Pr(z \mid x \wedge \neg y)$ is undefined.

I show elsewhere (2012a) that there is a *weaker* condition (weaker than (SOC)) for transitivity in probabilistic support. The condition is:

(SOC*) $\Pr(z \mid x \wedge y) \geq \Pr(z \mid y)$ and $\Pr(z \mid x \wedge \neg y) \geq \Pr(z \mid \neg y)$.

(SOC*) is weaker than (SOC) in that if $\Pr(z \mid x \wedge y) = \Pr(z \mid y)$ and $\Pr(z \mid x \wedge \neg y) = \Pr(z \mid \neg y)$, it follows that $\Pr(z \mid x \wedge y) \geq \Pr(z \mid y)$ and $\Pr(z \mid x \wedge \neg y) \geq \Pr(z \mid \neg y)$, but not *vice versa*. I thus show:

(TPS***) For any x, y, and z, if (i) $\Pr(y \mid x) > \Pr(y)$, (ii) $\Pr(z \mid y) > \Pr(z)$, and (iii) (SOC*) holds, then $\Pr(z \mid x) > P(z)$.[20]

(TPS***) makes it easier than does (TPS**) to establish claims of probabilistic support (as in many cases it is easier to see that (SOC*) holds than it is to see that (SOC) holds). So below I appeal to (TPS***) and not to (TPS**).

Let's return to (C), (D), and (E) (which I repeat for the reader's convenience):

(C) $\Pr(ABT_S \mid p) > \Pr(ABT_S)$;

[20] Mary Hesse (1970, pp. 54-55, 1974, Ch. 6, sec. III) establishes a principle similar to (TPS***). It can be put as follows: If (i) $\Pr(y \mid x) > \alpha$, (ii) $\Pr(z \mid y) > \beta$, and (iii) $\Pr(z \mid x \wedge y) \geq \Pr(z \mid y)$, then $\Pr(z \mid x) > \alpha\beta$. The antecedent of this principle, like the antecedent of (TPS***), does not require that $\Pr(z \mid x \wedge y) = \Pr(z \mid y)$ and does not require that $\Pr(z \mid x \wedge \neg y) = \Pr(z \mid \neg y)$. But it is not the case that when the antecedent of Hesse's principle is satisfied, and when $\alpha = \Pr(y)$ and $\beta = \Pr(z)$, it follows that $\Pr(z \mid x) > \Pr(z)$. See Roche (2012a, p. 114, n. 8). For discussion of, *inter alia*, transitivity in "**t**-evidence," where e is **t**-evidence for h iff (a) $\Pr(h \mid e) > \Pr(h)$ and (b) $\Pr(h \mid e) > \mathbf{t}$, where **t** is some specified value less than 1 and greater than or equal to .5, see Douven (2011) and Roche (2012c).

(D) $\Pr(Con_S \mid ABT_S) > \Pr(Con_S)$;
(E) $\Pr(Con_S \mid p) > \Pr(Con_S)$.

By (TPS***) it follows that (E) holds *if* (C), (D), and the following two theses all hold:

(F) $\Pr(Con_S \mid p \wedge ABT_S) \geq \Pr(Con_S \mid ABT_S)$;
(G) $\Pr(Con_S \mid p \wedge \neg ABT_S) \geq \Pr(Con_S \mid \neg ABT_S)$.

(F) holds, since each of the two probabilities equals 1. (G), it seems, holds. If anything, the first probability is greater than the second. Hence, since (C), (D), (F), and (G) all hold, it follows, by (TPS***), that (E) holds.

Note that it follows from (E) and (RPS) that:

(H) $\Pr(p \mid Con_S) > \Pr(p)$.

Consistency, thus, is truth-conducive in that, when Pr is understood so that the background information k codified in Pr includes just the claim that S believes p, and (c1)-(c5) all hold, Con_S increases the probability of p.

