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THE OBJECTIVITY OF TIME-FLUX AND THE DIRECTION OF TIME

I. McTaggart's attack (reprinted in [2], ch. 1) on the flow of time — that is, the fleeting characterization of events (taken to be actual, momentary, total [all-encompassing] events) in terms of being future, then present, then past — has received considerable attention in recent years (see for example [1], ch. 6). But having looked at his argument with the utmost attention, I find nothing in it but a simple confusion of two possible meanings of 'present', 'past', 'future': 'present (past, future)' can mean being *presently present* (past, future), or being *once present* (past, future); but it cannot, reasonably, mean both concepts at once. If one chooses the first meaning, then the sentence 'No [actual, momentary, total] event is both present and past, or present and future, or past and future' is straightforwardly true, but the sentence 'Every [actual, momentary, total] event is present and past and future' is straightforwardly false. If, however, one chooses the second meaning, then the first sentence is false, the second sentence true. Of course there are events that are once present (because they are presently present) and once past (because they will be past after being present) and once future (because they were future before being present); in fact, every [actual, momentary, total] event is once future, then present, then past, that is: once future, once present, once past.

Thus, if both meanings are carefully distinguished, then there simply is no antinomy that might make one skeptical about the possibility of a coherent conception of the flow of time. Because then the two sentences do not in the least seem to be both true, in spite of the fact that they *cannot* (given that there are any events at all, and that word-meanings are stable) be both true. If, however, one unwittingly conflates the first meaning with the second, then each sentence, in describing an essential feature of the flow of time, may very well appear to be true, while, most disturbingly, they cannot be true together. This appearance, however, would be due to one's own fault; it is not the fault of the conception of temporal flux.

II. Let me first of all give a consistent description of the phenomenon called 'the flow of time'. Later on I will provide an argument for its objective reality. (The thrust of this argument is that we would not be able to assign non-arbitrarily a direction to time, if there were no flow of time.)

The description is McTaggartian in so far, as it uses, like McTaggart, the temporal predicate 'x is present' ($\mathcal{N}(x)$) [in the first meaning considered above]. This predicate is meant to apply to events only. Hence we have as a first analytical principle:

P1 $\forall x(\mathcal{N}(x) \supset \text{Event}(x))$

(For all x: if x is present, then x is an event.)

In addition, the description makes use of tense operators (McTaggart, in a way, does so, too; see [2], pp. 32 f.; the *exclusive* use of tense operators is characteristic of Prior's minimalistic conception of the flow of time in [2], ch. 2). They are the ordinary tense operators 'It was the case that A' (PA), and 'It will be the case that A' (FA). For these operators, in addition to the principles of classical predicate logic, the following basic schemata for logical principles are assumed (logical consequence and equivalence is to be taken as determined by the logic thus defined):

A1 $A \supset \sim P \sim FA$.

A2 $PPA \supset PA$.

A3 $PA \wedge PC \supset P(A \wedge PC) \vee P(PA \wedge C) \vee P(A \wedge C)$.

A4 If A is a logical (or merely analytical) principle, then $\sim P \sim A$ is one as well.

B1–B4 are the mirror-images of A1–A4 ('F' replacing 'P', 'P' replacing 'F').

Given this, it is appropriate to define OA ('It is once the case that A') as follows:

D1 $OA \Longleftrightarrow PA \vee A \vee FA$.

And IA ('It is always the case that A') by

D2 $IA \Longleftrightarrow \sim O \sim A$ [that is: $\sim P \sim A \wedge A \wedge \sim F \sim A$].

We can add the definitions of the other two McTaggartian predicates:

D3 x is past [$\mathcal{V}(x)$] $\Longleftrightarrow P\mathcal{N}(x)$.

D4 x is future [$\mathcal{Z}(x)$] $\Longleftrightarrow F\mathcal{N}(x)$.

The events (keep in mind that they are supposed to be actual, momentary, total events) are naturally and essentially ordered in a certain manner by a certain relation R. The following sentences are analytical principles:

P2 $\forall x, y(xRy \supset \text{Event}(x) \wedge \text{Event}(y))$.
P3 $\forall x, y(xRy \supset {\sim}yRx)$.
P4 $\forall x, y, z(xRy \wedge yRz \supset xRz)$.
P5 $\forall x, y(\text{Event}(x) \wedge \text{Event}(y) \supset xRy \vee yRx \vee x = y)$.

