**Russell and the Temporal Contiguity of Causes and Effects**

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*There are some necessary conditions on causal relations that seem to be so trivial that they do not merit further inquiry. Many philosophers assume that the requirement that there could be no temporal gaps between causes and their effects is such a condition. Bertrand Russell disagrees. In this paper, an in-depth discussion of Russell's argument against this necessary condition is the centerpiece of an analysis of what is at stake when one accepts or denies that there can be temporal gaps between causes and effects. It is argued that whether one accepts or denies this condition, one is implicated in taking on substantial and wide-ranging philosophical positions. Therefore, it is not a trivial necessary condition of causal relations and it merits further inquiry.*

## 1. Introduction

After a cause ceases, must its effect occur immediately thereafter? That is, must there be no temporal gap between the termination of a cause and the initiation of its effect? If the answer to this question is in the affirmative, then the gap between putative causes and effects that are temporally distant like one's smoking and one's lung cancer must be bridged by intermediate causes and effects. Where such intermediaries are ruled out, so too are the causal relations.

Bertrand Russell gave an answer to this question in his Presidential Address to the Aristotelian Society on November 4th, 1912. Russell's address, later published as a paper titled "On the Notion of Cause" (1912), contains an argument against the claim that there could not be a causal relation where the cause is separated from the effect by a period during which neither is occurring. I call this claim 'No Temporal Gaps' (NTG). Russell's conclusion is that NTG is false: "if there are causes and effects, they must be separated by a finite time-interval" (1912, p. 5). Russell's answer to the question, then, is in the negative.

There is no doubting the influence of Russell's paper over the past one hundred years, but the arguments from Russell's paper that are the usual focus are those concerning the supposed absence of causal language and causal explanations in science, the deterministic nature of causation, and the direction of causation (see, e.g., Field 2003, Kistler 2002, Hitchcock 2007, Ross and Spurrett 2007, and Price 2014). Although these arguments are certainly the most prominent features of the paper, it is curious that many philosophers treat Russell's argument against NTG as a black box of sorts, not daring to look too closely at its innards. For instance, in his discussion of "superproportionality" Stephen Yablo breezes over Russell's argument, harvests only a few of its insights, and mischaracterizes its conclusion as the claim that "the only true causation is simultaneous causation", although Yablo grants that perhaps Russell only "provides the materials" for an argument with this conclusion (1997, pp. 268-269). This is not to blame, or to argue that such contexts demand further engagement with Russell, but it is to note that mischaracterizations are common and casual. If there is something to be gained from closer engagement, then I do not think we have gained all of it yet.

This curiosity is magnified by the fact that Russell's argument is not merely an aside. It is an important part of his assault on what he takes to be the prevailing notion of causation amongst philosophers. After all, Russell justifies turning to his positive position on causation, his vision

of its role in mature science, and the aforementioned topics by first attacking the philosophers' dogmas. One of these dogmas is that causes necessitate their effects (i.e. causal determinism), and another is NTG. Russell sees these dogmas as intimately connected because it is often thought that if ~NTG, then there could be an intervention that occurs posterior to the termination of some cause but prior to the beginning of its effect that blocks the effect from occurring. But if causal relations are necessary, then there could not be such an intervention. Given the prior conditional, NTG follows. After he argues against NTG, Russell advocates for the contingency of causal relations and an inductively-derived principle of the "uniformity of nature", as opposed to the philosophers' "law of causality", which allows—at least in principle—deductions of effects from causes. Yet, if we have not been convinced that ~NTG, then, at least in the context of Russell's paper, this advocacy may fall on deaf ears. Russell's dialectical position is stronger if he can show that ~NTG, and thus that it is not the case that causal relations are necessary.

In this paper, I take a closer look and I carefully analyze Russell's argument against NTG. To my knowledge, only a few other accounts of this argument have been given, and none of them are concerned with Russell's argument for its own sake. As a consequence, some of the details have been lost to the sands of time. It is my goal to drill down and expose the precise formulation of Russell's argument against NTG so that we are better equipped to use it for our purposes. In this way, my project is not simply one of Russell exegesis. I supplement my interpretative analyses with many critical comments, noting problems for Russell when they arise, as well as some points where he seems to be in good company. One of my main goals is to expose the consequences of the various positions one can take on NTG, and thereby map the terrain surrounding NTG, but I do not argue at length for any particular position. Russell's treatment of NTG may very well be the best in the metaphysics literature to date, but my analysis of it should not be seen as anything more than an attempt to illuminate the positions one can take on the substantive issues related to NTG. It is simply a good starting point for those interested in addressing this neglected topic.

In section 2, I begin by suggesting that some philosophers have held or hold NTG. Then I provide some reasons for and against NTG, and I explain the charitable motivating argument that Russell gives for NTG on behalf of his opponent. In section 3, I briefly outline Russell's overall argument against NTG (which is also presented in its entirety in the Appendix). Next, I extract and analyze two sub-arguments of Russell's overall argument which together contain most of the controversial premises, offering some insight into Russell's reasoning and some doubts about it as well. Along the way, I note the various paths that one could take when confronted with the issues at hand. In my conclusion, I summarize the import of the foregoing and propose that we stand to gain from taking a closer look at this underappreciated argument from Russell.