3.4 *Step Four*

Consider the thesis:

(I) $\Pr(Coh_S \mid Con_S) > \Pr(Coh_S)$.

It is a theorem of the probability calculus that, for any e and h, if h entails e, and $\Pr(h)$ and $\Pr(e)$ are non-extreme, then $\Pr(h \mid e) > \Pr(h)$. So, since Coh_S entails Con_S, and since, given the assumption that (c2), (c4), and (c5) all hold, $\Pr(Coh_S)$ and $\Pr(Con_S)$ are non-extreme, it follows that (I) holds.

It can now be shown that:

(J) $\Pr(Coh_S \mid p) > \Pr(Coh_S)$.

By (TPS***) it follows that (J) holds provided (E), (I), and the two theses below all hold:

(K) $\Pr(Coh_S \mid p \wedge Con_S) \geq \Pr(Coh_S \mid Con_S)$;
(L) $\Pr(Coh_S \mid p \wedge \neg Con_S) \geq \Pr(Coh_S \mid \neg Con_S)$.

(K), it seems, holds. If anything, the first probability is greater than the second. (L) holds, for each of the two probabilities is equal to 0. So, given that (E), (I), (K), and (L) all hold, it follows, by (TPS***), that (J) holds.

3.5 *Conclusion*

Recall the result of *Step One*:

(A) If $\Pr(Coh_S \mid p) > \Pr(Coh_S)$, then $\Pr(p \mid Coh_S) > \Pr(p)$.

It follows from (A) and (J) that:

(M) $\Pr(p \mid Coh_S) > \Pr(p)$.

This is the main conclusion.

Note that (M) implies that $\Pr(p \mid \neg Coh_S) < \Pr(p)$, which in turn implies that $\Pr(\neg p \mid \neg Coh_S) > \Pr(\neg p)$. Thus whereas coherence is truth-conducive in that coherence implies an increase in the probability of truth, *incoherence* (or, more precisely, a lack of coherence) is *falsity*-conducive in that incoherence implies (a decrease in the probability of truth and thus) an *increase* in the probability of *falsity*.

It remains to be shown that (c1)-(c5) and (A)-(M) are mutually consistent. I take up this task in the next subsection.

3.6 The mutual consistency of (c1)-(c5) and (A)-(M)

Suppose the following probability distribution:

p	$Cons_S$	Coh_S	ABT_S	Pr	p	$Cons_S$	Coh_S	ABT_S	Pr
T	T	T	T	.01	F	T	T	T	0
T	T	T	F	.04	F	T	T	F	.05
T	T	F	T	.02	F	T	F	T	0
T	T	F	F	.06	F	T	F	F	.08
T	F	T	T	0	F	F	T	T	0
T	F	T	F	0	F	F	T	F	0
T	F	F	T	0	F	F	F	T	0
T	F	F	F	.15	F	F	F	F	.59

Then, (c1)-(c5) and (A)-(M) all hold:

