***If time can pass, time can pass at different rates***

**Abstract**

According to the No Alternate Possibilities argument, if time passes then the rate at which it passes could be different. Thus, time cannot pass, since if time passes, then necessarily it passes at a rate of 1 second per second. One response to this argument is to posit hypertime, and to argue that at different worlds, time passes at different rates when measured against hypertime. Since many A-theorists think we can make sense of temporal passage without positing hypertime, we pursue a different response. We describe several worlds that do not contain hypertime, but do contain *differential passage*: worlds where time passes at different rates in different subregions *within the same world.* Hence we argue that even if we focus just on the set of worlds that do not contain hypertime (whether this is all, or only some of the worlds) we find that not all these worlds are such that time passes at a rate of 1 second per second. Thus the No Alternate Possibilities argument fails even when restricted to just this set of worlds.

**1. Troublesome Rates of Passage**

According to *dynamic* theories of time, time *passes*. We take temporal passage to consist in (a) there being a fact of the matter regarding which entities are objectively present, and (b) there being *changes* in which entities are objectively present.[[1]](#footnote-1) Presentism, the growing block theory, the dropping branches theory, and the moving spotlight theory are all theories according to which time passes.[[2]](#footnote-2) Such views face various objections. A common objection trades on the lack of fit between the supposition that there is a privileged hyperplane that is the objectively present moment, and what relativistic physics tells us about judgements of simultaneity from different frames of reference.[[3]](#footnote-3) In fact, we find this objection quite compelling, which is why we are not, in fact, dynamists. Nevertheless, in what follows we set this objection to the side. For we are interested in another objection to dynamism: an objection that arises from the idea that if time passes, it must pass at a rate, and the only plausible rate at which time can pass is 1 second per second.

Some have objected that a rate of 1 second per second is not a rate at all. Thus, they conclude, time cannot pass, since the only plausible answer to the question ‘at what rate does time pass?’ is not a rate.[[4]](#footnote-4) This paper focuses on the nearby objection according to which if time passes then it passes at some rate, and if it passes at some rate, then *the rate at which it passes could be different*. But the rate at which time passes (if it does) is, necessarily, 1 second per second. Hence time cannot pass, and hence does not pass.[[5]](#footnote-5) Tallant (2016) calls this the *No Alternate Possibilities* argument.[[6]](#footnote-6)

Contemporary discussion of the No Alternate Possibilities argument (in particular Tallant (2016) and Raven (2010)) centres on the question of whether there is anything objectionable about a putative rate holding of necessity. It is taken for granted that there are, indeed, no alternate possibilities—no alternate rates at which time could pass. It is not so clear that this assumption ought be taken for granted if one allows that hypertime is possible. For then it seems that time’s passing in each world can be measured against hypertime, and time can pass at different rates in different worlds. Perhaps time passes at 1 second of time per second of hypertime in w1, and 2 seconds of time per second of hypertime in w2. More generally, in worlds with hypertime we should not understand temporal passage in terms of a rate of seconds per second of time, but as a rate of seconds of time per second of hypertime. The latter kind of rate does not appear to hold of necessity—it plausibly varies between worlds—and thus the No Alternate Possibilities argument fails.

One might argue that there remains some residual problem of comparing rates across worlds even if those worlds contain hypertime. For perhaps it is hard to establish a shared metric by which we can compare the rate at which time passes in such worlds. We won’t consider this worry here, for in any case, defenders of temporal passage will find this response unsatisfactory if either they think that hypertime is metaphysically impossible, or they think (as many do) that we ought be able to make sense of time passing without appealing to hypertime, and hence think that we ought be able to make sense of its passing at different rates without appealing to hypertime. Thus, in what follows we consider the prospects of time passing at different rates in the set of worlds in which there is no hypertime, without taking a stance on whether this set contains all, or only some of, of the metaphysically possible worlds.[[7]](#footnote-7)

Without the prospects of hypertime, it is very hard to see how one could offer an inter-world comparison of the rate of temporal passage. For it is not clear on what basis one might claim that time passes faster in one world than in another. Thus, we focus on *intra-*world comparisons of the rate of temporal passage. We argue that amongst the metaphysically possible worlds that do not contain hypertime, are worlds in which there is *differential passage:* worlds in which time passes at different rates in different subregions *within a world*. While we focus only on growing block worlds, we think that some of what we say can be extended to cover worlds in which temporal passage is modelled in other ways—most straightforwardly to moving spotlight worlds—though we do not make that case here.