## 2. Preliminaries and Motivations

In order to defend his denial of NTG against the opposition, Russell goes on the offensive and attacks NTG, which he thinks rests upon the mistaken assumption "that causes 'operate,' i.e., that they are in some obscure way analogous to volitions" (1912, p. 12). The explicit target of Russell's argument against NTG is a definition of 'cause and effect' that he finds in James Mark Baldwin's *Dictionary of Philosophy and Psychology* (1901) that contains an expression of NTG:

> CAUSE AND EFFECT. (1) Cause and effect . . . . are correlative terms denoting any two distinguishable things, phases, or aspects of reality, which are so related to each other,

> that whenever the first ceases to exist, the second comes into existence immediately after, and whenever the second comes into existence, the first has ceased to exist immediately before. (1912, p. 2)

Although the wording of this definition allows backward causation as a possibility (the effect could be "the first" and the cause could be "the second"), the natural reading is that it is intended to be a definition of forward causation. Forward causal relations are those cause-effect pairs where at least the beginning of the cause occurs prior to the beginning of the effect. Given the use of 'immediately' to describe the temporal relation between cause and effect, this definition's assumption of NTG is clear, since NTG ensures that effects occur immediately and without any time elapsing after their causes have occurred. And since the definition states that the beginning of effects follow the termination of their causes, it also assumes that causes and effects cannot both occur at the same point in time or, as I will call it, overlap. Therefore, Russell's target is those who hold NTG to range over, or to be a necessary condition of, forward causal relations that do not overlap. (Nonetheless, much of the discussion of NTG in this paper is relevant regardless of one's position on the direction of causation.)

It is fair to assume that many philosophers maintain that there are forward causal relations that do not overlap since the cases that they introduce and analyze are often of this kind. Whether it be Hume's famous billiard balls or contemporary philosophers' cases involving rocks breaking windows, non-overlapping forward causal relations are taken to be the gold standard by many. As for NTG, some contemporary metaphysicians seem to think that it is a harmless assumption, if not trivially true of at least some causal relations. L. A. Paul and Ned Hall, for example, "assume, purely for the sake of simplicity, that [fundamental causal laws] are deterministic, and that they permit neither backwards causation nor causation across a temporal gap" (2013, p. 8; bracketed clarification mine). Sydney Shoemaker asserts that it is tempting to think that NTG is "an analytic or conceptual truth" and says he is inclined to believe that causal relations that violate NTG are "logically impossible" (1969, pp. 377-378). Historically, Hume's position is perhaps the most famous instance of the view that NTG is a necessary condition of all causal relations (see, e.g., *Treatise* 1.3.2.6; 2000, p. 54), although of course Hume interprets necessary conditions in an idiosyncratic way (Beauchamp and Rosenberg 1981, pp. 171-200; see Kline 1985 and Ma 1999 for discussions of Hume's position and its relation to Russell's argument). It is clear that Russell is attacking an occupied philosophical position, or at least one that has been deemed *prima facie* plausible by some philosophers, old and new.

But why should one maintain NTG? One candidate reason is the fact that NTG *seems* to be confirmed by many everyday causal relations. There are countless interactions that are widely held to be causal that seem to suffer from no delays and that seem to have no intermediaries between their constituent causes and effects. When a rock impacts a window, it does not seem that there is any gap before the window breaks. And when there seems to be a delay, intermediaries are subsequently discovered. When a bullet kills a man but he does not die instantly, we find that the bullet slowed and ultimately stopped the functioning of some vital organ or another. And when intermediate causes and effects cannot be found, their existence is assumed until they are discovered. For if some causal relations seem to have a gap between their relata, we find ourselves demanding of them an explanation of why their effects occur when they do. This demand comes from the Principle of Sufficient Reason (PSR), which requires an explanation of what it is about the causes in question that enables them to pass into non-existence for some duration and yet still bring about their effects (for recent defenses of the PSR, see

Weaver 2013 and Dasgupta 2016; for criticism, see Kleinschmidt 2013). Until we can confirm our hunch, our unconscious reliance on the PSR makes us assume that either the causes did not pass into non-existence after all or there were some undetected intermediaries that bridged the gap (Shoemaker 1969, p. 377). This assumption, of course, is rejected by Russell, who in maintaining ~NTG claims that causes "cause their effects after they have ceased to exist" and without the assistance of intermediaries (1912, p. 11). Elsewhere, he denies the PSR as well (1912, p. 13).

The fact that the NTG seems to be confirmed by many causal relations does not provide anything like conclusive evidence that NTG is true, but it does provide *prima facie* evidence for believing that it is, since a good explanation of why NTG seems to be confirmed by so many purported causal relations is that it is true. For those who believe that we can justifiably infer the existence of necessary causal relations from the observation of certain regularities in nature, the inference to NTG as a necessary condition of these relations should perhaps be equally plausible. This plausibility is reinforced and heightened by the aforementioned considerations from the PSR.

On the other hand, there is room to deny NTG. One reason to deny NTG is the fact that there seem to be clear cases of delayed causal relations, as in the case of one's smoking causing one's lung cancer or greenhouse gas emissions causing climate change. Given that many cases of this kind resist reduction either to chains of intermediate causes and effects or to more fundamental causal relata, one might suppose that there can be causal relations that violate NTG, and so it is not a necessary condition after all. This last inference does presume that causal relations constitute a unified phenomenon, such that there are substantive necessary conditions shared by all forward non-overlapping causal relations, but I assumed this above and it does seem to be Russell's assumption (though only because he thinks—I believe rightly—that it is an uncontroversial one amongst a sizable subset of philosophers).

These independent considerations for and against NTG are not mentioned by Russell. Although he himself rejects NTG, and we will soon come to his rejection, Russell gives a brief motivating argument for NTG to illustrate the appeal of his opponents' position. It is contained in the following passage:

> [. . .] there must be some finite lapse of time *t* between cause and effect. This, however, at once raises insuperable difficulties. However short we make the interval *t*, something may happen during this interval which prevents the expected result. I put my penny in the slot, but before I can draw out my ticket there is an earthquake which upsets the machine and my calculations. In order to be sure of the expected effect, we must know that there is nothing in the environment to interfere with it. But this means that the supposed cause is not, by itself, adequate to insure the effect. And as soon as we include the environment, the probability of repetition is diminished, until at last, when the whole environment is included, the probability of repetition becomes almost *nil*. (1912, pp. 7-8; bracketed ellipsis mine)

This passage indicates that Russell's worry is that he faces a dilemma concerning the proper analysis of the causal relation at issue in his example. The disjunction that drives the dilemma is this: either the cause is Russell's putting of the penny in the slot and the effect is his drawing of his ticket out of the machine, or the cause is the totality of circumstances (including the laws that govern them) that result in his drawing of his ticket out of the machine (which is the effect). If,

like Russell, one prefers to grab the first horn and assume that the cause is his putting of the penny in the slot and the effect is his drawing of his ticket out of the machine, then one is assuming that there is (and could be) a temporal gap between a cause and its effect. But if there is an interval of time between the conclusion of the cause and the beginning of the effect, then we can conceive that "something may happen during this interval which prevents the expected result", and so such an intervention could happen. What could this intervening event be? As Russell suggests, an earthquake could occur posterior to the termination of the cause that prevents the effect from occurring. But this consequence of NTG's falsity is untenable since causes are sufficient conditions for their effects (in Russell's terms, causes are "adequate to insure" their effects), so we have a contradiction.