(i) $\Pr(p) = .28$, so (c1) holds;
(ii) $\Pr(Coh_S) = .1$, so (c2) holds;
(iii) $\Pr(ABT_S) = .03$, so (c3) holds;
(iv) $\Pr(Con_S) = .26$, so (c4) holds;
(v) $\Pr(Coh_S) = .1$, so (c5) holds;
(vi) $\Pr(Coh_S \mid p) \approx .179 > \Pr(Coh_S) = .1$, and $\Pr(p \mid Coh_S) = .5 > \Pr(p) = .28$, so (A) holds;
(vii) $\Pr(p \mid ABT_S) = 1 > \Pr(p) = .28$, so (B) holds;
(viii) $\Pr(ABT_S \mid p) \approx .107 > \Pr(ABT_S) = .03$, so (C) holds;
(ix) $\Pr(Con_S \mid ABT_S) = 1 > \Pr(Con_S) = .26$, so (D) holds;
(x) $\Pr(Con_S \mid p) \approx .464 > \Pr(Con_S) = .26$, so (E) holds;
(xi) $\Pr(Con_S \mid p \wedge ABT_S) = 1 = \Pr(Con_S \mid ABT_S)$, so (F) holds;
(xii) $\Pr(Con_S \mid p \wedge \neg ABT_S) = .4 > \Pr(Con_S \mid \neg ABT_S) \approx .237$, so (G) holds;
(xiii) $\Pr(p \mid Con_S) = .5 > \Pr(p) = .28$, so (H) holds;
(xiv) $\Pr(Coh_S \mid Con_S) \approx .385 > \Pr(Coh_S) = .1$, so (I) holds;
(xv) $\Pr(Coh_S \mid p) \approx .179 > \Pr(Coh_S) = .1$, so (J) holds;
(xvi) $\Pr(Coh_S \mid p \wedge Con_S) = \Pr(Coh_S \mid Con_S) \approx .385$, so (K) holds;
(xvii) $\Pr(Coh_S \mid p \wedge \neg Con_S) = 0 = \Pr(Coh_S \mid \neg Con_S)$, so (L) holds;
(xviii) $\Pr(p \mid Coh_S) = .5 > \Pr(p) = .28$, so (M) holds.

(c1)-(c5) and (A)-(M) are thus mutually consistent.

The argument is now complete. The result is that coherence is truth-conducive in that, when Pr is understood so that the background information *k* codified in Pr includes just the claim that *S* believes *p*, and (c1)-(c5) all hold, it follows that $\Pr(p \mid Coh_S) > \Pr(p)$.

4 Discussion

4.1 Coherence versus consistency

Recall the point that *consistency* is truth-conducive in that:

(H) $\Pr(p \mid Con_S) > \Pr(p)$.[21]

It might be wondered, given the details of the above argument for (M), and given that on the probability distribution given above in 3.6 $\Pr(p \mid Coh_S) = .5 = \Pr(p \mid Con_S)$, whether the truth-

[21] (H) implies that $\Pr(p \mid \neg Con_S) < \Pr(p)$, which in turn implies that $\Pr(\neg p \mid \neg Con_S) > \Pr(\neg p)$. So inconsistency, as with incoherence, is *falsity*-conducive in that inconsistency implies (a decrease in the probability of truth and thus) an *increase* in the probability of *falsity*.

conduciveness of coherence is really just a matter of the truth-conduciveness of consistency in that *all* probability distributions on which (c1)-(c5) and (A)-(M) all hold are distributions on which $\Pr(p \mid Coh_S) = \Pr(p \mid Cons_S)$.[22]

Consider the following probability distribution (which differs slightly from the one given above in 3.6):

p	$Cons_S$	Coh_S	ABT_S	Pr	p	$Cons_S$	Coh_S	ABT_S	Pr
T	T	T	T	.01	F	T	T	T	0
T	T	T	F	.03	F	T	T	F	.04
T	T	F	T	.02	F	T	F	T	0
T	T	F	F	.05	F	T	F	F	.08
T	F	T	T	0	F	F	T	T	0
T	F	T	F	0	F	F	T	F	0
T	F	F	T	0	F	F	F	T	0
T	F	F	F	.15	F	F	F	F	.62

It can be verified that on this distribution (c1)-(c5) and (A)-(M) all hold. Moreover, it can be verified that $\Pr(p \mid Coh_S) = .5 > \Pr(p \mid Cons_S) \approx .478$. Thus it is *not* the case that *all* probability distributions on which (c1)-(c5) and (A)-(M) all hold are distributions on which $\Pr(p \mid Coh_S) = \Pr(p \mid Cons_S)$—some such distributions are distributions on which $\Pr(p \mid Coh_S) > \Pr(p \mid Cons_S)$. This suffices to answer the above worry.

