All the time in the world

Alex Malpass
a.p.malpass@gmail.com

The second premise of the Kalām cosmological argument, as defended by William Lane Craig, has two supporting arguments; the Hilbert's Hotel argument and the successive addition argument. In this paper we consider a counterexample to the successive addition argument, first put forward by Fred Dretske. We look at six possible objections to this counterexample, and find each of them problematic. In the end, we conclude that the successive addition argument is unsound.

1 Introduction

Proponents of the Kalām cosmological argument (henceforth the 'Kalām'), in particular William Lane Craig (1979), seek to show that the past must have had a beginning, a moment of creation. Craig offers two independent philosophical arguments for this conclusion. These are the 'impossibility of actual infinities' (or 'Hilbert's Hotel argument') and the 'impossibility of forming an actual infinity by successive addition' (henceforth the 'successive addition argument', or 'SAA'). The SAA will be our focus here.

Craig (1979, p. 103) and Craig & Sinclair (2009, p. 117) state the SAA as follows:

(1) The temporal series of events is a collection formed by successive addition;

(2) A collection formed by successive addition cannot be an actual infinite;

(3) Therefore, the temporal series of events cannot be an actual infinite.

In this paper we will argue that in a certain sense, (2) is false. The counterexample is provided in a paper by Fred Dretske (1965). We then consider six independent objections, made by Craig (explicitly or implicitly), showing how none of them provides good reason to doubt

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the legitimacy of the counterexample. In the end we conclude that Craig's argument is unsound.

Although the focus of this paper may seem narrow, it is of some significance. The literature relating to Craig's defence of the Kalām is vast, and the contemporary discussions of the argument are still influenced to a very large degree by Craig's original presentation and defences, many of which have remained largely the same for forty years. For recent examples of others still following his lead see, for instance, Loke (2017, pp. 61-75), Oderberg (2018, pp. 217-229), and Erasmus (2018, pp. 114-117). There are of course lots of critical replies to this part of Craig's defence of the Kalām, such as Oppy (2001), Morriston (2003; 2013), (Malpass and Morriston 2020, forthcoming) and Draper (2014), and so on. However, it is our contention that much of this work, on both sides of the aisle, overlooks the strength of the objection defended in this paper, and by bringing home the lessons learned here we can shed light on this still ongoing debate.

2. Dretske's argument

Imagine someone counting numbers. Let's call him George. Say he starts counting at time t. Let's suppose that the rate at which George counts is constant, say one number per second. Let's also suppose that no logically contingent thing happens to George to make him stop counting, like falling asleep, or getting bored, going mad, and so on.

Consider the *cardinality* of the numbers that George will count. Because George isn't going to stop counting, there is no number such that he won't eventually count it. Therefore, the cardinality of the numbers he will count is just the cardinality of the natural numbers, $\aleph_0$. And any set with cardinality $\aleph_0$ is Dedekind infinite, which is all Craig means by 'actually infinite'. Therefore, if it is possible that George starts counting and never stops, then it is possible that George will count each element in a set that is actually infinite.

Just this argument was made by Fred Dretske in his (1965) paper *Counting to Infinity*. Here is how he states his argument:

> If George never stops counting, then he will count to infinity. For take any finite number, n; George will count n . . . Hence, for all finite numbers n, George will count n. Since there are an infinite number of finite numbers, we can then say that George will count

> to infinity in the sense that he will count each and every one of the finite numbers - an infinite class. (Dretske 1965, p. 99)[1]

We can put this argument as follows:

(4) It is possible that George starts counting now and will never stop;

(5) If George starts counting now and will never stop, then for each natural number, n, George will count n;

(6) If George will count each natural number, then George will count $\aleph_0$-many numbers;

(7) Therefore, it is possible that George will count $\aleph_0$-many numbers.

At least *prima facie*, the possibility that George will count $\aleph_0$-many numbers seems enough to undermine premise (2) of the SAA – the claim that a temporal series of events formed by successive addition cannot be an actual infinite. After all, the series of George's future counting events appears to be both actually infinite (that is, Dedekind infinite) and formed by successive addition (that is, each is an addition of one which succeeds the previous step). On its face then, this appears to be a clear counterexample.