There are several key moves in this argument. First is the claim that preemption cases of this kind can be conceived to occur in a world where NTG is false. We do seem to be able to conceive of an earthquake that prevents Russell's putting of his penny into the slot from causing him to draw his ticket out of the machine, if there is a delay between the two. Second is Russell's assumption that conceivability implies possibility. Principles of this sort are standard fare amongst some philosophers, but they are strongly opposed by others. Some call for their limitation to certain types of conceivability and possibility (e.g. Chalmers 2002). Whether the present case satisfies the more limited versions is beyond the purview of this paper. Assuming that the defender of NTG can maintain such a principle in a relevant form, the possibility of the conceived preemption case follows.

The next premise of Russell's motivating argument is what he calls the "law of causality" (LOC), which is the claim that causes are sufficient conditions for their effects (which Russell says is equivalent to the claim that "the same causes produce the same effects"; see 1912, p. 6). If the LOC is true, then it is not possible for an effect to fail to occur—if its cause occurs—and any assumption that has this possibility as a consequence can be rejected. Russell himself doubts that a principle like the LOC is true unless its scope is limited to those causal relations that have causes that are "so complicated that it is very unlikely they will ever recur", like "two states of the whole universe" (1912, pp. 8-9). He later advocates for a probabilistic inductive principle called the principle of the "uniformity of nature" to replace the LOC (1912, pp. 12-13, 15-16), and this is how he escapes the motivating argument. The LOC rules out partial causes but allows for redundant causation (i.e. it being possible for there to be multiple causes for a given effect). And it is a principle that many philosophers have endorsed in virtue of being causal determinists. For instance, David Lewis endorses it in his early work, although he later clarifies that he also makes room for probabilistic causation (e.g. in his 1986, pp. 175-184; see also Noordhof 1999). There he defines an event E as causally depending on another event C such that "(i) if C had occurred, then E would have occurred, and (ii) if C had not occurred, then E would not have occurred", and he defines causation as a chain of causal dependencies (1973, pp. 562-563). Of course, there are many metaphysicians who deny the LOC as well, including contemporaries of Lewis (e.g. Trenholme 1975).

In his analysis of Russell's paper, Donald Lipkind agrees that this is the right way to characterize the LOC as Russell sees it, and Lipkind thinks that this argument should force us to grab the other horn (1979, pp. 707-709). That is, we should accept that the cause in Russell's example is the totality of circumstances (and relevant laws of nature) that result in his drawing of his ticket out of the machine (the effect), despite the fact that Russell is worried that this is not the natural understanding of the cause in this case and that this makes it so that "the probability of repetition becomes almost *nil*." Lipkind thinks that this totality is the "real cause," but he

argues that we should *not* reject looser causal language of the form suggested by the first horn. Epistemically, we always lack access to the totality of conditions that characterize any given cause and so we must speak and think of causes like *his putting of the penny in the slot* and effects like *his drawing of his ticket out of the machine*. Yet, our recognition of our limited epistemic position should not compel us to abandon our normal causal language. It only forces us to recognize that, pace J. L. Mackie, our "causal statements presuppose *ceteris paribus* clauses" (Lipkind 1979, p. 709; Mackie 1974, pp. 34-43).

If the *reductio* for NTG gave decisive reason to hold NTG, I would be sympathetic to Lipkind's suggestion. The problem is that roughly the same argument can be given for the conclusion that ~NTG. Using a conceivability implies possibility principle to argue for NTG backfires due to the power of principles of this kind. In an unbridled form, such a principle is not limited to cases where there needs to be time for an intervening event to occur to prevent a cause from causing its effect. As Hume states in the first *Enquiry*, "all events seem entirely loose and separate" (7.26; 1999, p. 144), and could be separated, regardless of their relations to one another (temporal or otherwise), so long as they are distinct. Or so one might argue. One solution would be to retreat to a more limited version of the conceivability implies possibility principle that trades on *physical* rather than *metaphysical* possibility. Although the stronger form of this principle used in the above argument generates metaphysical possibilities that lead to violations of NTG, one might think that the parallel argument for ~NTG would not go through if the principle is limited to physical possibilities. And there is reason to think that Russell is not making use of the stronger form of this principle in his *reductio* for NTG since his earthquake case seems to be intended to be understood as a physical possibility (for criticism of this argument in its weaker form, see Ehring 1987, pp. 28-29).

It goes without saying that one need not endorse the argument that Russell gives for NTG if one holds some version of NTG. As mentioned before, there are other reasons for holding NTG. Indeed, whether one ultimately accepts or rejects NTG should involve all of the relevant reasons, including those. Still, already we are seeing how Russell deftly exposes the substantial stakes involved when one takes positions in the territory surrounding NTG. If you reject NTG, then you need to develop consistent positions on the conceivability of preemption cases, the relation between conceivability and the various kinds of possibility, and the LOC. Also, per the preceding discussion, you need to consider how to interpret cases where NTG seems to be confirmed, all while taking into account the pressure applied by principles like the PSR. The invested reader might want to start a list of commitments—it is going to become harder to keep track.

