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The Dual Detector Argument against the Modal Theory

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The modal theory holds that facts (properties) are identical iff they are necessarily equivalent (coextensive). One of the most prominent arguments against the modal theory is Elliot Sober's dual-detector argument. According to this argument, the fact that some particular thing is a triangle is distinct from the necessarily equivalent fact that it is a trilateral, since it is only the former fact that causes an output of a certain machine. I argue that the dual-detector argument fails, in part because whatever initial plausibility it has relies on the failure to take into consideration a needed relativisation to times and the failure to distinguish between two facts collectively causing a fact and their conjunction singly causing it. I also argue that variants of the argument are equally unsuccessful.

One of the most popular and well known accounts of the identity-conditions of facts and properties is the modal theory.[1] According to this theory: i) two facts are identical iff they are necessarily equivalent to each other; and ii) two properties are identical iff they are necessarily coextensive to each other. That is, the modal theory holds that: i) the fact that ϕ = the fact that ψ iff, necessarily, (ϕ iff ψ); and ii) the property of being F = the property of being G iff, necessarily, for any x, (x is F iff x is G).[2] This theory is prima facie attractive, since it is simple to formulate and provides an account of the

1 A fact, as I will understand it here, is an obtaining state of affairs, where: i) a state of affairs is either a way things are or a way things aren't, and ii) a state of affairs obtains iff it is a way things are. A fact on this understanding is therefore just as way things are. Proponents of the modal theory include Stalnaker (1984), Lewis (1986a) and Jackso (1998).

2 For simplicity, I will assume necessitism, according to which, necessarily, for any x, necessarily, for some y, $x = y$. (Without this assumption, "necessarily, for any x" needs to be replaced with "necessarily, for any x, necessarily" in the above characterisation of the modal theory.) I will also assume an abundant theory of facts and properties according to which (except for restrictions needed to avoid paradox), all true sentences express facts, and all predicates that can be used to form true or false sentences express properties.

identity-conditions of facts and properties in terms of (at least relatively) well understood notions. Everything else being equal, the theory is also more parsimonious than rival theories that reject it, since, everything else being equal, there are less facts if the modal theory holds than if it fails to hold and there are distinct facts that are necessarily equivalent to each other.

A prominent argument against the modal theory is the dual-detector argument originally due to Elliot Sober.[3] Briefly, according to this argument, there could be a machine that, as a result of containing detectors measuring different aspects of an input, is causally sensitive to one fact without being causally sensitive to another necessarily equivalent fact. Since, by Leibniz's law, it follows from this that, contra the modal theory, there are distinct facts that are necessarily equivalent to each other, the argument concludes that the modal theory is false. Despite this argument's prominence, discussions of the argument by both its proponents and opponents have been brief and cursory. This paper will provide a more sustained evaluation of the dual-detector argument and will argue that such an evaluation shows that the argument is unsuccessful.[4]

I will proceed as follows. In section 1, I will formulate the dual-detector argument before then arguing in section 2 that it is unsuccessful. In section 3, I will then consider two variants of the argument and I will argue that these variants, and more generally that all variants, are also unsuccessful.

Before proceeding to section 1, it will be useful to briefly discuss another common argument against the modal theory—the constituency argument—in order to set it aside.[5] Suppose (1) and (2) are true, where "*W*" refers to some particular wire.

1. *W* is a closed straight-sided figure that has three *angles*.

2. *W* is a closed straight-sided figure that has three *sides*.

3 (See Sober 1982). A similar argument is also given by (Enç 1982). A recent proponent of the dual-detector argument, for example, is (Audi 2016). Other philosophers who are sympathetic to the argument include (Miller 1995, 859) and (Molnar 2003, 66). Opponents of the argument include (Jackson 1998, 125–126) and (Armstrong 1997, 145–146).

4 Two other arguments against the modal theory that appeal to causation have been given by (Achinstein 1974) and (Perry 1989). (Sober 1982, 84–85) gives what I take to be a convincing response to Achinstein's argument. For a response to Perry's argument, (see Marshall 2021).

5 (See, for example, Audi 2016).

According to the constituency argument, since the fact expressed by (1) has angularity as a constituent while the fact expressed by (2) doesn't have this property as a constituent, the facts expressed by (1) and (2) are not identical to each other. Since the modal theory entails that the facts expressed by (1) and (2) are identical to each other (since they are necessarily equivalent to each other), the constituency argument concludes from this that the modal theory is false.

The constituency argument arguably begs the question against the modal theory by in effect assuming the rival structured theory of facts. According to this rival theory, facts are structured in the same kind of way that sentences are structured. In particular, according to the structured theory, facts are built up out of objects, properties, relations, operators and quantifiers in the same way that sentences are built up out of names, predicates, operator expressions and quantifier expressions.[6] If the structured theory holds so that the facts expressed by (1) and (2) are built up out of objects, properties, relations, operators and quantifiers in the same kind of way that sentences are built up out of names, predicates and other expressions, then it is plausible that the fact expressed by (1) has angularity as a constituent while the fact expressed by (2) doesn't have this constituent. This is much less plausible, however, if the structured theory is false and facts aren't structured like sentences. For example, if facts are instead structured like visual experiences or pictures, then, since it is prima facie plausible to associate (1) and (2) with the same (type) of visual experience or picture, it is prima facie plausible that (1) and (2) express the same fact and hence prima facie plausible that the facts expressed by (1) and (2) don't differ in what constituents they have. (This is because it is at least prima facie plausible that any picture that represents W as being a closed straight-sided figure that has three *angles* also represents W as being a closed straight-sided figure that has three *sides*, and vice versa.) Since the argument from constituency provides no reason to think that facts are structured in the way that the structured theory holds that they are structured, rather than some other way, the argument therefore fails to provide a good reason to think

6 The structured theory can be formulated more precisely as a thesis endorsing schemas such as (PS) and (OS) (see, for example, Dorr 2016, 58–59).