For what follows later, it is important to realize that these four principles also hold analytically if R is replaced in them by R', since for these two dyadic predicate-constants we have as an analytical principle:

P6 $\forall x, y(xRy \equiv yR'x)$.

Clearly R' is the essential inverse of R, and events are just as essentially and naturally ordered by R' as they are by R.

Both R and R' have something to do with time: they are both before-relations. In fact, we may dub R 'the A-before relation', and R' 'the B-before relation', and P6, for example, may be rephrased as 'For all x and y: x is A-before y iff y is B-before x'. Consider now two events such that x is A-before y; well, then y is B-before x. But is x *before* y, or is y *before* x? For deciding *that*, obviously, some additional information is needed. The principles P2–P6 don't help us in this respect at all.

In fact B-Beforeness and A-Beforeness are related in a closer manner to time than by merely being before-relations:

P7 (a) $I\forall x, y(\mathcal{N}(x) \wedge \mathcal{V}(y) \supset yR'x)$,
$I\forall x, y(\mathcal{N}(x) \wedge \mathcal{V}(y) \supset xRy)$.
(b) $I\forall x, y(\mathcal{N}(x) \wedge \mathcal{Z}(y) \supset xR'y)$,
$I\forall x, y(\mathcal{N}(x) \wedge \mathcal{Z}(y) \supset yRx)$.

From P7(a) the following theorem can be deduced:

T1 $I\forall x(\mathcal{N}(x) \supset {\sim}\mathcal{V}(x))$

(It is always the case for all x: if x is present, then x is not past.)

Proof:

(1) $I\forall x(\mathcal{N}(x) \wedge \mathcal{V}(x) \supset xR'x)$ is a special case of P7(a).
$\forall x\,{\sim}xR'x$ is a straightforward logical consequence of P3 and P6, hence an analytical principle like P3 and P6; consequently we obtain by A4, B4, D2:
(2) $I\forall x\,{\sim}xR'x$. T1 follows logically from (1) and (2).

Analogously, the following theorem can be deduced from P7(b) [which, by the way, is logically equivalent to P7(a)]:

T2 $I\forall x(\mathcal{N}(x) \supset {\sim}\mathcal{Z}(x))$.

Finally we also have as a theorem:

T3 $I\forall x(\mathcal{V}(x) \supset \sim\mathcal{Z}(x))$.

Proof:

Assume x is past and future; hence by D3 and D4: $P\mathcal{N}(x) \wedge F\mathcal{N}(x)$; hence logically, mainly by A1 and B2: $P(\mathcal{N}(x) \wedge F\mathcal{N}(x))$ — contradicting T2; hence T2 logically implies T3.

T1, T2, and T3, in their turn, logically imply the first ingredient to McTaggart's 'antinomy' (see the quotation below): 'No event is both present and past, or present and future, or past and future.'

P7 provides a partial description of the flow of time: it indicates that this flow 'inexorably' follows *one* particular direction. The description is *almost* (but only almost) completed by adding:

P8 $\forall x O\mathcal{N}(x)$ [Every event is once present].

P8 says that the flow of time, or rather 'the wave of the present', inevitably reaches every event. 'Every event was, is, or will be present' is a synonymous formulation of P8 [via D1], and so is 'Every event is past, present, or future' [via D1, D3, D4] (in this formulation P8 is also asserted by McTaggart; see [2], p. 32, where McTaggart says: "Past, present, and future are incompatible determinations. *Every event must be one or the other*, but no event can be more than one."). From P7 and P8 we immediately obtain:

T4 $\forall x O(\mathcal{N}(x) \wedge \sim P\mathcal{N}(x) \wedge \sim F\mathcal{N}(x))$.

In other words: 'Every event is present once only.'