By showing that differential passage is possible in worlds that lack hypertime, we show that time need not pass at a rate of 1 second per second even in worlds that lack hypertime. For if there is a world in which time passes at twice the rate in subregion S1 as it does in subregion S2, then it cannot be that time passes at 1 second per second in every subregion of that world. If time passes at 1 second per second in S2, it follows that time passes at 2 seconds per second in S1. If time passes at 1 second per second in S1, it follows that time passes at 0.5 seconds per second in S2. Thus, if there are worlds with differential passage, the No Alternate Possibilities argument fails even if we restrict our attention to worlds that lack hypertime.

Given that this argument is our focus, in what follows we will assume, without argument, that dynamism is consistent with the special and general theories of relativity (though we are not sure that this is true). We aim to show that given this assumption, no *further* objection arises from the alleged necessity of the rate at which time passes. Thus our conclusion is conditional: we conclude that insofar as we can make sense of the idea of there being some preferred foliation, and of a single hyperplane of that foliation being the objectively present moment, we can also make sense of differential passage*.*

In what follows we begin by simply describing a class of worlds that, *prima facie,* seem to contain differential passage (§2). In §3 we proceed to argue that at least some worlds in this class are metaphysically possible. In §4 we argue that these worlds both contain differential passage and do not contain hypertime. Hence these worlds are counterexamples to the claim that if time passes, then necessarily it passes at a rate of 1 second per second.

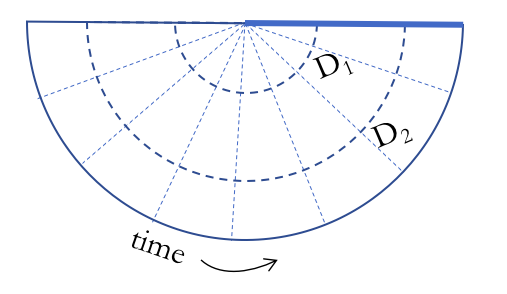
**2. Worlds with Differential Passage**

In what follows we describe a class of growing block worlds, and explain why, at least *prima facie*, these worlds seem to be ones in which there is differential passage. It is not until §§3-4 that we argue that things are as they *prima facie* seem: that these worlds are metaphysically possible, contain differential passage, and lack hypertime.

According to the growing block model, the totality of reality grows as new entities come into existence at one end of the block. The coming into existence of these entities constitutes the passage of time. Let’s call the totality of co-present things—objects, properties and relations—that come into existence at one end of the block, *a time*. In what follows we will be interested in a class of growing block worlds in which time is continuous. In such worlds, times are three-dimensional slices of reality: *hyper-planes*, and there will be continuum-many hyper-planes. In such worlds the block grows by the accretion of hyper-planes at the ‘growing’ end of the block, and the passage of time consists in the accretion of these hyper-planes. Let us call the hyper-plane on the outermost edge of the block the *privileged hyper-plane*. Then all (and only) those events, properties, and objects located on the privileged hyper-plane are objectively present.

Again, remember that we are assuming that we can make sense of there being such a hyper-plane within a dynamical metaphysics of time. If we cannot, then the question of whether time can pass at different rates or not appears to be largely moot, insofar as it just seems to follow that the actual world, at least, is not dynamical (and hence most motivation for endorsing a dynamical theory disappears).

The typical conception of a continuous growing block world has the hyper-planes accreting in such a way as to be *parallel* with one another, thus forming a four-dimensional growing *block*. However, this need not be so. Instead, the hyper-planes might accrete in such a way that the ‘block’ is not ‘block-shaped’ at all. The class of worlds in which this is so is the class with which we shall be interested. Let’s call this class *the continuously growing non-block worlds*. To get a feeling for such worlds, let’s consider a particular world in this class. Imagine that the privileged hyper-plane is represented by the hand on a clock. Suppose that the hand begins pointing to 9 o’clock and traces a continuous path towards 6 o’clock and then towards 3 o’clock, yielding a shape that is not a block, but a sector. Each successive location of the hand represents a hyper-plane that is accreted, and the privileged hyper-plane corresponds to the very last location of the hand. No hyper-plane is parallel with its predecessor: instead of a growing block world, we have a *growing sector world*. See figure 1 below.