## 3. Analyzing Russell's Argument Against NTG

### *3.1 - The Overall Argument*

The passage where Russell's argument against NTG is found is highly compressed and, at times, hard to follow. Here is the text in full:

> But a great difficulty is caused by the temporal contiguity of cause and effect which the definition asserts. No two instants are contiguous, since the time-series is compact; hence either the cause or the effect or both must, if the definition is correct, endure for a finite time; indeed, by the wording of the definition it is plain that both are assumed to endure

> for a finite time. But then we are faced with a dilemma: if the cause is a process involving change within itself, we shall require (if causality is universal) causal relations between its earlier and later parts; moreover, it would seem that only the later parts can be relevant to the effect, since the earlier parts are not contiguous to the effect, and therefore (by the definition) cannot influence the effect. Thus we shall be led to diminish the duration of the cause without limit, and however much we may diminish it, there will still remain an earlier part which might be altered without altering the effect, so that the true cause, as defined, will not have been reached, for it will be observed that the definition excludes plurality of causes. If, on the other hand, the cause is purely static, involving no change within itself, then, in the first place, no such cause is to be found in nature, and in the second place, it seems strange—too strange to be accepted, in spite of bare logical possibility—that the cause, after existing placidly for some time, should suddenly explode into the effect, when it might just as well have done so at any earlier time, or have gone on unchanged without producing its effect. This dilemma, therefore, is fatal to the view that cause and effect can be contiguous in time; if there are causes and effects, they must be separated by a finite time-interval *t*, as was assumed in the above interpretation of the first definition. (Russell 1912, p. 5)

The overall argument here is a *reductio* with ~NTG as its conclusion, so Russell assumes NTG to begin. He then implicitly introduces an exhaustive disjunction: either both causes and effects are instantaneous, or not. Russell argues that ~NTG follows when we assume the first disjunct because instantaneous causes and effects occupying distinct points in time cannot be temporally contiguous "since the time-series is compact". This sub-argument will be discussed below in section 3.2. With this conditional in hand, given that NTG was already assumed, it follows that it is not the case that both causes and effects are instantaneous.

Since Baldwin's definition assumes that *both* causes and effects are *not* instantaneous, Russell assumes that both causes and effects will be alike with respect to whether they are instantaneous or not, so he eliminates the second conjunct and is left with the claim that causes are not instantaneous. He argues that we then face a dilemma based on the disjunction that follows: either causes are processes that undergo change over time, or causes are static through time and do not change. Russell presses a contradiction on those who grab the first horn. Because dynamic causes can be infinitely divided into temporal parts, they could not have final temporal parts that cause the (equally impossible) first temporal parts of their effects. Yet, NTG makes it so that only the last temporal part of a cause could cause the first temporal part of its effect. The sub-argument that generates this contradiction from the first horn is the subject of section 3.3 below.

At this point in the overall argument, we are stuck with grabbing the second horn, but there Russell confronts us with a consequence—derived from his dual assertion of the non-existence and inexplicability of static causes—which generates the contradiction necessary for the overall *reductio*. Thus, ~NTG. In section 3.4, I consider this last part of the argument. Given the complexity of Russell's reasoning, seeing a more formal rendering of his argument can be very helpful. As such, I have provided one for the reader's reference in the Appendix.

### *3.2 - The First Sub-Argument (P3-P7)*

The role of the first sub-argument in the overall argument is to show via conditional proof that if both causes and effects are instantaneous, then ~NTG. To that end, Russell simply assumes that both causes and effects are instantaneous. Then he argues from this assumption that there must be a duration between causes and effects. So, ~NTG.

Considered in isolation from the overall argument, this sub-argument suffers from the fact that it seems that not all causes and effects are instantaneous. There appear to be many cases of causal relations where the causes and effects have duration, as in the smoking and lung cancer case mentioned before. However, this assumption is not necessary to arrive at Russell's conclusion. Given that the assumption that causes and effects are instantaneous is not necessary and potentially implausible, in his discussion of a similar argument Anjan Chakravartty generalizes from instantaneous causes and effects to those causes and effects separated by a duration, whether they are instantaneous or not (2005, p. 11). After all, there is a duration between a cause and its effect whether they are instantaneous or not, if it is assumed with Russell that time is dense (DT) and that there is neither backward nor overlapping causation (recall that the latter is where causes and effects co-occur for at least one point in time). DT is the proposition that there is another point in time between any two points in time. If there is only forward non-overlapping causation, then causes must terminate at a point in time prior to the point of time that their effects begin, whether they are instantaneous or temporally extended. But if causes terminate at a point in time prior to the point in time that their effects begin, and if no two distinct points in time are contiguous (per DT), then there are durations between causes and effects. These durations just are the periods of time that elapse from the termination of the causes to the initiation of their effects.

By extracting this version of the first sub-argument from the context of Russell's overall argument against NTG, we can see its power independent of the potentially problematic assumption that causes and effects are instantaneous. And this more general version of the first sub-argument has—other than the problematic assumption itself—all of the same premises, so analyzing it will shed light on it and Russell's version.

There are two issues with this kind of argument. The first is that it is not clear if the version of NTG that Russell is presuming here (and throughout) is the best one. If we were to relax Russell's assumption that causes could not terminate at the same point in time that their effects begin, then versions of NTG could be allowed where causes and effects overlap for at least one point in time. Or, the overlap restriction could remain in place, but causes and effects could have open and closed boundaries at a point in time. Whether DT is true or not, if causes and effects can overlap or can have corresponding open and closed temporal boundaries at a point, then there is room for a version of NTG to evade this kind of argument.