(PC) For any x and y, if the fact that x is F = the fact that y is G, then: i) $x = y$, and ii) the property of being F = the property of being G.

(OS) If the fact that $\pi_1(\phi_1)$ = the fact that$\pi_2(\phi_2)$, then: i) the operator of π_1 = the operator of π_2, and ii) the state of affairs of it being that ϕ_1 = the state of affairs of it being that ϕ_2.

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that (1) and (2) express distinct facts and hence fails to provide a good reason to reject the modal theory.

It is important to appreciate that the structured theory is neither self-evident nor prima facie highly plausible, and hence it cannot simply be assumed to hold in the above argument from constituency without begging the question against the modal theory. Three brief reasons for this are the following: First, prior to investigation and argument, the claim that facts are structured like sentences is no more plausible than the claim that facts have some other type of structure, such as that of visual experiences or pictures. Second, while (1) and (2) arguably differ in their cognitive significance, since a linguistically competent person arguably might endorse one of them while rejecting the other, such a difference in cognitive significance is widely thought to be able to be explained by a difference in what mode of presentation the facts expressed by (1) and (2) have when expressed by these sentences, where this explanation does not require that the facts expressed by these sentences are non-identical.[7] Third, the structured theory conflicts with claims that are widely thought to be at least as prima facie plausible as the structured theory itself, such as the claim made by (3).

3. "*W* is self-identical" expresses the same fact as "*W* is identical to *W*."

(3) conflicts with the structured theory, since, if the structured theory is true, the fact expressed by "*W* is self-identical" has the property of being self-identical as a constituent while the fact expressed by "*W* is identical to *W*" lacks this constituent and instead has the property of being identical to *W* as a constituent.[8] Due to the above difficulty with the constituency argument, and since we cannot simply assume the structured theory in arguing against the modal theory, I will assume in the following that the constituency argument against the modal theory fails.

7 McKay and Nelson (2010).

8 A further possible consideration against the structured theory is that, unlike the modal theory, it gives rise to the Myhill-Russell paradox. Goodman (2017). For attempted solutions to the Myhill-Russell paradox that are compatible with the structured theory, see, for example, (Walsh 2016), (Kment 2022) and (Yu 2017). (See Dorr 2016) and (Bjerring and Schwarz 2017) for futher arguments against the structured theory.

1 The Dual-Detector Argument

The dual-detector argument is not meant to rely on the cogency of the constituency argument discussed above, nor is it meant to rely on the truth of the structured theory of facts. Instead, the dual-detector argument is meant to provide a separate reason for rejecting the modal theory. The argument involves a machine *M* that contains two detectors: a closed straight-sided figure detector and a three-angle detector. These detectors are linked in a series in *M*, so that, if a wire (or several wires) are inputted into *M*, they are first inputted into the closed straight-sided figure detector and then, if they are outputted by this first detector, they are inputted into the three-angle detector. If the wire (or wires) are then outputted by the three-angle detector, they are then outputted by *M*. Indeed, I will assume in the following that what it is for something (or some things) to be outputted by *M* is just for it (or them) to be outputted by this second detector.

The closed straight-sided figure detector in *M* works so that "when given a piece of wire as input, it will output the piece of wire if and only if the wire is a closed [plane] figure and all sides of the figure are straight" (Sober 1982, 185). More explicitly, let us say that: i) when given a piece of wire as input that is a closed figure all of whose sides are straight, the closed straight-sided figure detector outputs the wire, and it does this *because* the wire is a closed figure all of whose sides are straight; whereas, ii) when given a piece of wire (or several pieces of wire) as input that is not a single closed figure all of whose sides are straight, the closed-straight-sided figure detector does not output it (or them). The three-angle detector, on the other hand, works so that "when given any number of straight pieces of wire, it outputs them if and only if they have three angles" (Sober 1982, 185). More explicitly: i) when given one or more pieces of wire with straight sides that collectively have three angles, the three-angle detector outputs them and it does this *because* the wire (or wires) collectively have three angles; whereas, ii) when given one or more pieces of wire with straight sides that don't collectively have three angles, the three-angle detector does not output them. The three-angle detector is causally sensitive to whether the input has three angles, and not to whether it has three sides, since, when given a four-sided open figure, it will output the object (since it has three angles), and it will fail to do this if the four-sided figure is closed. In addition, when the three-angle detector is given three unconnected pieces of wire, each containing exactly one angle,

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the detector will output them, even though it is made up of six straight line segments.

Sober states the dual-detector argument as follows:

> Now consider a particular object—a piece of wire—which is fed into the machine, passes through both [detectors], and is then outputted by the machine. What property of the object *caused* it to be outputted? Given the mechanism at work here, I think that the cause was the object's having the property of being a *closed straight-sided figure having three angles* (i.e., its being a triangle), and not its being a *closed straight-sided figure having three sides* (i.e., its being a trilateral). If this is right, and if a difference in causal efficacy is enough to insure a difference in property, it follows that being a triangle is not the same property as being a trilateral, even though "triangle" and "trilateral" are logically (mathematically) equivalent. (Sober 1982, 185, Author's emphasis)

Let "[ϕ]" abbreviate "the fact that ϕ," and suppose that W is the piece of wire that is fed into M. Let us also suppose that the above process of W being fed into and then being sequentially outputted by the two detectors has occurred. Then, according to Sober's dual-detector argument, (Angle) is true while (Side) is false.

Angle. [W is a closed straight-sided figure that has three *angles*] causes [M outputs W].