A futher point is worth making: *No* probability distributions on which (c1)-(c5) and (A)-(M) all hold are distributions on which $\Pr(p \mid Coh_S) < \Pr(p \mid Cons_S)$. By Bayes's Theorem:

$$\Pr(p \mid Coh_S) = \frac{\Pr(p)\Pr(Coh_S \mid p)}{\Pr(Coh_S)};$$

$$\Pr(p \mid Cons_S) = \frac{\Pr(p)\Pr(Cons_S \mid p)}{\Pr(Cons_S)}.$$

It follows that:

$$\Pr(p \mid Coh_S) > / = / < \Pr(p \mid Cons_S) \text{ iff } \frac{\Pr(Coh_S \mid p)}{\Pr(Coh_S)} > / = / < \frac{\Pr(Cons_S \mid p)}{\Pr(Cons_S)}.$$

[22] Thanks to an anonymous reviewer for raising in effect this issue.

Observe that:

$$\frac{\Pr(Coh_S \mid p)}{\Pr(Coh_S)} = \frac{\Pr(Coh_S \wedge Con_S \mid p) + \Pr(Coh_S \wedge \neg Con_S \mid p)}{\Pr(Coh_S \wedge Con_S) + \Pr(Coh_S \wedge \neg Con_S)} = \frac{\Pr(Coh_S \wedge Con_S \mid p)}{\Pr(Coh_S \wedge Con_S)};$$

$$\frac{\Pr(Con_S \mid p)}{\Pr(Con_S)} = \frac{\Pr(Con_S \wedge Coh_S \mid p) + \Pr(Con_S \wedge \neg Coh_S \mid p)}{\Pr(Con_S \wedge Coh_S) + \Pr(Con_S \wedge \neg Coh_S)}.$$

Next, verify that:

$$\begin{aligned}\frac{\Pr(Coh_S \mid p)}{\Pr(Coh_S)} - \frac{\Pr(Con_S \mid p)}{\Pr(Con_S)} &= \frac{\Pr(Coh_S \wedge Con_S \mid p)\left[\Pr(Con_S \wedge Coh_S) + \Pr(Con_S \wedge \neg Coh_S)\right] - \Pr(Coh_S \wedge Con_S)\left[\Pr(Con_S \wedge Coh_S \mid p) + \Pr(Con_S \wedge \neg Coh_S \mid p)\right]}{\Pr(Coh_S \wedge Con_S)\left[\Pr(Con_S \wedge Coh_S) + \Pr(Con_S \wedge \neg Coh_S)\right]} \\ &= \frac{\Pr(Coh_S \wedge Con_S \mid p)\Pr(Con_S \wedge Coh_S) + \Pr(Coh_S \wedge Con_S \mid p)\Pr(Con_S \wedge \neg Coh_S) - \Pr(Coh_S \wedge Con_S)\Pr(Con_S \wedge Coh_S \mid p) - \Pr(Coh_S \wedge Con_S)\Pr(Con_S \wedge \neg Coh_S \mid p)}{\Pr(Coh_S \wedge Con_S)\left[\Pr(Con_S \wedge Coh_S) + \Pr(Con_S \wedge \neg Coh_S)\right]} \\ &= \frac{\Pr(Coh_S \wedge Con_S \mid p)\Pr(Con_S \wedge \neg Coh_S) - \Pr(Coh_S \wedge Con_S)\Pr(Con_S \wedge \neg Coh_S \mid p)}{\Pr(Coh_S \wedge Con_S)\left[\Pr(Con_S \wedge Coh_S) + \Pr(Con_S \wedge \neg Coh_S)\right]} \\ &= \frac{\Pr(Con_S \mid p)\Pr(Coh_S \mid p \wedge Con_S)\Pr(Con_S)\Pr(\neg Coh_S \mid Con_S) - \Pr(Con_S)\Pr(Coh_S \mid Con_S)\Pr(Con_S \mid p)\Pr(\neg Coh_S \mid p \wedge Con_S)}{\Pr(Coh_S \wedge Con_S)\left[\Pr(Con_S \wedge Coh_S) + \Pr(Con_S \wedge \neg Coh_S)\right]}.\end{aligned}$$