In what follows, we will consider six objections from Craig to this point. We will consider first Craig's most direct response, the 'no immediate predecessor' argument; secondly, that we might have smuggled in the B-theory; thirdly, that we might have made an illicit modal scope fallacy; fourthly, that we might have confused an actual infinity with a potential infinity; fifthly, that we might have violated something called the 'simple-to-perfect' inference; and lastly, that this is not 'formed' by successive addition after all.

In the end, we will argue that none of these arguments presents any good reason to doubt the counterexample, and conclude that the second premise of the SAA is false, and hence the argument itself is unsound.

[1] Dretske's sense of the phrase 'counting to infinity' is somewhat out of keeping with ordinary usage. If one counts '0, 1, 2, 3', for example, then one has counted four numbers, but no-one would say that one has counted 'to 4'; rather, one has counted to 3. Thus 'counting to' seems to be about ordinal numbers, whereas Dretske is making a point about cardinality. This may help explain why Craig thinks that his article is so confused. Fortunately, nothing in our argument requires the idiomatic usage of that phrase 'counting to infinity', and we avoid it where being careful.

3. The no immediate predecessor objection

The first objection we shall consider is the 'no immediate predecessor' (NIP) argument. Craig directly addresses Dretske's argument in a footnote to his (1979) book on the Kalām. There he calls Dretske's paper a 'brief but very confused article'. He goes on to say:

> Dretske capitalises on ambiguous use of terms. George will never arrive at infinity; therefore the set of all numbers counted will not be an actual infinite. He will never count $\aleph_0$, but if he never does that, he will not count to an actual infinity. In what sense then is George going to count 'to infinity?' —only in the sense that he will count 'forever', or 'without limit'. (Craig 1979, p. 187)

This central point is amplified in the main body of the book, where Craig says:

> Another way of seeing the point is by recalling that $\aleph_0$ has no immediate predecessor. Therefore one can never reach $\aleph_0$ by successive addition or counting, since this would involve passing through an immediate predecessor to $\aleph_0$. (Craig 1979, p. 104)[2]

Craig's idea seems to be this. To count numbers is just to engage in the process of stating the immediate successor of each previous number stated. But if this is all one is doing, then one would never find oneself saying 'aleph-0' out loud. That is because $\aleph_0$ has no immediate predecessor. In that sense then, one can't 'count to infinity'.

We might put Craig's argument like this:

(8) In order to count to x, one must first count the immediate predecessor of x

(9) $\aleph_0$ has no immediate predecessor

(10) Therefore, one cannot count to $\aleph_0$

Call this the NIP argument. It is obviously valid. Premise (8) seems to be an uncontroversial statement of part of what it means to count to a number. Premise (9) is obviously true. If this is the right way to convey what Craig's argument is at this point, there is nothing to

[2] Craig makes a very similar point in his entry to the *Blackwell Companion to Natural Theology*: 'For given any finite number n, n + 1 equals a finite number. Hence, $\aleph_0$ has no immediate predecessor; it is not the terminus of the natural number series but stands, as it were, outside it and is the number of all the members in the series' (Craig & Sinclair 2009, p. 118).

disagree with. One cannot count to a number with no immediate predecessor. If that is what it takes to 'count to infinity', then it seems that one certainly cannot count to infinity.

Despite its clarity and plausibility, it is very important to get clear on exactly what the NIP argument establishes, and what it doesn't establish. Let us concede that it is metaphysically impossible that there is an 'infinity-eth' future counting event (one at which George says 'aleph-0' out loud). The point is that such a concession is compatible with the premises of Dretske's argument, as given in premises (4)–(7) above. This is because they only require the *cardinality* of the numbers that will be counted to be infinite, and not that they include an 'infinitieth' number in the order of counting. Thus one can consistently embrace both Dretske's argument and the NIP, and because of this the NIP cannot constitute an objection to Dretske's argument.