Presentness is not an eternal property. In contrast, Eventhood is an eternal property, and R and R' [A-Beforeness and B- Beforeness] are eternal relations. We have as analytical truths:

P9 (a) $\forall x(\text{Event}(x) \supset I\text{Event}(x))$; $\forall x(\sim\text{Event}(x) \supset I\sim\text{Event}(x))$.

(b) $\forall x, y(xRy \supset IxRy)$; $\forall x, y(\sim xRy \supset I\sim xRy)$.
$\forall x, y(xR'y \supset IxR'y)$; $\forall x, y(\sim xR'y \supset I\sim xR'y)$.

(In each line of P9 the first principle suffices, since the second one can be logically obtained from it. Note that the principles in P9, being analytical truths, can — by applying A4 and B4 — be prefixed by 'I' as defined in D2.)

I have said that by the addition of P8 to P7 the description of the flow of time is *almost* completed. (Completed in the sense that *the heart of the matter* has been completely described; its fuller description, of course, can be indefinitely prolonged without coming to the point that nothing interesting remains to be told about it; but at some point or other in its description the work of the ontologist of time has definitely ended, and the work of the historian of nature and human affairs definitely begun.) What is still missing? Two more principles. First:

P10 $I\forall x, y(\mathcal{N}(x) \wedge (xR'y \vee yR'x) \supset \sim\mathcal{N}(y))$.

P10 says that 'the wave of the present' has minimal latitude. It does not even distribute itself over events in the immediate vicinity of the event that is reached by it.

Using P7, P8, P9 and P10 we obtain the following beautiful theorem:

T5 $\forall x, y(xR'y \equiv O(\mathcal{N}(x) \wedge F\mathcal{N}(y)))$

[For all x and y: x is B-before y iff it is once the case that: x is present, and y will be present].

Proof:

(i) Assume: it is once the case that x is present and y will be present; hence by P7(b): it is once the case that x is B-before y; hence by P9(b) [contraposition of the second principle for R'] $xR'y$.

(ii) Assume: x is B-before y; hence by P2: x and y are both events; hence by P8: x is once present, and y is once present; hence by D1: $(P\mathcal{N}(x) \vee \mathcal{N}(x) \vee F\mathcal{N}(x)) \wedge (P\mathcal{N}(y) \vee \mathcal{N}(y) \vee F\mathcal{N}(y))$.

(1.1) Assume: x was present, and y was present; hence by A3: $P(\mathcal{N}(x) \wedge P\mathcal{N}(y)) \vee P(P\mathcal{N}(x) \wedge \mathcal{N}(y)) \vee P(\mathcal{N}(x) \wedge \mathcal{N}(y))$. From the first member of this disjunction we obtain by P7(a) and D3: $P(yR'x)$, hence by D1: $O(yR'x)$, hence by P9(b): y is B-before x, contradicting the first assumption in (ii), 'x is B-before y', in view of P3. From this assumption and the third member of the disjunction we obtain by P9(b):
$P(\mathcal{N}(x) \wedge xR'y \wedge \mathcal{N}(y))$, contradicting P10.
This leaves us with the second member of the disjunction: $P(P\mathcal{N}(x) \wedge \mathcal{N}(y))$, which logically implies $P(\mathcal{N}(x) \wedge F\mathcal{N}(y))$, hence also: it is once the case that: x is present, and y will be present.

(1.2) Assume: x was present, and y is present; hence logically: $P(\mathcal{N}(x) \wedge F\mathcal{N}(y))$, hence: it is once the case that: x is present, and y will be present.

(1.3) Assume: x was present, and y will be present; hence logically: $P(\mathcal{N}(x) \wedge F\mathcal{N}(y))$, hence: it is once the case that: x is present, and y will be present.

(2.1) Assume: x is present, and y was present; hence by P7(a): $yR'x$ — contradicting the basic assumption in (ii): $xR'y$ (in view of P3).

(2.2) Assume: x is present, and y is present; but this contradicts the assumption '$xR'y$' (in view of P10).

(2.3) Assume: x is present, and y will be present; hence: it is once the case that x is present, and y will be present.

(3.1) Assume: x will be present, and y was present; hence logically: $P(\mathcal{N}(y) \wedge F\mathcal{N}(x))$; hence by P7(b): $PyR'x$, hence $OyR'x$; hence by P9(b): $yR'x$ — contradicting '$xR'y$'.