*Figure 1. The growing sector world. The bold line represents the privileged hyper-plane.*

The curved part of the sector represents the temporal dimension. As new hyper-planes accrete (from left to right) new times come to be arrayed along the temporal dimension. There’s nothing special about the growing sector world amongst the class of continuously growing non-block worlds. If the growing sector world contains differential passage, then (at least *prima facie*) so will other shaped continuously growing non-block worlds.

Moreover, it does seem as though the growing sector world is a world with differential passage. One way to understand growing block worlds (and we return to this in §4) is that they are worlds in which time is conceived both as a *dynamical quantity*—the accretion of hyper-planes—as well a *dimension* along which hyper-planes are arrayed. This is to say that in such worlds we need to appeal both to A-determinations (or A-properties)—i.e. pastness, presentness and futurity—and to B-relations, in order adequately to characterise the temporal structure of the world. Typically these two align. If events E and F are co-present with one another (such that if one instantiates presentness, then so does the other) and events E\* and F\* are co-present with one another, then the temporal distance between E and E\*—as measured by static B-relations—is expected to be the same as that between F and F\*.

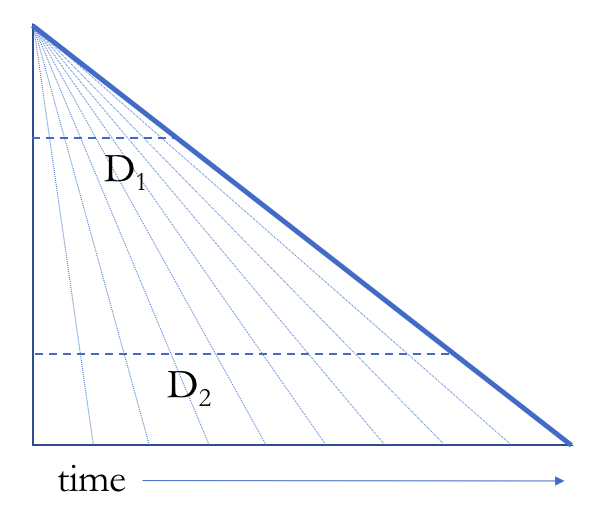
In the worlds we are describing, however, this is not so. Paths D1 and D2 in Figure 1 both originate at events that are co-present, and terminate at events that are co-present. In other words, these paths both originate and terminate at the very same moments in time: respectively, the very first hyper-plane, and the privileged (present) hyper-plane. However, the temporal distance—as measured by static B-relations—for an object traversing D1 is much shorter than the temporal distance for an object traversing D2. If temporal distance D, is larger than temporal distance D\*, then more time has passed for an object traversing D than D\*. Hence more time has passed for the object traversing D2 than the object traversing D1.

*Prima facie,* then, the growing sector world (and hence other continuously growing non-block worlds) is a world with differential passage: a world where time does not pass at 1 second per second in every subregion. Of course, only if continuously growing non-block worlds are metaphysically possible do they constitute a counterexample to the claim that if time passes, then necessarily it passes at a rate of 1 second per second. Moreover, if the possibility of these worlds entails that differential passage is possible in the absence of hypertime, it must be that these worlds lack hypertime. §3 argues that at least some such worlds are metaphysically possible, and §4 argues that the worlds we have described do not tacitly appeal to a hypertemporal dimension.

**3. Metaphysical Possibility**

There are numerous ways to argue that no worlds in the class of continuously growing non-block worlds are metaphysically possible. Some of these are arguments to which we will not respond here. For instance, one might argue that these worlds are metaphysically impossible because dynamical time is metaphysically impossible.[[8]](#footnote-8) We won’t consider this avenue here, since we are interested in the No Alternate Possibilities objection to dynamical theories of time. That objection is only interesting if there is not some more straightforward argument for the metaphysical impossibility of dynamical time. Alternatively, one might concede that dynamical time is metaphysically possible, but argue that growing block worlds are metaphysically impossible: perhaps one thinks, for instance, that presentism is true, and necessarily so. We won’t consider this response either. We are principally interested in reasons to think that continuously growing non-block worlds in particular are metaphysically impossible, not reasons to think that growing block worlds, *simpliciter*, are impossible.