4. The B-theory objection

The next objection we shall consider relates to the B-theory. Sometimes arguments similar to Dretske's are made in pretty explicit B-theoretical terminology, such as this example from Oppy:

> If, for example, we are considering a possible world in which there is a first day, then there is no day in that world at which the collection of days forms a completed infinity. Nonetheless, it may be that, *from a standpoint external to that possible world*, we can say of its days that they form a completed infinity, for it contains infinitely many days that are ordered by the 'is the next day after' relation. (Oppy 2006, p. 237, emphasis added)

Here, the thought is that from the 'outside' of the world, it can be considered an actual infinity, even if that is not the case from the 'inside'. It is passages like this that lead Craig to comment that:

> While we can imagine an actually infinite series of events mapped onto a tenselessly existing infinite series of temporal intervals, such that each consecutive event is correlated with a unique consecutive interval, the question remains whether such a sequence of intervals can be instantiated, not tenselessly, but one interval after another. (Craig & Sinclair 2009, p. 118)

We can put Craig's objection as follows. Oppy's version of the argument presupposes aB-theoretic perspective. But on the B-theory there is no real successive addition at all. Each event exists timelessly and not ‘one interval after another’. Given this, an actually infinite series of B-theoretic eventsis not a counterexample to the claim that ‘a collection formed by successive addition cannot be an actual infinite’.

Yet this response seems to misunderstand what ‘successive addition’ is on the B-theory. These events may all exist ‘tenselessly’ together, but it is still true to say (in the language of the B-theory as it were) that they are instantiated ‘one interval after another’. That’s because, on the B-theory, all it means for one event to be ‘after’ another is just for it to be later than the other. Thought about like this, any endless series of consecutive events (such as days) is an example of an actual infinite formed by successive addition on the B-theory.

In their 2009 article on the Kalām, Craig & Sinclair say:

> By ‘successive addition’, one means the accrual of one new element at a (later) time. (Craig & Sinclair 2009, p. 117)

This simple statement is compatible with this B-theoretical reading, as each day in Oppy’s example is ‘later than’ the previous one. However, in his (2018) reply to Oppy, Craig gives the following remark:

> It seems to me that this objection is based on multiple misunderstandings. In the first place, by ‘successive addition’ I meant the accrual of one new element per (later) time through a process of temporal becoming. As we shall see, Oppy understands successive addition tenselessly or even timelessly. (Craig 2018, p. 160)

The clarification above adds in the condition ‘*through a process of temporal becoming*’, which seems to exclude such a B-theoretical reading as a matter of definition.

However, we can work with this new definition, which was arguably implicit all along anyway. The reason is that Dretske’s argument, and the formulation in premises (4)–(7) above, is entirely stated in tensed terms (’he will count to infinity’, ‘George will count n’, ‘he will count each and every one of the finite numbers’, and so on). These are *tensed* statements, evaluated as situated at an internal temporal standpoint. There is no question that this is an argument that relies on B-theoretic phrasing, or mapping onto a ‘tenselessly existing infinite series of temporal intervals’. All we need to recognise is the (seemingly) unassailable tense-logical inference that if George will not stop counting, then he will count each natural number. Perhaps an intuitionist or strict finitist might deny this inference, but there is no reason that an

A-theorist *qua A-theorist* should. Thus even if we allow that successive addition just entailsthat the A-theory is true as a matter of definition, our argument is unscathed.

5. The modal scope fallacy objection

Moving on, in conversation Craig has said that this argument commits a modal scope fallacy, and this is the next objection we shall consider. He referenced the fallacy of inferring that 'there is a mother of all of humanity' from 'each person has a mother'. His comments present little more than an outline of an objection, but in this section we will explore several ways one might fill that outline in to see if there is a salient objection one could make here.

Craig's example involves changing the scope of an existential and universal quantifier. In our example, it seems that the following would represent the closest way of adapting that:

(11) (∀n)F(George counts n)

(12) Therefore, F(∀n)(George counts n)

This would be fallacious. (11) says that for each number, n, there is a future time, t, where that number is counted. (12) says that there is one particular future time at which all numbers are counted. Obviously (12) does not follow from (11), and if the Dretske argument involved a shift like this it would be bad news.

Another plausible way to interpret Craig's complaint is that the inference involves a slide from 'each' to 'all'. From 'George will count each number' can we infer 'George will count all numbers'? Consider the following inference, which uses 'possibly' instead of 'will':

(13) It is possible that George eats each slice of bread.