Of these two alternative versions of NTG, the one that allows causes and their effects to overlap may be the less plausible one. This is because it seems that, strictly speaking, all causes must be fully realized before their effects occur (n.b., this worry applies no matter how long the overlap is). If a cause *c* were to persist (*qua* cause of its effect *e*) during some duration $t_0$ to $t_1$, then *e* could not yet occur (*qua* effect of *c*) until after $t_1$. If *e* could occur at or before $t_1$, with *c* occurring at the same time, then *c* occurring at $t_1$ would not be necessary to *e* occurring at $t_1$. What is *c* doing (*qua* cause of *e*) at $t_1$? Once *e* has begun occurring, *c* is no longer needed. It is often thought that causes are necessary for their effects once the causal relations that they constitute are realized, so although a particular effect could come about in virtue of many different causes, once one of them is its cause, that cause is necessary for that effect (see Russell

1912, pp. 10-12 for his discussion of this principle). Thus *c* and *e* could not both occur at the same time.

Conversely, some claim that similar considerations point in the opposite direction and, in fact, causes and effects must occur at the same time. It is *because* causes are necessary for their effects that they must overlap with them for their whole durations (i.e. be simultaneous with them). An early proponent of such a view is Kant, who argues in the first *Critique* not only that "the majority of efficient causes in nature are simultaneous with their effects" but that "in the instant in which the effect first arises, it is always simultaneous with the causality of its cause, since if the cause had ceased to be an instant before then the effect would never have arisen" (A203/B248; 1998, p. 312; for discussion of Kant's position, see Watkins 2005, pp. 252-257). Transporting this idea to the prior example, we would say that *e* cannot yet occur (*qua* effect of *c*) at $t_1$. Indeed, the idea is that generally *e must* occur at $t_0$ when *c* occurs, for otherwise what makes *e* occur (*c*) would not be there to do its causal work. Kant's famous examples are a heated stove causing warmth in a room and a ball resting on a pillow causing a dent in it, but many other cases can be generated of the same sort. There are many recent defenders of overlapping causation (e.g. Waterlow 1974, Brand 1980, Huemer and Kovitz 2003, Dummett 2005), most of whom think that causes and effects must occur simultaneously and not just at a single point in time. Of course, others think such cases are misdescribed and that there must be a temporal separation between cause and effect (e.g. Kline 1980, Mellor 1995). Hume argues that if all causal relata were simultaneous, there would be no succession and so no time (*Treatise* 1.3.2.7; 2000, p. 54; for discussion, see Ehring 1985).

The second alternative version of NTG makes use of the concepts of open and closed boundaries. Applied to the same generalized case from above, the idea is that, for a given *c* and *e*, either *c* occurs up until some point in time *t* and *e* occurs at *t*, or *c* occurs at *t* and *e* occurs after *t*. That is, this version of NTG is the following proposition: for all *c* and *e*, where *c* is a cause and *e* is its effect, *c* must occur during the range (. . ., *t*] with *e* occurring during (*t*, . . .), or *c* must occur during the range (. . ., *t*) with *e* occurring during [*t*, . . .). Since it does not require causes and effects to occur at a shared point in time like the prior version of NTG, this form of NTG does not suffer from complications surrounding overlap. And, just like prior version, this form of NTG is immune to the first sub-argument.

However, one complication with this second alternative version of NTG is that it is not clear how it is to be decided, for a given cause-effect pair, which one has the open boundary at *t* and which one does not. Although we can mathematically represent and thus distinguish both options, it seems as if we cannot even conceive of the difference between them in any given case. This is not to argue that causal relata do not have open and closed temporal boundaries, but it is to note that a version of NTG that relies on them amounts to little more than the suggestion of a formal mathematical solution that cannot be verified empirically (of course, DT itself is no different and so, dialectically, the critic of Russell might be justified in making a suggestion of this kind). The problem of deciding which of the cause-effect pair has which kind of boundary is a general problem with any theory that assigns open and closed boundaries like this, and it is one that has been studied at length and given the name 'Peirce's puzzle' (see Peirce 1933, Varzi 1997, Smith and Varzi 2000, Weber and Cotnoir 2015).

The second issue that Russell's argument faces stems from its reliance on DT, and this issue cuts against the second form of NTG since it presumes DT. Recall that DT is the claim that there is a point in time between every two points in time. Note that if time is dense, then it does not follow that it is continuous. If time is continuous (CT), then there is no point that the time

line (or any of its parts) does not have. Continuity is the conjunction of density and completeness (Dainton 2010, pp. 269-270; see also Dummett 2000, p. 499). Russell does not provide any reason for DT. He seems to think that DT is obviously true when he asserts without argument that "the time-series is compact" (1912, p. 5). One reason to think that DT is true stems from the fact that continuity entails denseness. Namely, since some of our best systematic physical theories (including classical mechanics, special relativity, and general relativity) assume that space and time are continuous (CT), it follows that our best physical theories assume that time is dense. This is not to claim that explanatorily equivalent but discrete versions of these theories are ruled out *a priori*, as attempts to derive such theories have been made for many years (e.g. Lorente 1976; see also Lorente 1986a, 1986b, and 1993). And it is not to claim that some systematic physical theories do not rely on time being discrete, because some recent theories do, like loop quantum gravity and lattice gauge theory. It is to claim that there may be weighty evidence from the sciences for CT and thus DT in the absence of such viable alternative theories.

There may be other reasons to be concerned about CT. Michael Dummett argues that CT is unjustified because, as an intuitionist, he denies that "there are true propositions which we can understand, but which we not merely do not know, or which, however favourably placed, we should have no effective means of deciding, but which we cannot ever in principle come to know" (2005, p. 141). Those who affirm that there are such true propositions are labeled "super realists" by Dummett, and they are super realists because they think, despite the fact that we can only ever measure any quantity to some value plus or minus some non-zero margin of error, that physical reality is "completely determinate [. . .] independent of our capacity to discover it" (2000, p. 498; bracketed ellipsis mine). Since we cannot even in principle know if CT is true, it follows that CT cannot be maintained unless one maintains super realism as well. Given that Dummett and others of a kin argue that super-realism can only be taken on faith, the same goes for CT and thus for DT, if one justifies DT via CT.