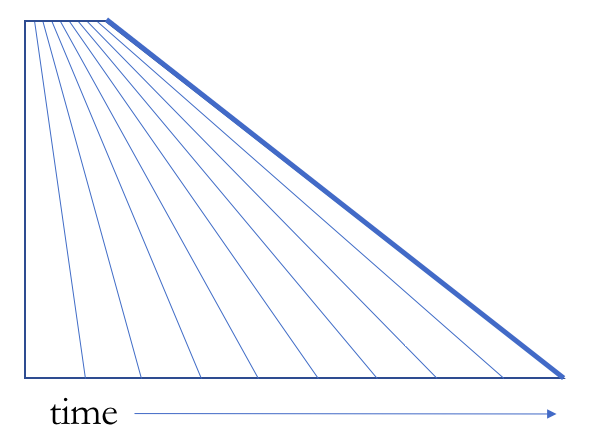
Why suppose that all of the continuously growing non-block worlds are metaphysically impossible? Let’s return to the growing sector world. One might worry that this world is metaphysically impossible because it has a curved temporal dimension. If one thinks that, of necessity, the temporal dimension is straight, then one ought think that the growing sector world is metaphysically impossible. While we are not sure why one would think that the temporal dimension is necessarily straight, even if it is, at most this shows that the growing sector world is impossible. It says nothing about other continuously growing non-block worlds. For instance, consider another world in that class: what we will call the *growing triangle world*. In this world, as time passes the universe itself expands along the spatial dimensions, so that later hyper-planes are spatially larger than earlier ones. As a result, the temporal dimension remains straight. See figure 2 below.



*Figure 2.* *The growing triangle world.*

Like the growing sector world, the growing triangle world is one in which the distance in B-time between the first and present time is very small near the top of the triangle, and is much larger at the bottom of the triangle—D1 is much shorter than D2. Hence time passes more quickly towards the bottom of the triangle than towards the top. *Prima facie,* then, the growing triangle world is a world with differential passage and a straight temporal dimension. Since there are worlds in the relevant class that contain a straight temporal dimension, this objection fails.

Another objection to the metaphysical possibility of continuously growing non-block worlds would point to a similarity between the growing sector and growing triangle worlds. Namely, that in both worlds all the hyper-planes intersect at a point. The offending point is at the ‘centre of the clock’ and the ‘tip of the triangle’, respectively. At the offending point, there is no temporal passage. But perhaps if there is temporal passage in a world, then necessarily there is temporal passage everywhere in that world. Moreover, it is odd for a world to include a point that is part of every time. This, one might contend, is metaphysically impossible. Let’s suppose this is so. Then the growing sector and growing triangle worlds are metaphysically impossible. Again, though, this doesn’t show that all worlds in this class are impossible. Consider another world in that class, which we call the *growing cut-off triangle world*. This world is just like the growing triangle world, except it does not include the problematic ‘tip’ of the triangle.[[9]](#footnote-9) See figure 3 below.



*Figure 3. The growing cut-off triangle world.*

Like the growing triangle world, the growing cut-off triangle world appears to be a world with differential passage. It is a world where time passes more quickly towards the bottom of the cut-off triangle than towards the top. If time passes at 1 second per second towards the top of the cut-off triangle, then time passes at more than 1 second per second towards the bottom. If time passes at 1 second per second towards the bottom of the cut-off triangle, then time passes at less than 1 second per second towards the top. It is also a world in which the temporal dimension is straight, and in which there is temporal passage everywhere, since there is no point that is part of more than one time. So, neither objection succeeds: there remain worlds in the relevant class that have not been shown to be metaphysically impossible.

So far, however, none of this shows that these really are worlds with differential passage, or, at least, that they are worlds with differential passage in which we are not tacitly appealing to hypertime. It is to this worry that we now turn.

**4. Hypertime and Differential Passage**

So far we have described several worlds and suggested that they contain differential passage. Moreover, we have made no mention of hypertime in these worlds. Nevertheless, one might object that in fact what we have described are really worlds containing both time and hypertime. We noted previously that growing block worlds are worlds in which time is conceived both as a *dynamical quantity*—the accretion of hyper-planes—as well a *dimension* along which hyper-planes are arrayed. Hence growing block worlds are worlds in which we need to appeal both to A-determinations and B-relations. Further, we described worlds in which there are two pairs of events—E and E\*, and F and F\*—such that E and F occur at the same moment in time (they are co-present) and E\* and F\* occur at the same moment in time (they are co-present) and yet the temporal *distance* between E and E\* is different from the temporal *distance* between F and F\*.