(14) Therefore, it is possible that George eats all the slices of bread.

We can read premise (13) in the distributive sense, and (14) in the collective sense. On this reading, (13) means just that no individual slice is such that George could not eat it. The conclusion would be that he can eat the entire loaf. In that case, it is clear that the conclusion does not logically follow, because the loaf might be a 'Hilbert's

Loaf' with infinitely many slices, each of which is small enough to eat on its own.[3] This type of each-to-all inference is clearly invalid.

However, when we change context from modal to temporal, things are not so clear. For instance, it is far less clear that the following is invalid:

(15) It will be that George eats each slice of bread.

(16) Therefore, it will be that George eats all the slices of bread.

Intuitions differ here, but we hear (16) as following logically from (15), in a way that (14) does not from (13). Modern logic is notoriously bad at modelling the subtleties of the natural language expressions 'each', 'every' and 'all', and this is a point where the additional complicating factors of both modal and temporal contexts are in play. Our intuition is that (16) does follow from (15). At the least it is not clear that a fallacy is involved here, in contrast to the inference from (13) to (14) where it is clear.

Suppose (15) – (16) was unambiguously invalid. We are still left wondering where in the argument from (4) to (7) above are we supposed to see either of these types of inference taking place. The only remotely plausible premise that could be making some kind of fallacy like that is premise (6). But this premise is really just an instance of a rule which we could state like this:

(R) If each element in a set S has property P, and the cardinality of the elements of S is X, then the cardinality of the elements that are P is also X.

If each child in the classroom is five years old, and there are thirty children in the classroom, then there are thirty five-year-old children in the classroom, and so on. Such inferences seem trivial. Similarly, if each natural number will be counted, and there are $\aleph_0$-many natural numbers, then $\aleph_0$-many natural numbers will be counted. The application of rule (R) involves no operator shifts, and no slide from each to all. Thus it seems quite clear that none of these reconstructions of Craig's suggestion constitutegenuine criticisms of the argument. If there is a fallacy of the sort that Craig mentioned involved in the argument from (4) to (7), we cannot see it.

[3] This example was suggested to me by Landon Hedrick

6. The potential infinite objection

The next objection concerns the potential infinite. A footnote that appears almost word for word in both Craig & Sinclair (2009, fn. 16) and Craig (2018, fn. 36) suggests a reply that Craig might want to make at this point. The footnote runs as follows:

> Similarly, Oppy's earlier discussion of counting to infinity is predicated upon Dretske's assumption that if one never stops counting, then one does count to infinity (Oppy, *Philosophical Perspectives on Infinity*, p. 61). Oppy fails so much as to mention, much less take account of, the difference between an actual and a potential infinite in this case. One who, having begun, never stops counting counts 'to infinity' only in the sense that one counts potentially infinitely.

Craig's claim is that Oppy doesn't ever consider how a potential infinite might be relevant here. So let's address that directly, and consider what a potential infinite is for Craig, and how that might bear on the question in hand.

The basic point that Craig wants to make seems to be that George will count to infinity only in the metaphysically unproblematic sense of counting potentially infinitely, but this is not the same thing as counting an actual infinity. Unfortunately, Craig doesn't spell out how this is supposed to work in any detail. So let's fill in the details to get clear about it. Craig's idea of a potential infinite is something that is:

(i) ever increasing,

(ii) while remaining finite,

(iii) with infinity as a limit that it approaches without reaching.

Here are a few examples of him making this case:

'Because set theory does not utilise the notion of potential infinity, a set containing a potentially infinite number of members is impossible. Such a collection would be one in which the members are not definite in number but *may be increased without limit*'. (Craig 1979, pp. 68-69, emphasis added)

What one constructs is a potential infinite only, an indefinite collection that *grows and grows as each new element is added*'. (Craig 1979, p. 104, emphasis added)

> ...[A] potential infinite is a collection that is *increasing toward infinity as a limit but never gets there.* (Craig 2008, p. 116, emphasis added)
>
> The concept of a potential infinite is a dynamic notion, and strictly speaking, we must say that *the potential infinite is at any particular time finite.* (Craig & Sinclair 2009, p. 103, emphasis added)
>
> [The potential infinite is] composed of a *finite but ever-increasing number of events with infinity as a limit.* (Craig 2010, p. 452, emphasis added)