Suppose (c1)-(c5) and (A)-(M) all hold, hence (K) holds. Then it follows that

$$\Pr(Coh_S \mid p \wedge Con_S) \geq \Pr(Coh_S \mid Con_S),$$

and so

$$\Pr(\neg Coh_S \mid Con_S) \geq \Pr(\neg Coh_S \mid p \wedge Con_S).$$

Hence:

$$\frac{\Pr(Con_S \mid p)\Pr(Coh_S \mid p \wedge Con_S)\Pr(Con_S)\Pr(\neg Coh_S \mid Con_S) - \Pr(Con_S)\Pr(Coh_S \mid Con_S)\Pr(Con_S \mid p)\Pr(\neg Coh_S \mid p \wedge Con_S)}{\Pr(Coh_S \wedge Con_S)\left[\Pr(Con_S \wedge Coh_S) + \Pr(Con_S \wedge \neg Coh_S)\right]} \geq 0.$$

Thus when (c1)-(c5) and (A)-(M) all hold, it follows that:

$$\frac{\Pr(Coh_S \mid p)}{\Pr(Coh_S)} - \frac{\Pr(Con_S \mid p)}{\Pr(Con_S)} \geq 0.$$

Therefore $\Pr(p \mid Coh_S) \geq \Pr(p \mid Con_S)$.[23]

I turn now to the question of how the truth-conduciveness of coherence bears on coherentist theories of justification.

4.2 Coherentist theories of justification

Coherentist theories of justification are distinct from foundationalist, social contextualist, and infinitist theories in that, *inter alia*, coherentist theories require (for justification) a "circular" chain of implication (or evidential support):

> *Circular Chain of Implication* (CCI): *S*'s belief in *p* is justified only if (i) *S*'s belief in *p* is implied (deductively or inductively) by certain of her other beliefs, which themselves are implied by certain of her other beliefs, and so on, and (ii) this chain of evidential support circles back around at some point and does not continue on *ad infinitum* with new belief after new belief.

(CCI) should be understood so that (ii) does not require that the chain of implication in question literally take the shape of a circle, where, say, *S*'s belief in *p* is implied by her belief in *q*, which is implied by her belief in *r*, which is implied by her belief in *p*. It would be enough if, say, (a) *S*'s belief in *p* were implied by her belief in *q* together with her belief in *r*, (b) *S*'s belief in *q* were implied by her belief in *p* together with her belief in *r*, and (c) *S*'s belief in *r* were implied by her belief in *p* together with her belief in *q*.[24]

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[23] Note that on the first distribution given above (the one given in 3.6), where $\Pr(p \mid Coh_S) = \Pr(p \mid Con_S)$, $\Pr(Coh_S \mid p \wedge Con_S) = \Pr(Coh_S \mid Con_S) \approx .385$ and $\Pr(\neg Coh_S \mid Con_S) = \Pr(\neg Coh_S \mid p \wedge Con_S) \approx .615$, whereas on the second distribution given above (the one given in this subsection), where $\Pr(p \mid Coh_S) > \Pr(p \mid Con_S)$, $\Pr(Coh_S \mid p \wedge Con_S) \approx .364 > \Pr(Coh_S \mid Con_S) \approx .348$ and $\Pr(\neg Coh_S \mid Con_S) \approx .652 > \Pr(\neg Coh_S \mid p \wedge Con_S) \approx .636$.

[24] For discussion of the "regress problem" and foundationalist, social contextualist, infinitist, and coherentist theories, and for references, see Cling (2008). It might be best to allow for coherentist

Here is a fairly simple coherentist theory:

(CT) *S*'s belief in *p* is justified if and only if (i) (CCI) holds and (iii) Coh_S.