Side. [W is a closed straight-sided figure that has three *sides*] causes [M outputs W].

The dual-detector argument then employs Leibniz's law to infer from this that, since they differ in what they cause, [W is a closed straight-sided figure having three *angles*] is not identical to the necessarily equivalent [W is a closed straight-sided figure having three *sides*]. The argument then infers from (4) and the non-identity of these facts that the property of being a closed straight-sided figure that has three *angles* (or being triangular) is not identical to the necessarily coextensive property of being a closed straight-sided figure that has three *sides* (or being trilateral).

4. For any x, IF x is F, x is G, and the property of being $F =$ the property of being G, THEN $[x \text{ is } F] = [x \text{ is } G]$.

Since these facts and properties are respectively necessarily equivalent to each other and necessarily coextensive with each other (and hence are identical to each other according to the modal theory), the dual-detector argument then concludes from the above results that the modal theory is false.[9]

2 Against the Dual-Detector Argument

One initial problem with the dual-detector argument is that (Angle) is not strictly speaking true, at least if we assume as we did above that the above described process involving W and M has already occurred.

> ANGLE. [W is a closed straight-sided figure that has three *angles*] causes [M outputs W].

To see why this is the case, let us suppose that, after being fed into M and put inside the closed straight-sided figure detector at t_1, W is outputted by the closed straight-sided figure detector so that, at t_2, W is inside the three-angle detector. Let us also suppose that W being inside the three-angle detector at t_2 results in W being outputted by the three-angle detector at t_3, and hence results in W being outputted by M at t_3. Finally, let us also suppose that the times t_1, t_2 and t_3 are all past times. Then the fact that W is a closed straight-sided figure that has three angles (either simpliciter or at the present time)

9 I am assuming that facts can cause other facts, where this claim is compatible with it also being the case that events can cause other events. If it is instead held that it is only events that can be causal relata, then "fact" can be replaced with "event" in the above presentation of the dual-detector argument to get the conclusion that there are distinct necessarily equivalent events (where two events are necessarily equivalent iff, necessarily, they either both occur or they both fail to occur). This conclusion together with (A) entails that there are distinct necessarily equivalent properties which, given (MF), entails that there are distinct necessarily equivalent states of affairs.

(A) If the property of being $F =$ the property of being G, then, for any x, the event of x having $F =$ the event of x having G.

(MF) The property of being $F =$ the property of being G iff, necessarily, for any x, the state of affairs of x being $F =$ the state of affairs of x being G.

Taking facts to be obtaining states of affairs (as in footnote 1), it follows from this that there are distinct necessarily equivalent facts.

does not cause M to do anything to W, since W is no longer interacting with M.

The above problem with the dual-detector argument shows that, as it is most charitably understood, it is not (Angle) that is true according to the argument, but is instead either (Angle$_{t1}$) or (Angle$_{t2}$).[10]

ANGLE$_{t1}$. [*At* t_1, W is a closed straight-sided figure that has three *angles*] causes [M outputs W at t_3].

ANGLE$_{t2}$. [*At* t_2, W is a closed straight-sided figure that has three *angles*] causes [M outputs W at t_3].

As a result of this need to relativise to either time t_1 or time t_2, we therefore have two versions of the dual-detector argument. The first version—the t_1-version—holds that (Angle$_{t1}$) is true and (Side$_{t1}$) is false, from which it infers that, contra the modal theory, the necessarily equivalent facts [at t_1, W is a closed straight-sided figure that has three *angles*] and [at t_1, W is a closed straight-sided figure that has three *sides*] are non-identical.

SIDE$_{t1}$. [*At* t_1, W is a closed straight-sided figure that has three *sides*] causes [M outputs W at t_3].

The second version of the dual-detector argument—the t_2-version—holds instead that (Angle$_{t2}$) is true and (Side$_{t2}$) is false, from which it infers that, contra the modal theory, the necessarily equivalent facts [at t_2, W is a closed

10 In response to the above problem with Sober (1982)'s original formulation of the dual-detector argument, we might modify M so that its two detectors act on W at the same time rather than sequentially. Such a modified version of the argument faces the same difficulties as the t_1-version of the argument discussed below. First, given this modification, while it is plausible that (Angle*) is true and (Side*) is false (when relativised uniformally to the relevant time), there is an exclusion argument that argues from the truth of (Angle*) to the falsity of (Angle).

(Angle*) [W is a closed straight-sided figure] and [W has three *angles*] collectively cause [M outputs W].

(Side*) [W is a closed straight-sided figure] and [W has three *sides*] collectively cause [M outputs W].

Second, this modified version of the argument faces the problem that, even if this exclusion argument is rejected, it doesn't seem possible to justify both the truth of (Angle) and the falsity of (Side).

straight-sided figure that has three *angles*] and [at t_2, W is a closed straight-sided figure that has three *sides*] are non-identical.

> SIDE$_{t2}$. [*At* t_2, W is a closed straight-sided figure that has three *sides*] causes [M outputs W at t_3].

As we will see, both these versions of the dual-detector argument have serious problems.[11]

The t_2-version of the dual-detector argument can be quickly seen to fail as follows: It is [W has three angles at t_2] that causes W to be outputted by the three-angle detector at t_3, rather than say [at t_2, W has three angles *and is blue*] that causes this fact (even supposing that W is blue at t_2). This is intuitively because [at t_2, W has three angles and is blue] goes beyond what is causally relevant to whether W is outputted by the three-angle detector at t_3. Similarly, it is [W has three angles at t_2] that causes W to be outputted by the three-angle detector at t_3 rather than [at t_2, W *is a closed straight-sided figure* that has three angles] that causes this fact. This is because the latter fact also goes beyond what is causally relevant to whether W gets outputted by the three-angle detector at t_3. Since W getting outputted by the three-angle detector just is what it is for M to be outputted by W, it follows that (Angle$_{t2}$) is false.