So, when Craig says that one 'counts "to infinity" only in the sense that one counts potentially infinitely', we should understand him to be saying that the number that George counts is always finite, while increasing towards infinity as a limit. Say George counts one number per second. After ten seconds, he has counted up to ten. After n seconds, he has counted up to n. At no point has he counted up to any number that is not finite. While the number he has counted up to each second increases without limit, it remains finite and only approaches infinity without ever getting there. He never completes the task (there is no time at which it is a completed infinity), as there are always more numbers left to count at each second. As Craig puts it ' [R]egardless of the time available, a potential infinite cannot be turned into an actual infinite by any amount of successive addition since the result of every addition will always be finite' (Craig & Sinclair 2009, p. 118).

Now that we have this understanding of what Craig means by a potential infinite under our belt, we need to see how that fits into Dretske's notion of counting to infinity. The first thing to note is that Dretske seems to have anticipated Craig's reply. Dretske says:

> It is true that at any stage of his task George will not yet have counted some numbers. But, clearly this fact is not relevant to whether he *will* count to infinity; it only shows that he never *will have* counted to infinity. (Dretske 1965, p. 100, emphasis in original)

This is a neat little tense-logical distinction. It's the distinction between the simple future tense and the future perfect tense. And when we look to see which of the actual and potential futures apply to which tense here, the clear answer is that the simple future is an actual infinite, whereas the future perfect is a potential infinite.

As we saw already, the cardinality of the numbers George *will* count is $\aleph_0$. This follows by impeccable reasoning. If George will never stop counting, then for each and every finite number, n, George will count

n. So, the set of numbers that George will count has the cardinality of $\aleph_o$, which makes it an actual infinite (not a potential infinite). This cardinality is not growing (or even shrinking). It is not approaching anything as a limit. It is always the same. It is always such that there exist bijections from the whole to proper parts. For instance, it will always be the case that the cardinality of the set of numbers he will count equals the cardinality of the set of even numbers he will count, and so on.

In contrast, the numbers George *will have* counted, at any time, is always finite. As time passes, the number he *will have* counted endlessly increases, and approaches infinity as a limit without ever getting there. Thus the future perfect is obviously Craig's potential infinite in this setting.

Dretske's quote is pointing out that it doesn't matter that, in Craig's sense, George is counting potentially infinitely, and that he never *will have* counted every finite number. That fact on its own does not logically prevent it from also being true that he *will* count each and every number. The two are not mutually exclusive. This means that it is not an objection to point to this Craigian sense of the potential infinite here. That's because, once we get our tenses straight, the following is consistent:

The amount of numbers George *will have* counted is potentially infinite, and the amount of numbers that George *will* count is actually infinite.

One does not need to 'turn a potential infinite into an actual infinite'; rather, both the simple future and future perfect tenses apply *at the same time*, because they fundamentally apply to different things. Thus the appeal to the potential infinite is not an objection to Dretske's argument. As with the NIP, once properly appreciated can be held alongside Dretske's argument.

7. The simple-to-perfect objection

The next objection relates to what we might call the 'simple-to-perfect' inference. Some may wish to object along the following lines. Dretske is arguing that 'It will be that p' is true (George will count infinitely many numbers), but without it also being true that 'It will have been that p' (it will be that George has counted infinitely many numbers). Yet, one might have the intuition that if it is true that 'It will be that p', then it must also be true that 'It will have been that p'.

Call this the ‘simple-to-perfect inference’. If that inference were correct, then because it is false that George will have counted infinitely many numbers, we could infer (via *modus tollens*) that he will not count infinitely many numbers.