A circular chain of *implication* should not be confused with a circular chain of *justification*. Coherentists (of the sort I have in mind) deny that justification is transferred between beliefs. Coherentists hold that justification is *holistic*: Beliefs are justified *together* when the requisite conditions are satisfied.[25]

(M), of course, is not the thesis:

(N) $\Pr(p \mid \text{(CCI) holds} \wedge Coh_S) > \Pr(p)$.

And it is not true in general that if $\Pr(h \mid e) > \Pr(h)$, then $\Pr(h \mid e^* \wedge e) > \Pr(h)$. It is plausible, though, that (N), like (M), holds. Recall:

(J) $\Pr(Coh_S \mid p) > \Pr(Coh_S)$.

Clearly:

(O) $\Pr(\text{(CCI) holds} \wedge Coh_S \mid Coh_S) > \Pr(\text{(CCI) holds} \wedge Coh_S)$.

Now consider:

(P) $\Pr(\text{(CCI) holds} \wedge Coh_S \mid p \wedge Coh_S) \geq \Pr(\text{(CCI) holds} \wedge Coh_S \mid Coh_S)$;

theories on which some justification is noninferential, and thus on which it is *not* required for justification that (CCI) be satisfied. See Lycan (2012) and Poston (2012).

[25] For further discussion of this and related issues, see Roche (2012d). For discussion of forms of coherentism on which coherence is a matter not just of the subject's *beliefs* (or the propositional contents of the subject's beliefs), but also of her *experiences* (e.g., perceptual experiences), see Cohen (2002), Horgan and Potrc (2010), Kvanvig (1995), Kvanvig and Riggs (1992), and Roche (2012d). It might be that coherentists should hold that what matters for justification is the coherence not of the subject's belief system *as a whole* (or "belief-and-experience" system as a whole), but of a certain *proper subset* (or "module") of that system. This issue is discussed in Kvanvig (2012), Lycan (1996, 2012), and Olsson (1997). For defense of a form of coherentism requiring (for justification) more than just coherence, see BonJour (1985).

(Q) $\Pr((\text{CCI}) \text{ holds} \wedge Coh_S \mid p \wedge \neg Coh_S) \geq \Pr((\text{CCI}) \text{ holds} \wedge Coh_S \mid \neg Coh_S)$.

(P) holds, it seems, and so too does (Q) since each probability in (Q) equals 0. By (TPS***), (J), (O), (P), and (Q) it follows that:

(R) $\Pr((\text{CCI}) \text{ holds} \wedge Coh_S \mid p) > \Pr((\text{CCI}) \text{ holds} \wedge Coh_S)$.

By (RPS) it then follows that (N).

Should coherentists take comfort in (M) and (N)? Perhaps *some* comfort. Consider (M) in particular. There is a clear sense in which it is a *good* thing epistemically for *S* to have a *coherent* belief system: $\Pr(p \mid Coh_S) > \Pr(p)$. And there is a clear sense in which it is a *bad* thing epistemically for *S* to have a *non-coherent* (i.e., incoherent or neither coherent nor incoherent) belief system: $\Pr(p \mid \neg Coh_S) < \Pr(p)$.

But, it seems to me, for three reasons, coherentists should *not* take *much* comfort in (M) and (N). First, what I said in the prior paragraph about coherence can be said *mutatis mutandis* about many properties. Take *consistency* for instance. There is a clear sense in which it is a *good* thing epistemically for *S* to have a *consistent* belief system, namely, $\Pr(p \mid Con_S) > \Pr(p)$. And there is a clear sense in which it is a *bad* thing epistemically for *S* to have an *inconsistent* belief system, viz., $\Pr(p \mid \neg Con_S) < \Pr(p)$. So coherentists cannot claim, say, that because it is a good thing in the specified sense to have a *coherent* belief system it follows that *coherence* is *sufficient* for justification. For, if they claimed that, then they would need to concede that because it is a good thing in the specified sense to have a *consistent* belief system it follows that *consistency* is *sufficient* for justification, and thus would need to give up the claim that *coherence* is *necessary* for justification.[26] Second, it might well be that *k* (the background information codified in Pr)