> ANGLE$_{t2}$. [*At* t_2, W is a closed straight-sided figure that has three *angles*] causes [M outputs W at t_3].

Since the falsity of (Angle$_{t2}$) conflicts with the t_2-version of the dual-detector argument, this version of the argument fails.

11 There is also a temporally mixed version of the dual-detector argument that holds that (Angle$_{t1,t2}$) is true and (Side$_{t1,t2}$) is false.

(Angle$_{t1,t2}$) [W is a closed straight-sided figure at t_1 that has three *angles* at t_2] causes [M outputs W at t_3].

(Side$_{t1,t2}$) [W is a closed straight-sided figure at t_1 that has three *sides* at t_2] causes [M outputs W at t_3].

This version of the argument at best only shows that [W is a closed straight-sided figure at t_1 that has three *angles* at t_2] is not identical to [W is a closed straight-sided figure at t_1 that has three *sides* at t_2], which does not conflict with the modal theory since these facts are not necessarily equivalent to each other.

I will now argue that the t_1-version of dual-detector argument is also unsuccessful and hence that both versions of the dual-detector argument fail. I will do this by first giving an argument from causal exclusion that, contrary to the dual-detector argument, (Angle$_{t1}$) is false. I will then argue that, even if this causal exclusion argument is rejected, it is not possible to justify both the truth of (Angle$_{t1}$) and the falsity of (Side$_{t1}$), the justification of both of which is required for the t_1-version of the argument to be successful. (Or at least, I will argue that one cannot justify the truth of (Angle$_{t1}$) and the falsity of (Side$_{t1}$) without appealing to some other argument against the modal theory that, if successful, would refute the modal theory by itself and hence would render the dual-detector argument superfluous.)

To set up the needed background for the argument from causal exclusion against (Angle$_{t1}$), note that, in the case of M processing W, [W is a closed straight-sided figure at t_1] causes W to be outputted by the closed straight-sided figure detector, and so causes W to be in the three-angle detector at t_2. Hence we have (5)

5. [W is a closed straight-sided figure at t_1] causes [W is in the three-angle detector at t_2].

Since [W is in the three-angle detector at t_2] and [W has three angles at t_2] collectively cause W to be outputted by the three-angle detector at t_3, which is what it is to be outputted by M at t_3, we also have (6).

6. [W is in the three-angle detector at t_2] and [W has three angles at t_2] collectively cause [M outputs W at t_3].

Since plausibly one of the causes of W having three angles at t_2 is that it had three angles at previous times before t_2, (7) plausibly also holds.

7. [W has three angles at t_1] causes [W has three angles at t_2].

Assuming, as is plausible, that the causal transitivity principle (T) holds in this causal situation, (5-7) then entail (Angle*$_{t1}$).[12]

12 While causation is plausibly transitive in many typical cases, such as in the case above, many philosophers hold that causation is not unrestrictedly transitive. For alleged counterexamples to transitivity, see, for example, (Kvart 1991) and (McDermott 1995). For a defense of transitivity unrestrictedly holding, (see Hall 2000).

T. IF the members of Φ_1 collectively cause r_1, the members of Φ_2 collectively cause r_2 ... and r_1, r_2 ... collectively cause r; THEN the members of $\Phi_1 \cup \Phi_2 \cup \ldots$ collectively cause r.

ANGLE*$_{t1}$. [W is a closed straight-sided figure at t_1] and [W has three angles at t_1] collectively cause [M outputs W at t_3].

With the above background in place, it might seem like it should now be easy to derive (Angle$_{t1}$) from (Angle*$_{t1}$), and hence establish that (Angle$_{t1}$) holds.

ANGLE$_{t1}$. [At t_1, W is a closed straight-sided figure that has three *angles*] causes [M outputs W at t_3].

However using the above background, we can now give the following argument from causal exclusion that (Angle$_{t1}$) is instead false: Just as [at t_2, W is a closed straight-sided figure that has three angles] fails to cause the closed straight-sided figure detector to output W at t_3 (since the former fact goes beyond what is causally relevant), [at t_1, W is a closed straight-sided figure that has three angles] fails to cause the closed straight-sided figure detector to output W (since this fact also goes beyond what is causally relevant) and hence this fact fails to cause [W is in the three-angle detector at t_2]. Hence we have (8).

8. [at t_1, W is a closed straight-sided figure that has three angles] does not cause [W is in the three angle detector at t_2].

Similarly, while [W has three angles at t_1] is a cause of [W has three angles at t_2], it is not the case that [at t_1, W is a closed straight-sided figure that has three angles] causes this fact, since it goes beyond what is causally relevant. Hence we have (9).

9. [at t_1, W is a closed straight-sided figure that has three angles] does not cause [W has three angles at t_2].

Since [at t_1, W is a closed straight-sided figure that has three angles] is also not caused by either [W is in the three-angle detector at t_2] or [W has three angles at t_2], and the causal chain that leads up to [M outputs W at t_3] goes through [W is in the three-angle detector at t_2] and [W has three angles at t_2], it therefore follows from (8) and (9) that [at t_1, W is a closed straight-sided figure that has three angles] isn't part of the causal chain that leads to [M outputs W at t_3] and hence does not cause it. Hence (Angle$_{t1}$) is false.

> ANGLE$_{t1}$. [*At* t_1, W is a closed straight-sided figure that has three *angles*] causes [M outputs W at t_3].