The simple-to-perfect inference has strong intuitive appeal. If I will eat this apple, then I will have eaten this apple. After all, unless I actually do finish eating this apple at some point, then how can ‘I will eat the apple’ have been true at some earlier time? In the same way, how can it be true that I will count every number unless it is also true that I will have finished counting all the numbers at some point? As Jonathan Bennett (1971) puts it:

> It does seem natural to think that if I shall count them all I shall eventually have counted them all; or to think that if it is true of each of them that I shall eventually have counted it, then I shall eventually have counted all of them. (Bennett 1971, p. 134)

It seems to us that Craig endorses the simple-to-perfect inference. Consider Craig’s example of the man running across slabs (1979, p. 104):

> Suppose we imagine a man running through empty space on a path of stone slabs, a path constructed such that when the man’s foot strikes the last slab, another appears immediately in front of him. (Craig 1979, p. 104)

About this example, Craig says the following: ‘It is clear that even if the man runs for eternity, he will never run across all the slabs’ (ibid).

As Oppy (2018, p. 140) notes, the question shouldn’t be put in terms of whether ‘all’ the slabs will be crossed. Because the slabs only pop into existence when the man’s foot ‘strikes the last slab’, at any one time the man has already crossed all the slabs (all those that currently exist). What Craig means is that he will never finish his task of stepping on slabs.

Interestingly, Craig uses the exact same phrase, ‘will never’, when discussing this example in his 2018 paper:

> For if temporal becoming is real, an infinite number of slabs will never be crossed: the finite series will just go on forever. (Craig 2018, pp. 160-161)

The phrase ‘an infinite number of slabs will never be crossed’ is subtle in its scope. Similar constructions can be found in other places in Craig’s work on this topic. Consider the following:

> . . .[O]ne might be tempted to say that in an endless future there will be an actually infinite number of events, just as in a beginningless past there have been an actually infinite number of events. But in a sense that assertion is false; for there never will be an actually infinite number of events since it is impossible to count to infinity. (Craig 2009, p. 116)

It is possible to hear these 'will never' and 'never will' phrases in several ways. They are rather like duck-rabbit phrases, which can take on different meanings in English. Here is one way of hearing them. Imagine there were ten slabs, and that there was a grim reaper on the sixth who kills anyone who tries to get past him. That way, although there are ten slabs, and the first five are perfectly possible to cross, we might say 'Five slabs *will never* be crossed', referring to the final five. Now imagine that there is an infinitely long series of slabs, but the same grim reaper patrols the sixth slab killing anyone who attempts get past him. In this circumstance, although there is an infinite number of slabs, only five can be stepped on. We might use Craig's phrasing and say about the ones numbered 6 and above: 'An infinite number of slabs will never be crossed'. Heard in this way, the phrase means something like 'There is an infinite number of slabs (6, 7, 8, . . .), and each of them is such that it will never be crossed'.

But this would not be the right way to understand how Craig uses the constructions 'will never' and 'never will' in his original example. In his set up, it is not that there is some maximum number of slabs that the man will cross (such as 5). Craig is not saying that in his example some number of slabs are such that they will never be crossed, let alone that infinitely many will not. Rather, there is *no* number of slabs such that they will never be crossed, because the man will never stop running — for each number n, the man will step on the n+1 slab. This implies that *each* slab will be crossed, eventually.

It seems that the only way to understand Craig's phrase 'an infinite number of slabs will never be crossed' is to interpret him as saying something like the following:

> There is never a point at which infinitely many slabs *have been* crossed.

He isn't saying that there is some number of slabs (such as 5), higher than which will not be crossed, but rather that there is no point at which all of the numbered slabs have already been crossed. How else are we to understand the phrase?

If that is the correct way to read Craig, then he is making the following argument:

(17) If George will count every number, then George will have counted every number.

(18) George will never have counted every number.

(19) Therefore, George will not count every number.

Premise (17) is the simple-to-perfect inference. The argument is obviously valid, and Dretske is conceding premise (18). Therefore, it looks as though we have a strong objection.

However, the simple-to-perfect inference is not logically valid. Bennett agrees but concludes that the reason is that we are dealing with an infinite set:

> I conclude that those who say that I shan't count all the natural numbers because I shan't ever have counted them all are ignoring a distinction . . . which is usually negligible but which is important in just such contexts as Dretske's, where . . . what is being counted is an infinite set. (Bennett 1971, p. 134)

Yet, the idea that it is infinite contexts here that makes the inference invalid cannot be the correct analysis. The reason is that there are other counterexamples to the simple-to-perfect inference, ones which do not involve infinite sets at all. One such is the following:

Imagine a world where p is true right at the end of time, and that p is never true before that (perhaps p is the proposition 'This is the end of time'). In such a world, 'It will be that p' is true right up to the end of time, but 'It will have been that p' never true, because 'It has been that p' is never true.