One way to understand this claim is to suppose that in growing block worlds there are two kinds of time—A-time and B-time. A-time consists in the accretion of new hyper-planes. B-time is the dimension along which the hyper-planes are arrayed. In worlds with differential passage these two kinds of time come apart. Then E and F occur at the same moment in A-time, as do E\* and F\*, but the temporal distance between E and E\* *in B-time* is different from the temporal distance between F and F\*.[[10]](#footnote-10) But if this is the right way to describe such worlds, then a natural suggestion is that really we have just described a world with time and hypertime. In particular, since A-times are arrayed along the B-time dimension, it is natural to think that B-time is really hypertime. After all, hypertime is nothing more than a second temporal dimension against which one can measure time. Since A-time is a good candidate to be time (in the context of thinking that time is dynamical) it seems plausible to think that B-time is really just B-theoretic hypertime. If that is so, then, at best, we have shown that there can be differential passage in the *presence* of hypertime.

We think this objection fails. There are those who hold that any coherent growing block theory must be committed to independent A-determinations and B-relations,[[11]](#footnote-11) or to time and hypertime.[[12]](#footnote-12) Others disagree.[[13]](#footnote-13) This is not a dispute we can adjudicate here. We can, however, say the following: we see no reason to think that positing both A-determinations and B-relations is tantamount to positing both time and hypertime.

Positing A-determinations and B-relations is tantamount to positing time and hypertime only if (a) positing A-determinations and B-relations entails positing two kinds of time—A-time and B-time—and (b) one of A-time and B-time ought be identified as time, and one as hypertime.

It’s not at all obvious that (a) is true. Instead, we might think that there is a single thing, time, which has two characteristics: a dynamical characteristic measured by accretion of slices, as well as a non-dynamical characteristic measured by the distance *between* existing slices. But there is not both some independent dimension, which is B-time, along with which A-time unfurls. There is just the growth of the block in time, and said growth generates B-relations that allow us to measure distances within the block of space-time itself.

But let’s suppose, for the sake of argument, that (a) is true: positing both A-determinations and B-relations amounts to positing two kinds of time. Even given this concession, it is still not clear that (b) is true: it is not clear that we ought identify one of these kinds of time as time, and one as hypertime. To see why, consider a standard growing block world, which, by supposition, contains both A-time and B-time. Ought we think that A-time is time, and B-time is hypertime? No. Hypertime is typically conceived as an *independent* temporal dimension with respect to which we can measure the passage of time. In such a world, however, B-relations are *generated* by the accretion of slices through the passage of time. B-relations are not independent of this accretion. That’s why it makes little sense to wonder if slices could accrete faster, in B-time, than in fact they do. By contrast, hypertime is a genuinely independent temporal dimension whose positing allows us sensibly to wonder whether the block as a whole, could grow faster, or slower, than it does, when measured against this independent axis.

The crucial difference, then, is that B-relations are relations within the block, which are grounded in the accretion of new slices in time (or A-time), whereas hypertime is an independent temporal axis: independent both of the accretion of slices, as well as of the various B-relations that this accretion generates. So as we see it, even if there is both A-time and B-time in a standard growing block world, neither of these ought be identified with hypertime. But there is no more temporal structure in continuously growing non-block worlds than in standard growing block worlds. The only difference is the shape of the ‘block’. Thus, if B-time is not identified with hypertime in standard growing block worlds, we see no reason why B-time should be identified with hypertime in continuously growing non-block worlds. So, even if continuously growing non-block worlds contain two kinds of time, there is not reason to think that they contain hypertime.

That brings us to a final objection, according to which the worlds we have described are metaphysically possible, and they do not contain hypertime, but the phenomenon we have described is not really differential passage at all. Perhaps it merely looks like differential passage because of the diagrammatic representations we have offered. But we really don’t see what case can be made for this claim. Perhaps an objector might resist our characterisation of these worlds, by suggesting that where we have represented D1 and D2 being of different *temporal* lengths, we should instead have represented them as being of different *spatiotemporal* lengths. That would leave open that they are in fact the same temporal length.