A more rigorous version of the above argument against (Angle$_{t1}$) can be given by appealing to the version of the principle of causal exclusion given by (PCE).[13]

> PCE. In cases where there is no genuine causal overdetermination, if S is a set of facts that occur at a time t whose members collectively completely cause f, then S is the unique set of facts that occur at t and collectively completely cause f.

In (PCE), a fact is said to occur at a certain time iff the fact only concerns how things are at that time. Genuine causal overdeterminism, on the other hand, occurs when two independent causal processes converge on the same effect, such as when a house burns down because a lit match starts a fire in the garbage at the same time as lightning strikes the house.

Since there is no genuine causal overdetermination in the case of W being outputted by M, (PCE) can be used to argue that (Angle$_{t1}$) is false as follows: Suppose, for reductio, that (Angle$_{t1}$) is true. Then [W is a closed straight-sided figure that has three angles at t_1] together with the members of some possibly empty set Ψ_1 completely cause [M outputs W at t_3]. Since (Angle*$_{t1}$) holds, it is also true that [W is a closed straight-sided figure at t_1], [W has three angles at t_1] together with the members of some possibly empty set Ψ_2 collectively completely cause [M outputs W at t_3]. Since the relevant facts occur at the same time, these two consequences together with (PCE) then entail (10).

> 10. [W is a closed straight-sided figure at t_1],[W has three angles at t_1], [W is a closed straight-sided figure that has three angles] and the members of some possibly empty set Ψ collectively completely cause [M outputs W at t_3].

13 For discussion of the principle of causal exclusion, see, for example (Kim 2005) and (Moore 2018).

If (10) is true, then [W is a closed straight-sided figure at t_1], [W has three angles at t_1] and the members of Ψ by themselves collectively completely cause [M outputs W at t_3], since [at t_1, W is closed straight-sided figure that has three angles] is superfluous given the presence of [W is a closed straight-sided figure at t_1] and [W has three angles at t_1]. Given (PCE), however, this consequence conflicts with (10). Hence, the reductio assumption (Angle$_{t1}$) is false.

The above argument shows that (Angle$_{t1}$) fails to hold if (PCE) holds. Not all philosophers, however, accept (PCE), and these philosophers will not be convinced by the above argument from causal exclusion that the dual-detector argument fails. For example, some philosophers reject (PCE) on the grounds that it conflicts with the popular counterfactual dependency thesis (Dep).[14]

> DEP. Suppose that f and g obtain, and that, had f failed to obtain, it would have been that g failed to obtain. Then, f causes g.

Other philosophers reject (PCE) because they hold that, in cases where there is no genuine causal overdetermination of a fact, there can still be multiple complete causal chains that converge on that fact, provided these chains are systematically related to each other in the right way. In particular, some philosophers hold that there can be multiple such causal chains provided that, for each such chain, either that chain generates all the other chains, or that chain is generated by at least one other such chain. Someone who endorses this view, for example, might endorse (Conj).[15]

> CONJ. If f_1 and f_2 together with the members of a set Φ collectively completely cause f, then the conjunction of f_1 and f_2 together with the members of Φ collectively completely cause f.

It follows from (Conj) that, contra (PCE), if there is one causal chain leading to f that contains the facts f_1 and f_2 occurring at a time t, then there is a further causal chain which is systematically related to it by virtue of containing the

14 (See, for example, Loewer 2007). Proponents of (Dep) typically place certain restrictions on (Dep), such as requiring that the counterfactual is to be read in a suitable non-backtracking sense (see Lewis 1973), that the facts (or events, when (Dep) is applied to events) that stand in the causation relation are "sufficiently distinct" (so that, for example, we don't have the consequence that each fact causes itself) Lewis (1986c), and that these facts (or events) are non-disjunctive (see Lewis 1986c).

15 Φ in (Conj) can be the empty set.

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conjunction of f_1 and f_2 instead of f_1 and f_2 themselves. Given (Conj), it is natural to hold that this further causal chain containing the conjunction of f_1 and f_2 is generated by the former chain containing its conjuncts.

In light of the above views, the argument from causal exclusion does not by itself decisively refute the t_1-version of the dual-detector argument. In addition to facing the argument from causal exclusion, however, the t_1-version of the dual-detector argument faces the problem that, even if the caual exclusion argument fails, it doesn't appear possible to justify the truth of (Angle$_{t1}$) while also justifying the falsity of (Side$_{t1}$). (Or at least, it doesn't seem possible to do this without relying on some other argument against the modal theory which, if successful, would by itself refute the modal theory. I will discuss two attempts to give such a justification, and I will argue that both these attempts fail. The failure of these two attempts will give us reason to think that no such justification is possible, and hence reason to think that, even if (PCE) and the argument from causal exclusion fail, the t_1-version of the dual-detector argument is still unsuccessful.

The first attempt to justify the truth of (Angle$_{t1}$) (while also justifying the falsehood of (Side$_{t1}$) appeals to (Conj) above. This first attempt accepts (Angle*$_{t1}$) on the basis of the transitivity reasoning given for it above. It then infers from (Angle*$_{t1}$) and (Conj) that the conjunction of [*W* is a closed straight-sided figure at t_1] and [*W* has three angles at t_1] collectively (partially) cause *M* to output *W* at t_3. Assuming (as I will from now on) that this conjunction is the fact [at t_1, *W* is a closed straight-sided figure that has three angles], it follows from this that (Angle$_{t1}$) is true.

> ANGLE$_{t1}$. [*At* t_1, *W* is a closed straight-sided figure that has three *angles*] causes [*M* outputs *W* at t_3].

Let us assume that the above justification of (Angle$_{t1}$) is successful. The question that now needs to be addressed is whether we can go on to justify the falsehood of (Side$_{t1}$).