This example clearly does not require anything infinite. We are explicitly imagining that time has an end, and so the future is not infinite. Thus the general lesson of Dretske's point cannot be that the simple-to-perfect inference is valid in finite contexts, but not in infinite contexts. Rather, what seems to be the important point is that the inference fails in contexts *where there is no internal standpoint which comes after the subject of the future tensed statement*. The reason George *will* count every number, but George will not *have counted* every number, isn't just that there are infinitely many numbers; it is because there is no point in time which follows his counting. His counting numbers, as it were, 'fills the future', leaving no room for an internal temporal standpoint at which we could look back and say that it was complete. It literally takes up all the time in the world.

Thus one cannot object to Dretske by using the simple-to-perfect inference, because that inference is invalid. In particular, it is not truth-preserving in the very context which we are discussing, as it is one where there is (or will be) no internal temporal standpoint from which we can look back on every one of his counting events. So, in this context, 'It will be that p' is true, even though 'It will have been that p' is false. That makes premise (17) false, and the argument above unsound.

8. The accumulation objection

Readers familiar with Craig's writing on this subject may have the feeling that a simple objection has not yet been raised, and it is time to do so now. The issue has to do with accumulation, and how this is temporally asymmetrical.

Imagine dropping marbles into a jar one by one. What matters, according to this objection, is how many marbles there are in the jar at any one time, that is, the cardinality of the class C:

$$C = \{x \mid x \text{ is in the jar}\}$$

This class is always finite, no matter how long we drop marbles in. Even if, as Dretske's argument establishes, it is possible that I will drop actually infinitely many marbles into the jar one by one, the jar will always have only finitely many marbles in. *This*, we might think, is the point that Craig is making.

One might think that when made like this, it sidesteps Dretske's argument. After all, the numbers that George *will* count (or the marbles he will drop into the jar) are not yet part of the collection that is being formed by successive addition. So even if actually infinitely many marbles will be dropped into the jar, the number of marbles in the jar will always remain finite. This point holds even if Dretske's argument is correct.

In order to evaluate this objection, we need to get clear on precisely what Craig means by 'successive addition'. As we saw already, in his 2009 paper he says the following:

> By ‘successive addition’, one means the accrual of one new element at a (later) time. (Craig & Sinclair 2009, p. 117)

The notion is of a step by step ‘accrual’, or accumulation, of a collection. So there are at least two aspects to this notion; the ‘succession’ condition (it is one by one) and the ‘accumulation’ condition (they form a totality). To make this clear, we will state it as follows:

> A collection is ‘formed by successive addition’ if and only if
>
> *Succession*: The addition of each element to the collection succeeds the previous one (apart from the first, if there is one);
>
> *Accumulation*: There is a totality that accumulates from the succession.

With the marbles example, the marbles are dropped one at a time (rather than all at once, and so on), which satisfies *Succession*. In addition, as they do so they accumulate a collection, specifically class C becomes non-empty, which satisfies *Accumulation*.

However, there is a problem when we apply this to a temporal series of events. The simple fact is that the elements in a consecutive sequence of events (like counting numbers) never exist together, in the sense of existing at the same time as each other. It is not just their being ‘dropped into the jar’ that is successive, but their very *existence*. In this sense then, the temporal series is disanalogous to dropping marbles into a jar.

This point is particularly pertinent for Craig, who holds to a presentist theory of temporal ontology. On this view, there is no point at which consecutive past events, such as George’s counting events, ever exist together. Rather, the only event that exists is the present event. If we are dropping marbles in a jar, then presentism is a jar with a hole in the bottom. For this reason, on presentism the mere passing of time is not enough to constitute the forming of a collection of events by successive addition, because the *Accumulation* condition (crucial to successive addition) is never satisfied.

One might try dropping the *Accumulation* condition to get round this problem. However, this would not help. If we did that, then all that it would mean to be ‘formed by successive addition’ is for the events in question to follow from one another, which George’s future counting events obviously do. Then, because Dretske’s argument establishes the possibility of George counting each natural number, it would follow that such an infinite sequence can be ‘formed by successive addition’.