But in the absence of a positive proposal for how to make sense of this claim, it is not more than an assumption or stipulation. In a growing block world there are facts about what is simultaneous with what (or so we have assumed).[[14]](#footnote-14) Then all the events on each hyper-plane are co-present, and simultaneous with one another. As such, there is a preferred foliation of such slices. While distances between events located on different hyper-planes will represent spatiotemporal distances, it ought be straightforward to partition these into spatial and temporal lengths precisely because there is a preferred foliation of the hyper-planes. Given this, we see no reason to think that the right thing to say is that D1 and D2 are the same temporal length, but different spatiotemporal lengths, since we can specify conditions under which E and E\*, and F and F\*, are temporally, and not spatially, separated. Hence, in the absence of a positive reason to interpret the cases in this way, we think it is most natural to suppose that these are worlds with differential passage.

**5. Conclusion**

We hope to have shown that it is plausible that there are metaphysically possible worlds containing subregions where time does not pass at 1 second per second, and hence shown that time can pass at different rates. Moreover, we hope to have shown that this is so even restricting ourselves to considering worlds that lack hypertime.

The upshot of this is that those who espouse dynamic theories of time need not argue that there is nothing objectionable about a putative rate holding of necessity. Even if so-called necessary rates are not *really* rates, this is no threat to time’s passing at a rate.

Of course, this leaves open that there might be something objectionable about time passing at *any* rate, and, indeed, that there might be something contradictory about changes in which entities are objectively present.[[15]](#footnote-15) Our conclusion is thus conditional: if it is possible for time to pass, and for time to pass at a rate, then it is possible for time to pass at different rates. The No Alternate Possibilities argument fails.

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1. See *inter alia* Skow (2015), Olson (2009), Leininger (2018), Markosian (2003) and Tallant (2016). [↑](#footnote-ref-1)
2. The exception proves the rule: Tallant (2012) defends a version of presentism that does not posit temporal passage. [↑](#footnote-ref-2)
3. For a recent overview of these debates, see Baron (2018). [↑](#footnote-ref-3)
4. See Smart (1949) and Price (1996). Price characterises a rate of seconds per seconds as not a rate but a “dimensionless quantity” and suggests that “We might just as well say that the ratio of the circumference of a circle to its diameter flows at n seconds per second!” (1996:13). For discussion of this objection see Tallant (2016, 2010), Raven (2011), Philips (2009), Skow (2010) and Olson (2009). [↑](#footnote-ref-4)
5. Raven says “The necessity of the rate of time’s passage entails that there are no possible alternative rates, hence (allegedly) entailing the incoherence of the rate itself” (2010:464). [↑](#footnote-ref-5)
6. This argument appears in Maudlin (2002), Markosian (1993), and Price (1996). [↑](#footnote-ref-6)
7. We take metaphysical possibility to be the widest genuine kind of possibility (i.e. possibility that is not merely doxastic or epistemic). [↑](#footnote-ref-7)
8. See McTaggart (1908). Recall also the objection from relativity that we put to the side at the beginning of the paper. [↑](#footnote-ref-8)
9. Equivalently, we could excise the centre of the clock. [↑](#footnote-ref-9)
10. Of course, the *number of slices* between the respective pairs of co-present events is the same. There are infinitely many slices between *any* two times in continuous growing block worlds. Thus we shouldn’t think of temporal distance in B-time in terms of number of slices, lest all such distances be implausibly rendered equal. Instead, we ought think of temporal distance in B-time in terms of a *measure* over these slices. Thus conceived, it is clear that the temporal distance in B-time (and hence the temporal duration) between E and E\* is different from that between F and F\*. [↑](#footnote-ref-10)
11. See McTaggart (1908:469); Broad (1938:278); Crisp (2003, §2.4.2). [↑](#footnote-ref-11)
12. Tooley (1997). [↑](#footnote-ref-12)
13. Schlesinger (1980:32); Button (2007, §1); Skow (2015:61-68); Correia and Rosenkrantz (2013). [↑](#footnote-ref-13)
14. That is, we have assumed that special relativity is false at such worlds. [↑](#footnote-ref-14)
15. See McTaggart (1908). [↑](#footnote-ref-15)