> SIDE$_{t1}$. [*At* t_1, *W* is a closed straight-sided figure that has three *sides*] causes [*M* outputs *W* at t_3].

One argument that tries to justify the falsehood of (Side$_{t1}$) is the following: Unlike (Angle$_{t1}$), (Side$_{t1}$) cannot be generated from the causal facts given to us in the description of *M* processing *W* given in the dual-detector argument using causal generational principles such as (T) and (Conj). As a result, the truth of (Side$_{t1}$) would require some additional primitive causal fact to hold in the case of M processing W, which would be unparsimonious. Moreover, since any such additional primitive causal fact would only contingently hold, the possibility of such a fact holding can be removed by simply stipulating that no such additional primitive causal fact holds in the possible case of M processing W that we are concerned with. Hence, according to this argument, the truth of (Side$_{t1}$) can be ruled out either on parsimony grounds or by stipulation.

The problem with this argument for the falsity of (Side$_{t1}$) is that it begs the question against the modal theory. It does this because, if the modal theory is true, then, contra the above argument, (Side$_{t1}$) can be generated from the causal facts given to us in the description of the case of M processing W in the dual-detector argument and the generational principles (T) and (Conj) in the same way that (Angle$_{t1}$) can be so generated. This is because, if the modal theory is true, then [at t_1, W is a closed straight-sided figure that has three *sides*] is the conjunction of [W is a closed straight-sided figure at t_1] and [W has three angles at t_1], just as much as [at t_1, W is a closed straight-sided figure that has three *angles*] is. Hence, if the modal theory is true, then (Side$_{t1}$) can be derived from (Angle*$_{t1}$) and (Conj) in the same way that (Angle$_{t1}$) can.

An alternative way of trying to justify the falsehood of (Side$_{t1}$) appeals to (Conj*).[16]

> Conj*. If the conjunction of f_1 and f_2 partially causes f, then f_1 and f_2 collectively partially cause f.

We can give the same kind of argument from parsimony and contingency for the falsity of (Side*$_{t1}$) as was given above for the falsity of (Side$_{t1}$), with the

16 (Conj) and (Conj*) are in the vicinity of two principles, (A) and (B), that Sober appeals to when defending the dual-detector argument.

(A) If two devices, "which are linked in series in the [machine], are sensitive just to properties P and Q, respectively, then the [machine] itself is sensitive to the conjunctive property P-and-Q." (Sober 1982, 186)

(B) If "two devices which are linked in series are such that the first is sensitive to P and the second is *not* sensitive to R (where $P \neq R$, and neither implies the other), then the [machine] is *not* sensitive to the conjunctive property P-and-R." (Sober 1982, 186)

As argued below in the case of (Conj*), (B) immediately conflicts with the modal theory and is hard to justify.

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difference that this argument for the falsity of (Side*$_{t1}$), unlike the argument for the falsity of (Side$_{t1}$), does not beg the question against the modal theory.

> Side*$_{t1}$. [W is a closed straight-sided figure at t_1] and [W has three *sides* at t_1] collectively cause [M outputs W at t_3].

Indeed, plausibly both opponents and proponents of the modal theory should reject (Side*$_{t1}$). Given the falsity of (Side*$_{t1}$), however, the falsity of (Side$_{t1}$) follows from (Conj*).[17] If we are justified in endorsing (Conj*), then, we can use it to justify the falsehood of (Side$_{t1}$).

One problem with (Conj*) is that the principle directly conflicts with the modal theory. This is because, if the modal theory holds, then (Conj*) has the absurd consequence that, if f partially causes g, then any fact h that is necessitated by f also causes g. (This is because, according to the modal theory, if a fact f necessitates a fact h, then f is the conjunction of f and h.) If [Suzy throws a rock] causes [the window breaks], for example, then, if the modal theory holds, (Conj*) entails that [Suzy throws a rock or Suzy does not throw a rock] (which is necessitated by [Suzy throws a rock]) also causes [the window breaks], which is absurd. In light of this, one problem with (Conj*) is that, if it is accepted, then we don't need the dual-detector argument to refute the modal theory, since (Conj*) by itself achieves this task. If the dual-detector argument needs to rely on (Conj*) in order to be successful, then, the argument is superfluous.

A second (more serious) problem with (Conj*) is that it is not clear why we should believe it. A proponent of (Conj*) might attempt to justify the principle by arguing that, in ordinary language, sentences of the form (11) are equivalent to sentences of the form (12).

> 11. φ because ϕ and ψ.
>
> 12. φ because ϕ and because ψ.

Such a proponent might then argue that (on its relevant causal use) (11) is equivalent to (11*) and (12) is equivalent to (12*).

> 11*. [ϕ and φ] causes [φ].

17 I am assuming that [at t_1, W is a closed straight-sided figure that has three sides] is the conjunction of [W is a closed straight-sided figure at t_1] and [W has three sides at t_1].

12*. [ϕ and φ] collectively cause [φ].

Assuming that these equivalences all hold, it follows that (11*) entails (12*), from which it follows that (Conj*) holds.

A problem with this attempted justification for (Conj*) is that (12) is plausibly ambiguous between a conjunctive reading and a non-conjunctive reading, just like (13) is.[18]

13. Jane wants to go swimming and go hiking.

(13) has a non-conjunctive reading on which the proposition Jane is described as desiring is the proposition that Jane goes swimming and hiking. On this reading, (13) is true iff (13n) is true.

13*n*. Jane wants to go (swimming and hiking).

(13) also has a conjunctive reading on which (13) is true iff (13c) is true.

13*c*. Jane wants to go swimming and Jane wants to go hiking.

(11) is plausibly similarly ambiguous between a non-conjunctive reading on which it is equivalent to (11n) and a conjunctive reading on which it is equivalent to (11c).