The conclusion here seems to be that either the notion of successive addition includes *Accumulation*, in which case the numbers George has counted do not qualify, or it does not include *Accumulation*, in which case the numbers that George will count do qualify. What one does not seem to be able to do, however, is have one notion which applies to the numbers he has counted but not to the numbers he will count.

Another alternative would be to abandon presentism. An advocate of the other extreme position in the ontology of time, eternalism, does not have a jar with a hole in the bottom. For them, past events 'exist' even though they are not all present together; eternalists will typically quantify existentially over past events, and take this to be timeless and ontologically committing. This is true for B-theoretic versions of eternalism, such as that of Russell (1915), or for A-theoretical ('moving spotlight') theories, such as Cameron (2015). In either case, an eternalist would see George's past counting events as a collection of existing things, and this means that, even if we included *Accumulation* in the definition of successive addition, past events would qualify – which is good news for the defender of the SAA.

However, it is misleading to think of anything being 'formed' by this process. The events themselves all exist timelessly, regardless of whether the moving spotlight has passed over them; nothing existentially relevant happens to them. Thus what we really have is one big collection of all events, past, present and future, and its membership does not change. To return to our metaphor, the eternalist jar just timelessly has all the marbles in it.

What eternalism and presentism have in common is *symmetry* with respect to the ontology of time; both say that the ontological status of the past and the future is the same. However, there is a cluster of views in the ontology of time that do not share this view, known as 'no future' or 'growing block' theories, defended by people like Broad (1923), Adams (1986), Tooley, (1997), and Forrest (2005). On this view, to put it simply, future events do not exist, in contrast to past and present events, which do. Now, it seems, we have our desired result. We can treat future events as a presentist would, and past events as an eternalist would.

If we include the accumulation condition in the definition of successive addition, then we find that George's past counting events constitute a collection that is made up of elements that exist at a time, whereas George's future counting events constitute a collection that is made up of elements that do not exist at a time. The growing block theorist can concede that the number of future counting events is an actual infinite, but that they do not count as a collection 'formed by successive addition' because they do not exist (at a time). This restores premise 2 of the SAA.

Yet things are not quite so simple. Among growing block theorists, there is nuance about the claim that the future does not exist. Perhaps the person who has best worked out a version of the theory, Michael Tooley, is critical of traditional A-theoretical doctrines such as the irreducibility of tensed quantification. As Tooley puts it:

> Tensed accounts of the nature of time, by contrast, almost invariably view tensed quantification as basic. But, as I argued earlier, attractive though such an approach may initially seem to those who favour a tensed account, it is simply untenable. Quine's claim that tenseless quantification is fundamental must be accepted, regardless of one's views on the nature of time. (Tooley 1997, p. 305)

Does this mean that Tooley does believe in the existence of future events after all? Tooley goes on to make the following comments:

> The answer, once again, turns upon the crucial point that a dynamic view of the world requires both the concept of being actual *simpliciter*, and the concept of being actual as of a time. Tenseless quantification does presuppose that the future is actual *simpliciter*. But it does not presuppose that the future is actual as of the present moment. (ibid)

Therefore, Tooley does not quite treat future events as a presentist would; there is still a residual symmetry in play on his view. This complicates the clarity of the growing block reply to the dilemma. On the one hand, there is a jar which gradually accumulates marbles as they are dropped in (tensed quantification); however, on the other hand there is an irreducible sense in which all the marbles timelessly exist in one jar (tenseless quantification). Thus it is certainly not clear that the appeal to the growing block theory allows the defender of the Kalam to escape Dretske's argument.

One thing is clear however, namely that one cannot follow Craig completely. If one is a presentist, then there is no workable notion of accumulation in play, and that undermines the idea that there is any successive addition whatsoever.

9. Conclusion

In conclusion, then, we have considered a counterexample to the second premise of Craig's successive addition argument. We have looked at six possible objections to this, with reference to the parts of Craig's work where he either directly or indirectly makes them himself. In each case we have found that the objections can be resolved. We think this leaves the original argument as unsound, given the existence of a viable counterexample to the second premise.

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