Dummett also generates several kinds of cases that he takes to show that CT implies that the "law of causality" (LOC) could be false of some causal relations. But since Dummett, like many other metaphysicians, thinks that the LOC, which asserts that causes are sufficient conditions for their effects, could not be violated, ~CT follows. These cases involve different kinds of discontinuities in physical quantities over time. One is a form of the so-called "Thomson's lamp" thought experiment and it consists of a pendulum (or similarly oscillating object) swinging increasingly fast from one side to another such that after one minute, it will have made infinitely many swings because the $n$-th swing takes $2/(n+1)(n+2)$ minutes. There is a function $f(t)$ that takes minutes of time expressed in real numbers as inputs and generates positions of the pendulum as outputs (with the two extreme positions designated with the values -1 and 1, say). Crucially, $f$ does not approach any limit as $t$ approaches 1 from 0. The problem, Dummett argues, is that this means that "what happens to the body for $t < 1$ does not tell us at all where it will be at the instant $t = 1$. Its position at that instant is completely indeterminate" (2000, pp. 503-504). But since Dummett maintains that our concept of causation requires that the position of the pendulum prior to $t = 1$ *determine* its position at $t = 1$ (that is, the LOC is true of the causal relation holding between its positions prior to $t = 1$ and its position at $t = 1$), CT must thus be rejected. It is CT which "allows as possibilities what reason rules out, and leaves it to the contingent laws of physics to rule out what a good model of physical reality would not even be able to describe" (2000, p. 505; see also 2003, pp. 387-389, 2005, pp. 142-144, and Meyer 2005).

The use of the LOC here to defend NTG from the contiguity objection syncs neatly with the central role that the LOC plays in Russell's charitable motivating argument for NTG from

section 2. In fact, Dummett endorses NTG and simultaneous causation precisely because he endorses the LOC (2005, pp. 143-144). However, Dummett's conclusion does not sync at all with the version of NTG that makes use of open and closed boundaries, since the positing of an open boundary presupposes CT. Therefore, those NTG defenders who are attracted to Dummett-style attacks on CT must utilize a form of NTG that either requires simultaneous causation or requires causes to occupy successive temporal minima of some kind or another (two versions of the latter option are pursued by Dummett; see 2000, p. 505 onward).

*3.3 - The Second Sub-Argument (P11-P20)*

The role of the second sub-argument in Russell's overall argument is to show via *reductio* that it is not the case that causes are processes that undergo change over time. Russell begins by assuming that if causes are processes that undergo change over time, then they have temporal parts. But if causes have temporal parts, causality is universal, and NTG, then each temporal part could only be caused by the temporal part prior to it and could only cause the temporal part posterior to it. It is not entirely clear what Russell means when he asserts that causality is universal, but for this part of the argument to work, it would have to be a form of the claim that everything that exists is causally enmeshed (i.e. is both a cause and an effect). The thought then is that the temporal parts of causes must be causally enmeshed, but only with those temporal parts that they are contiguous with, given NTG. However, by the same token, only the last temporal part of a cause could cause the first temporal part of its effect. As Russell says, the other temporal parts of a cause could be altered without any alteration in its effect, so long as the last temporal part remains the same. But if causes are infinitely dynamic and DT, then causes do not have last temporal parts. Any temporal part that is a candidate for the last temporal part would itself have temporal parts, and so on *ad infinitum*. So there must be no causes that are processes that undergo change over time. Yet, as Russell assumes, there are in fact causes of this sort.

Russell does not state why he thinks that the fact that causes are processes that undergo change over time implies that they have temporal parts. Nonetheless, it is a natural thought that dynamic causes have temporal parts that correspond to their changes (it is a thought had by Lewis, for instance; see Lewis 1986, pp. 172-175), especially if one grants that causes are events. The latter seems to be Russell's assumption on behalf of his opponents throughout the overall argument, despite his use of the term 'processes' here and despite the fact that he does not himself endorse the identification of causes with events (see, e.g., 1912, pp. 4, 7, 9, 10, 12, 13). The next step in the argument is the move from causes having temporal parts to these temporal parts themselves being causes and effects of one another. As noted, Russell asserts that the universality of causality justifies this move. This principle entails the causal version of the Principle of Sufficient Reason (PSR), so if one denies that everything has a cause—which, again, Russell does outside of the context of his argument against NTG (1912, p. 13)—then one denies the universality of causation. Nevertheless, this entailment is a potential source of strength, given that arguments for the causal PSR would only need to be supplemented by the relatively limited claim that the temporal parts of causes are themselves causes of one another. If causes have temporal parts and the causal PSR is in hand, then one might think that there are no better candidates for the causes of each of these temporal parts than their brethren.

There are two issues with this sub-argument. First, if one can deny DT, then it falls just like the first sub-argument. However, if one accepts DT and evades the first sub-argument with

the version of NTG that makes use of open and closed boundaries, one does not thereby evade this second sub-argument. In this way, the second sub-argument is not strictly weaker than the first, despite it relying on DT and having more premises than the first. Second, Russell seems to forget the starting assumption that causes are processes that undergo change over time. Russell is right to assume that if DT, causes are infinitely dynamic, and changes correspond to temporal parts, then causes could not have last temporal parts. But the starting assumption is that causes are processes that undergo change over time, not that they are infinitely dynamic. If there are dynamic causes that are not infinitely dynamic at any point, then this sub-argument does not go through.

Indeed, there is nothing to prevent some dynamic causes from undergoing a finite series of changes, with each occurring after a period of stasis. Given that the period encompassing the final such change for a given dynamic cause could demarcate its last temporal part, it follows that some dynamic causes could have a last temporal part. Therefore, while it is true that infinitely dynamic causes could not have last temporal parts, some dynamic causes could have last temporal parts.