11*n*. φ because (ϕ and ψ).

11*c* (φ because ϕ). and (φ because ψ).

On its conjunctive reading, while (11) is equivalent to ((12) (on its causal use), there is no reason to think that (on its causal use) (11) is equivalent to (11*) (or at least no such reason has yet been provided).[19] On its non-conjunctive reading, on the other hand, there is no reason to think that (11) is equivalent to (12). As a result, appealing to natural language does not appear to help a proponent of the dual-detector argument justify (Conj*). In light of this, it

18 Cf. (Marshall 2021, 8035).

19 The claim that (12) is equivalent to (12*) can also be resisted, since it might be denied that "f causes h" and "g causes h" entails "f and g collectively cause h." For example, this inference might be thought to fail if f and g are individually complete causes of h that concern different times.

is not clear how (Conj*) might be justified.[20] As a result, it does not appear possible to justify the truth of (Angle$_{t1}$) by appealing to (Conj) while also justifying the falsity of (Side$_{t1}$).

I will discuss one further attempt to justify both the truth of (Angle$_{t1}$) and the falsity of (Side$_{t1}$). Instead of appealing to (Conj), this second attempt appeals to the popular counterfactual dependency thesis (Dep) stated above.[21]

> Dep. Suppose that f and g obtain, and that, had f failed to obtain, it would have been that g failed to obtain. Then, f causes g.

Assuming that (Dep) holds, we can derive (Angle$_{t1}$) as follows: In the case of M outputting W, had it not been that, at t_1, W was a closed straight-sided figure that had three *angles*, then either: i) W would not have been a closed straight-sided figure at t_1; or ii) W would not have had three angles at t_1, in which case W would also not have had three angles at t_2. If W had failed to be a closed straight-sided figure at t_1, W would not have been outputted by the closed straight-sided figure detector at t_2, and hence W would not have been outputted by M at t_3. On the other hand, if W had failed to have three angles at t_2, it would not have been outputted by the three-angle detector at t_3, and hence would also not have been outputted by M at t_3. Hence, had it not been that, at t_1, W was a closed straight-sided figure that had three *angles*, M would not have outputted W at t_3. It therefore follows from (Dep) that (Angle$_{t1}$) is true.

> Angle$_{t1}$. [*At* t$_1$, W is a closed straight-sided figure that has three *angles*] causes [M outputs W at t$_3$].

Assuming that (Dep) holds, then, a proponent of the dual-detector argument can use (Dep) to justify (Angle$_{t1}$). Unfortunately for proponents of the dual-detector argument, however, if (Dep) holds it can also be used to justify the truth of (Side$_{t1}$). To see why, note that, had it not been that, at t_1, W was a closed straight-sided figure that had three *sides*, then W would also either:

20 Or at least, it is not clear how (Conj*) might be justified without begging the question against the modal theory. It might perhaps be possible to justify (Conj*) if we assume the structured theory and give a general account of how less fundamental facts get to have their causal features in terms of the causal features of more fundamental facts that involves principles like (Conj).

21 Related principles we might try to appeal to in order to simultaneously justify the truth of (Angle) and the falsity of (Side) (which have similar problems to (Dep) are difference-making principles, such as those proposed by (Sartorio 2005) and (List and Menzies 2009).

i) not have been a closed straight-sided figure at t_1 or ii) not have had three angles at t_1, in which case it would not have had three angles at t_2. Hence, had it not been that, at t_1, W was a closed straight-sided figure having three *sides*, at least one of the detectors would not have outputted W, and so M would not have outputted W at t_3. Hence, it also follows from (Dep) that (Side$_{t1}$) is true. Hence, a proponent of the dual-detector argument cannot use (Dep) to justify the combination of (Angle$_{t1}$) being true and (Side$_{t1}$) being false. This second attempt at justifying the truth of (Angle$_{t1}$) and the falsehood of (Side$_{t1}$) therefore fails.

I have now discussed two attempts to justify the truth of (Angle$_{t1}$) and the falsity of (Side$_{t1}$), and I have argued that both of these attempts fail. As far as I can see, other attempts to do this are equally unsuccessful. If this is the case, then both the t_1-version and the t_2-version of the dual-detector argument fail.

3 Variants of the Dual-Detector Argument

In the face of the failure of the original version of Sober's dual-detector argument, it might be thought that the argument can be modified so that it evades the problems discussed in section 2. In particular, it might be thought that these problems can be evaded by replacing the necessarily equivalent facts expressed by ($1t_1$) and ($2t_1$) with some other necessarily equivalent facts and describing a machine that is causally sensitive to one of these facts but not the other.

$1t_1$. W is a closed straight-sided figure that has three *angles* at t_1.

$2t_1$. W is a closed straight-sided figure that has three *sides* at t_1.

As far as I can see, however, this cannot be done.

To illustrate the difficulty involved in successfully modifying the dual-detector argument in the above manner, I will briefly consider two attempts to do this that replace the facts expressed by ($1t_1$) and ($2t_1$) with the facts expressed by (14) and (15), where W^* is a circular wire and where the facts expressed by (14) and (15) are both necessarily equivalent to the fact that W^* is a circle.[22]

22 This variant was suggested by a referee.

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14. W^* is a closed (plane) figure all of whose points are equidistant from a point.