(3.2) Assume: x will be present, and y is present; hence by P7(b): $yR'x$ — contradicting '$xR'y$'.

(3.3) Assume: x will be present, and y will be present; hence by B3: $F(\mathcal{N}(x) \wedge F\mathcal{N}(y)) \vee F(F\mathcal{N}(x) \wedge \mathcal{N}(y)) \vee F(\mathcal{N}(x) \wedge \mathcal{N}(y))$; from the second member of this disjunction we obtain by P7(b): $FyR'x$, hence by P9(b): $yR'x$ — contradicting the basic assumption in (ii): $xR'y$. From this assumption and the third member of the disjunction we obtain by P9(b): $F(\mathcal{N}(x) \wedge xR'y \wedge \mathcal{N}(y))$ — contradicting P10. This leaves us with the first member of the disjunction, which logically implies: it is once the case that: x is present, and y will be present.

Clearly, (3.3) completes the proof of T5.

Completing the description of the heart of the matter at hand, we need to set down:

P11 There are events.

And we may immediately add:

P12 $\forall x(\text{Event}(x) \supset \exists y(yR'x) \wedge \exists y'(xR'y'))$.

There can be hardly any doubt about P11, and P12 is at least highly plausible. Whatever one thinks about P12, a McTaggartian principle (although McTaggart, deplorably, did not get it into sharp focus; see [2], p. 32) can be gotten from it:

T6 $\forall x(O\mathcal{N}(x) \wedge O\mathcal{V}(x) \wedge O\mathcal{Z}(x))$

[Every event is once present, once past, and once future].

Proof:

Assume: x is an event; hence by P12: there is a y which is B-before x; hence by T5: $O(\mathcal{N}(y) \wedge F\mathcal{N}(x))$; hence by D4: it is once the case that x is future [1].

Also from the assumption by P12: there is a y' such that x is B-before

y'; hence by T5: $O(\mathcal{N}(x) \wedge F\mathcal{N}(y'))$; hence logically: $O(P\mathcal{N}(x) \wedge \mathcal{N}(y'))$; hence by D3: it is once the case that x is past [2].
Also from the assumption by P8: it is once the case that x is present [3].

As a further theorem we have:

T7 It is always the case that *at most one* event is present.

(There is nothing inadequate about this, since events are understood to be actual, *total*, momentary events.)

Proof:
Assume: it is once the case that *two different* events, x' and y', are present; by P5, P6, A4, B4, D2: $I\forall x, y(\text{Event}(x) \wedge \text{Event}(y) \supset xR'y \vee yR'x \vee x = y)$; hence we have by P10: $x' = y'$ — contradicting the assumption.
And as a principle that corresponds in an obvious manner to T7 we can add:

P13 It is always the case that at *least one* event is present.

This principle states that the 'wave of the present' always engulfs some event, and hence is never without events to be engulfed by it.

From P13 P11 follows trivially. And with the help of P13 we can prove:

T8 It is always the case that there are events x, y, and z such that: y was present, x is present, and z will be present.

Proof:
Assume: x is present; hence by P1 and P12: $\exists z(xR'z) \wedge \exists y(yR'x)$; hence by T5: it is once the case that x is present and z *will be present* [1], and it is once the case that y is present and x will be present [2] (for some events z and y);
by D1, T1, T2 and the assumption 'x is present' from [1]: x is present, and z will be present; by D1, T1, T2 and the assumption 'x is present' from [2]: $P(\mathcal{N}(y) \wedge F\mathcal{N}(x))$, hence: *$y$ was present*.
Hence we have: '$\forall x(\mathcal{N}(x) \supset \exists y, z(P\mathcal{N}(y) \wedge F\mathcal{N}(z)))$'. We can prefix this by 'I' ['It is always the case that'], since only principles that can be prefixed by 'I' without losing their validity [in fact, *all* principles advanced above are of this kind] have been used in its deduction. Hence we get via P13 T8.