[26] An anonymous reviewer asked about the property of "prime-consistency," where *S*'s belief system is prime-consistent, "Con'_S," just in case (a) *S*'s belief system's cardinality is prime and (b) *S*'s belief system is consistent. Is prime-consistency truth-conducive? It seems so. Clearly, $\Pr(Con'_S \mid Coh_S) > \Pr(Con'_S)$. Given this, and given that (J) holds, it follows by (TPS***) that $\Pr(Con'_S \mid p) > \Pr(Con'_S)$ if (a) $\Pr(Con'_S \mid p \wedge Coh_S) \geq \Pr(Con'_S \mid Coh_S)$ and (b) $\Pr(Con'_S \mid p \wedge \neg Coh_S) \geq \Pr(Con'_S \mid \neg Coh_S)$. Each of (a) and (b), it seems, holds. So, $\Pr(Con'_S \mid p) > \Pr(Con'_S)$. Therefore, by (RPS), $\Pr(p \mid Con'_S) > \Pr(p)$. So, supposing the argument just given is sound, there is a clear sense in which it is a *good* thing epistemically for *S* to have a *prime-consistent* belief system, namely, $\Pr(p \mid Con'_S) > \Pr(p)$, and there is a clear sense in which it is a *bad* thing epistemically for *S* to have a *non-prime-consistent* belief system, viz., $\Pr(p \mid \neg Con'_S) < \Pr(p)$. Thus coherentists cannot claim, say, that since it is a good thing in the specified sense to have a *coherent* belief system it follows that *coherence* is *necessary* for justification. If they claimed that, then they would need to concede that since it is a good thing in the specified sense to have a *prime-consistent* belief system it follows that *prime-consistency* is *necessary* for justification,

should include *more than* just the claim that *S* believes *p when testing a theory of justification in terms of truth-conduciveness*, or at least when testing a *coherentist* theory in terms of truth-conduciveness. Third, it does not follow from (M) that $\Pr(p \mid Coh_S)$ is *high* or even *greater than .5*, and it does not follow from (N) that $\Pr(p \mid (\text{CCI}) \text{ holds} \wedge Coh_S)$ is high or even greater than .5. It might well be, though, that coherentist theories are adequate in terms of truth-conduciveness only if $\Pr(p \mid Coh_S)$ is high or at least greater than .5, or that (CT) in particular is adequate in terms of truth-conduciveness only if $\Pr(p \mid (\text{CCI}) \text{ holds} \wedge Coh_S)$ is high or at least greater than .5. The issues here—regarding how to properly test a theory of justification with respect to truth-conduciveness—are many and difficult.[27]

5 Conclusion

Coherence is truth-conducive in that coherence implies an increase in the probability of truth. More precisely: When the background information *k* codified in Pr includes just the claim that *S* believes *p*, and (c1)-(c5) all hold, it follows that (A)-(M) all hold, hence $\Pr(p \mid Coh_S) > \Pr(p)$. It does not follow, however, that coherentist theories of justification are correct, or even that coherentist theories are adequate in terms of truth-conduciveness. But it remains the case—though this should not be of much comfort to coherentists—that *S*'s having a coherent belief system is a good thing epistemically in that $\Pr(p \mid Coh_S) > \Pr(p)$, and that *S*'s having a non-coherent belief system is a bad thing epistemically in that $\Pr(p \mid \neg Coh_S) < \Pr(p)$.

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and therefore would need to give up the claim that *coherence* is *sufficient* for justification (and likewise with respect to (CCI) and coherence).

[27] See, e.g., Cohen (1984), Conee (2004), Fumerton (2011), Kvanvig (2007), and Lehrer and Cohen (1983).

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