15. W^* is a closed (plane) figure of constant curvature.

For the first attempt, consider a machine M_1^* that, when given a closed (plane) figure as an input, scans that figure by having a distinct curvature detector for each point of the figure. Suppose that each of these detectors measures the curvature of their associated point in the figure and sends the result of this measurement in the form of a signal to the CPU of M_1^*. Further, suppose that, if all the signals the CPU receives are of the same value, then the fact that the signals it receives have the same value causes the figure to be outputted by M_1^*. Finally, suppose that the circular wire W^* is inputted into this machine M_1^*, is scanned by it, and is then outputted by it. It might then be claimed that, in this case, (Curv) is true while (Dist) is false, and that, due to Leibniz's law, this difference in truth-value entails that the modal theory is false.

CURV. [W^* is a closed figure with constant curvature] causes [M_1^* outputs W^*].

DIST. [W^* is a closed figure all of whose points are equidistant from a point] causes [M_1^* outputs W^*].

A problem with this first attempt at finding a successful variant of the dual-detector argument is that it is no more obvious that (Curv) holds than it is that (Angle$_{t1}$) holds in Sober's original case.

ANGLE$_{t1}$. [*At* t_1, W is a closed straight-sided figure that has three *angles*] causes [M outputs W at t_3].

Instead, using transitivity reasoning, what can be uncontroversially established in the variant case of machine M_1^* is a claim along the lines of (Curv*), just as what can be uncontroversially established using such reasoning in Sober's original case of machine M is Angle$^*_{t_1}$.

CURV*. [Point p_1 of W^* has curvature C], [point p_2 of W^* has curvature C]... collectively cause [M_1^* outputs W^*].

ANGLE*$_{t1}$. [W is a closed straight-sided figure at t_1] and [W has three angles at t_1] collectively cause [M outputs W at t_3].

Moreover, an opponent of the modal theory who wishes to show that (Curv) and (Dist) differ in their truth-value faces the same challenges that a proponent of Sober's original version of the dual-detector argument faces in showing that (Angle$_{t1}$) and (Side$_{t1}$) differ in their truth-value. First, they need to resist an argument from causal exclusion that (Curv*) entails the falsehood of (Curv). And second, they need to find some way of justifying the truth of (Curv) while also justifying the falsehood of (Dist), a task that appears to be just as difficult as finding a way of justifying the truth of (Angle$_{t1}$) while also justifying the falsehood of (Side$_{t1}$). Hence, this first attempt at describing a machine that is differentially sensitive to the facts expressed by (14) and (15) results in a variant of the dual-detector argument that is no more successful than Sober's original argument.

For a second attempt to show that there could be a machine that is causally sensitive to one of the facts expressed by (14) and (15) but not the other, consider a machine M_2^* that contains an extendable straight rod that rotates around one of its endpoints. When given a closed figure as input, M_2^* works by placing this rod inside the inputted closed figure, fixing the location of one of the rod's endpoints, extending the length of the rod until its other endpoint touches the inputted figure, and then rotating the rod around its fixed endpoint while keeping the length of the rod fixed. If the rod does a full rotation without moving the inputted figure or losing touch with it, then the fact that it does this causes M_2^* to output the figure. Suppose now that the circular wire W^* is inputted into M_2^* and that the rod of M_2^* is placed inside of W^* and does a full rotation meeting the above conditions, so that W^* gets outputted by M_2^*. It might then be claimed that, in this case, (Dist) is true and (Curv) is false, and hence that the modal theory is false.

The problem with this second variant of Sober's version of the dual-detector argument is that, if W^* is a circle that is inputted into and then outputted by M_2^*, then there is no reason to think that (Curv) and (Dist) differ in their truth-value. In particular, if W^* is so inputted and outputted, it is equally plausible to say that the machine measures the curvature of the points of W^* as it is to say that it measures the equidistance of those points from a common point. After all, the rod would fail to do its full rotation (while touching but not moving W^*) if the points of W^* didn't have constant curvature, just as it would fail to do this if the points of W^* weren't equally distant from some

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common point. There is therefore no grounds for thinking that W^* being outputted by M_2^* is due to one of these facts rather than the other. Hence, M_2^* also fails to be a demonstrable case of a machine that is causally sensitive to one of the facts expressed by (14) and (15) and not the other.

Other variations of Sober's original version of the dual-detector argument face similar problems to those described above. Indeed, the above two attempts to construct a successful variant of Sober's original version of the argument arguably illustrate a dilemma facing any such attempt. This dilemma is the following: Suppose we have a machine whose output is intended to be caused by the fact f_1 and not by the necessarily equivalent fact f_2. Then the machine will either contain multiple detectors that differ in what aspects of the input they measure (as in the cases of M and M_1^*), or the machine will only contain detectors (or a single detector) that don't so differ (as in the case of M_2^*). If the machine contains multiple detectors that differ in what aspects of the input they measure, then the argument against the modal theory based on this machine will arguably face the same challenges facing Sober's original argument and the first variant of it discussed above. In particular, the argument will need to resist an argument from causal exclusion and will face the same difficulties in justifying the claim that the input being outputted is caused by f_1 and not by f_2 that Sober's original dual-detector argument faces in justifying the truth of (Angle$_{t1}$) and the falsity of (Side$_{t1}$). On the other hand, if the machine contains only a single detector (or multiple detectors that don't differ in what aspects of the input they measure), then it will arguably fail to be even initially plausible that f_1 and f_2 differ in whether they cause the input to be outputted just as there is no even initial plausibility for thinking that the facts expressed by (14) and (15) differ in whether they cause W^* to be outputted by machine M_2^*. Hence, whether or not we have a machine that contains detectors that differ in what aspects they measure, the argument against the modal theory based on this machine will arguably fail. In light of this, it is reasonable to conclude that, not only does Sober's original version of the dual-detector argument fail, but it is not possible to modify the argument so that it is successful. If this is correct, then all variants of the dual-detector argument fail and some other kind of argument will be needed if we are to have reason to reject the modal theory of facts and properties.*

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