As an illustration, conceive of a cause that undergoes a finite number of changes with each occurring after a period of stasis. Each of these periods of stasis spans from some initial point in time $t_n$, when the cause is first constituted in a certain way, up until some later point in time $t_{n+x}$, when it first changes from how it was constituted at $t_n$. So, for instance, we can conceive of a cause that begins to exist at $t_1$, persists in stasis until it changes at $t_2$, and then persists in stasis once again until it changes at $t_3$, after which it ceases to exist. This cause persists for the period $[t_1, t_3]$, and it is constituted in three different ways, with the first two realized during the following periods of stasis: $[t_1, t_2)$, $[t_2, t_3)$. The final one is realized at one instant at $t_3$. Since any temporal part of this cause that could be a candidate for being the last one must be able to cause the first temporal part of the effect, and the starting assumption of the second sub-argument is that causes are processes that undergo change over time, this means that the last temporal part could not be the temporal part of the cause that persists during the period $[t_2, t_3)$, or any of *its* temporal parts. In fact, since Russell is assuming that each temporal part contains a change, any static point or period could not demarcate a temporal part. Thus the last temporal part could not just be the cause at $t_3$ since the cause is static at any given point in time, although the last temporal part must include $t_3$ given NTG. Finally, the last temporal part could not encompass two or more changes since then it could be divided into further temporal parts. A temporal part that satisfies these conditions—and thus could be the last—is the cause during the period $(t_2, t_3]$.

Now, one might argue that the last temporal part could also be the cause during any continuous period beginning after $t_2$ but before $t_3$, so long as it includes $t_3$. After all, during any such period the cause undergoes one change. However, any such temporal part leaves a non-zero period of stasis from $t_2$ until it begins. For example, the cause during $(t_{2.17}, t_3]$ is such a candidate last temporal part, but it follows a period of stasis during $[t_2, t_{2.17}]$. As noted, the cause during a static period like this one could not be a temporal part (and the same goes for any of its temporal parts). Supposing as we have that the cause is static and instantiating a different set of properties during the period $[t_1, t_2)$, the penultimate temporal part would, in this alternative scenario, have to begin at a point in time prior to $t_2$, and then persist up until $t_{2.17}$. Otherwise it would not undergo change and thus be neither a temporal part nor causally efficacious, thereby breaking the causal chain and rendering the last temporal part uncaused. Yet, the problem with alternative specifications like this one is that the period prior to the penultimate temporal part would be a

period of stasis. In this case, the period of stasis could be, say, the period [$t_1$, $t_{1.92}$), assuming that the penultimate temporal part begins at $t_{1.92}$. Any division other than that where the last temporal part persists during the period ($t_2$, $t_3$] and where the penultimate one persists during the period [$t_1$, $t_2$] would leave a causally inefficacious first period, which would break the causal chain and leave the subsequent temporal parts uncaused.

Assuming conceivability implies possibility in this case, since we can conceive of this cause as having a last temporal part, namely during the period ($t_2$, $t_3$], it is possible for some dynamic causes to have last temporal parts that are indivisible into further temporal parts. Similar reasoning can be applied to generate first temporal parts of effects. This counterexample arises when we recall the starting assumption of the second sub-argument, which is the assumption that causes are processes that undergo change. Not all dynamic causes are infinitely dynamic. Since cases of causes and effects can be generated where the cause has a last temporal part and the effect has a first temporal part, it follows that Russell's second sub-argument is not successful in its current form.

It must be admitted that Russell does not countenance open and closed boundaries, so the defender of the second sub-argument could object to my reliance on open and closed boundaries. Nevertheless, there are not any unique issues arising from my reliance on open and closed boundaries in this context that do not arise in other contexts. A stronger response comes in the form of the rest of Russell's argument, which challenges the possibility of intermittent stasis and might explain why Russell smuggled in the assumption that dynamic causes will be always be changing.

### *3.4 - The Rest of the Overall Argument (P21-P25)*

In the context of the overall argument, the second sub-argument generates the claim that it is not the case that causes are processes that undergo change over time. Then, given the already established disjunction that either causes are processes that undergo change over time or causes are static through time and do not change, Russell can infer that causes are static and do not change over time. Since it has already been argued that causes are not instantaneous, all Russell needs to argue now is that there are no static but non-instantaneous causes in nature and even if there were, there would be no explanations of why effects occur when they do.

Russell does not give any argument for the claim that there are no static but non-instantaneous causes in nature. He seems to take it as self-evident but, as Chakravartty notes, it does seem like "many if not most of what are generally regarded as causes and effects are indeed changes" (2005, p. 12). Perhaps the best way to argue for this claim—beyond arguing by induction from cases—would be to argue for the stronger claim that there *could not be* any static but non-instantaneous causes in nature. Russell does just this. He argues that if there were static causes, then their ability to bring about their effects would be inexplicable, but this is untenable. As previously quoted, this is how he puts it:

> [. . .] it seems strange—too strange to be accepted, in spite of bare logical possibility—that the cause, after existing placidly for some time, should suddenly explode into the effect, when it might just as well have done so at any earlier time, or have gone on unchanged without producing its effect. (Russell 1912, p. 5; bracketed ellipsis mine)

But why is this inexplicability untenable? The most direct way to argue that this sort of inexplicable explosion could not happen would be with the assistance of the Principle of Sufficient Reason (PSR). If a cause is the same for some non-zero duration prior to the occurrence of its effect, then there is nothing about the cause that explains why the effect occurs when it does and not before (or after), but nothing can lack an explanation of this kind (by the PSR), so there are no such causes. Of course, this assumes that causes are sufficient for their effects, which is the "law of causality" (LOC) from before. If the LOC were false, then the placid cause could be assisted by something external to itself and thereby generate its effect.

Arguments similar to this one have a venerable history. As A. David Kline (1982) notes, philosophers from Hume (*Treatise* 1.3.2.7; 2000, p. 54) to Myles Brand (1980) have wrestled with their consequences. Shoemaker, for instance, offers an argument relying on the PSR and the LOC for the conceptual impossibility of causes that are static for some duration before their effects occur, but he proposes that—if we cleanse our concept of causality of the demands of the PSR—there is room to reinterpret cases like these such that the cause just is the period of stasis prior to the occurrence of the effect (1969, pp. 375-378). Kline argues that if it is impossible for causes to be static for some duration before their effects occur, then there could not be any temporally extended causes that are *not* simultaneous with their effects, unless *either* causes and effects can have open and closed boundaries *or* ~DT and the causes are temporally extended for only one temporal minima (a point also made by Shoemaker in his 1969, p. 376). And if there are instantaneous causes and DT is true, then "causally related events form a dense sequence" (Kline 1982, pp. 71-72). For if there are any causal chains with duration (i.e. there is a non-zero duration between the instantaneous occurrence of one member of a chain and another member of that same chain), then they must consist of an infinite number of members since there can be no stasis at any point in their duration.

Russell's argument against the possibility of static but non-instantaneous causes can be used to attack my suggestion at the conclusion of section 3.3. For if, as I supposed, there could be a dynamic cause that undergoes stasis during the periods $[t_1, t_2)$ and $[t_2, t_3)$, then one might worry that there is no reason for the change at $t_2$ to occur when it did. Why should we think that the cause, after existing placidly for some time, should suddenly explode into change at $t_2$, when it either might have done so at an earlier time that is nonetheless posterior to $t_1$, or might have gone on unchanged without changing at $t_2$?

I see two ways of dodging this potential response from Russell. First, one could argue that the LOC should not be granted in the context of the second sub-argument. But without the LOC, then this response cannot go through. Indeed, perhaps causes require background conditions (including laws of nature) to be sufficient, as Lipkind (1979, pp. 706-711) and countless others have argued. Another way to dodge this response would be to deny the PSR, or cleanse our concept of causation of it (*à la* Shoemaker). As noted, Russell himself denies it beyond his dialogue in this argument with "the philosophers". It should now be clear that there are many assumptions he makes because he thinks most philosophers make them, and he wants to undermine their position. And Russell's reason for denying it is shared by many contemporary philosophers (see Ehring 1987, p. 30 for an expression of it in this very context). It is that we should not assume, independent of experience, that the world must be a certain way or another: "we shall only believe in causal sequences where we find them, without any presumption that they always are to be found" (Russell 1912, p. 13).

Since the rest of the overall argument had left us with the claim that causes are static and do not change over time (which is what we started this section with), and this last part of the

overall argument derives the negation of this claim from the PSR and the LOC, Russell finally has the contradiction needed for the overall *reductio*.

## 4. Conclusion

No one who considers the evidence would doubt Russell's great philosophical ability, but the foregoing analysis shows that sometimes he only needed a single paragraph to display it. I have shown that Russell's argument has a relatively clear logical structure, it can be made valid with the alteration of a few premises and the addition of a few suppressed ones (the Appendix shows this more clearly), it is relatively simple, and many of its premises have some measure of plausibility. More important, though, are its wide-ranging consequences—however one grapples with Russell's argument, one must commit to positions on many significant philosophical issues.

Indeed, my goal was to show that whether one endorses NTG or not, one must go in for many other views. If one accepts NTG, then one is forced to admit simultaneous causation, argue that there are causal relata with open and closed temporal boundaries, and/or reject DT. One probably should accept the LOC but also be wary of its power, when conjoined with the PSR, to undermine the possibility of stasis in causes. And if one agrees with Russell that ~NTG, then one must reject one of the premises of the motivating argument for NTG that he provides—the options are essentially limited to denying the LOC or rejecting conceivability implies possibility—and one should consider affirming DT, denying the PSR, and perhaps moving away from an event-based causal ontology entirely (as Chakravartty advocates in his 2005). I conclude, then, that Russell's lesser-known argument from "On the Notion of Cause" is worth considering once again, whether one endorses NTG or not.

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## Appendix - Russell's Overall Argument

*Show:* ~NTG

P1. ~~NTG. [assumption for *reductio* proof]
P2. Either both causes and effects are instantaneous, or not. [law of excluded middle]
P3. Both causes and effects are instantaneous. [assumption for conditional proof]
P4. If both causes and effects are instantaneous, then there is a duration between them.
P5. If there is a duration between causes and effects, then ~NTG.
P6. ~NTG. [P3, P4, P5, *modus ponens*]
P7. If both causes and effects are instantaneous, then ~NTG. [P3, P6, conditional proof]
P8. It is not the case that both causes and effects are instantaneous. [P1, P7, *modus tollens*]
P9. Causes are not instantaneous. [P2, P8, Baldwin's definition]
P10. Either causes are processes that undergo change over time, or causes are static through time and do not change. [P9]
P11. Causes are processes that undergo change over time. [assumption for *reductio* proof]
P12. If causes are processes that undergo change over time, then they have temporal parts.
P13. Causality is universal.
P14. If causes have temporal parts, causality is universal, and NTG, then each temporal part of a cause could only be caused by the temporal part prior to it and could only cause the temporal part posterior to it.
P15. If each temporal part of a cause could only be caused by the temporal part prior to it and could only cause the temporal part posterior to it, then only the last temporal part of the cause could be the cause of the first temporal part of the effect.
P16. There could not be a last temporal part of a cause.
P17. Only the last temporal part of a cause could be the cause of the first temporal part of its effect, and there could not be a last temporal part of a cause. [P11, P12, P13, P14, P15, *modus ponens*, P16, conjunction introduction]
P18. There are no causes that are processes that undergo change over time. [P17]
P19. There are causes that are processes that undergo change over time.
P20. It is not the case that causes are processes that undergo change over time. [P11, P18, P19, *reductio* proof]
P21. Causes are static and do not change over time. [P10, P20, disjunctive syllogism]
P22. If causes are static and do not change over time, then there are no causes in nature and there are no explanations of why effects occur when they do.
P23. It is not the case that there are no causes in nature and there are no explanations of why effects occur when they do.
P24. It is not the case that causes are static and do not change over time. [P22, P23, *modus tollens*]
P25. ~NTG [P1, P21, P24, *reductio* proof]

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