III. It is easy to see that P1–P13 (on the basis of A1–A4, B1–B4) form a *consistent* theory: this can be proven by providing a model for this theory.

Imagine a never changing straight continuous line stretching to infinity in both directions, one of which is called 'direction A', and the other 'direction B'. The [total, actual, momentary] events are the points on this line. If x and y are points on the line such that point y lies further down the line in direction A than point x, then and only then we say: x is A-before y, or in other words, xRy. If x and y are points on the line such that point y lies further down the line in direction B than point x, then and only then we say: x is B-before y, or in other words, $xR'y$. By this description we have taken care of the truth of P2–P6, P9, P11 and P12 [take them in the form where they are all prefixed by 'I']. Imagine now a point p^* always moving uniformly in a constant distance above the line into direction B. If x is a point on the line that is [momentarily] precisely opposite to p^*, then and only then we say: x is present. By this further description we have also taken care of the truth of P1, P7, P8, P10 and P13 [take them in the form where they are all prefixed by 'I'].

So, clearly, there is nothing whatever inconsistent about time-flux. If someone still holds on to McTaggart's claim (if not to McTaggart's 'proof' of it) that time-flux is inconsistent, he or she will have to declare the above description of a model for time-flux to be mere gibberish — a position fairly hard to defend.

The above model can easily be modified for the purpose of independence proofs. P13, for example, is proved to be independent of the rest of the principles like this: Suppose the line has a gap in it, a point on the line and another point on the line, and for the length of 1m there is no point belonging to the line in between; p^*, undisturbed in its uniform motion, simply crosses the gap and resumes its travel parallel to the line on the other side. Everything else is as in the model above. This means that P13 does no longer hold true, while all principles other than P13 are fulfilled.

By proving time-flux to be consistent, we have not yet provided an argument for its objective reality. This argument, however, lies close at hand. Suppose, one is convinced of the principles P1–P13, and suppose, somebody asks "What is the direction of time?" — one has all the means necessary for providing a well-justified answer to this question. By 'the direction of time' one means the direction of the succession of events in conformity to which events happen to be without qualification *before* or *earlier than* other events (the latter events being without exception further 'down the line' in *that direction* than the former), and are not merely essentially A-before, or B-before them. Consider P7. This true principle tells one that the 'flow of time' always sticks to a certain uniform direction in its movement along the succession of events, and it tells one that this direction happens to be direction B. I submit that this is the best possible reason we can have to say that direction B is [as a matter of fact] the direction of time; or in other words: that Beforeness 'is' [contingently coincides extensionally with] B-Beforeness.

Of course, being merely told this, one has not become in any degree acquainted with Beforeness. This can easily be remedied. Let m be the [actual, total, momentary] event of which one particular momentary phase of the explosion of the Hiroshima bomb is a part. Let m' be the event of which one particular momentary phase of the explosion of Mount St. Helens is a part. It was the case that: m is present, and m' will be present; hence: it is once the case that: m is present, and m' will be present; hence by T5: m is B-before m'; hence, since Beforeness 'is' B-Beforeness: m is before m' [m' later than m]. — Examples can be multiplied to any extent.

Now drop all the flux-principles from P1–P13, forget about tenses and tense-operators. How could one know then that m is before m', and not m' before m? The mere position of m relative to m' in the succession of events does not tell one this — not even if events wore numbers on their backs, the number of m being smaller than the number of m'; for, who says that for this reason m is before m'? (Note that number 1945 is as much before [smaller than] number 1980 as 1980 is before [greater than] 1945.) Of course, one may simply stipulate that Beforeness is identical to B-Beforeness; but the other stipulation, that Beforeness is identical to A-Beforeness, is just as well motivated. One might now turn to scrutinizing the contents of the events m and m'. If one were granted omniscience relative to m and m' (which are rather comprehensive items), one would presumably find out that the world is a bit more run down in m' than it is in m, or in technical terms: that the degree of entropy in m' is higher than the degree of entropy in m. But does this by itself, or even that there is a steady increase of the degree of entropy in all the events from m to m', make m' *later than* m? Surely not.

To put it boldly: the truth of the matter is that 'it is once the case that: x is present, and y will be present' [alternatively: 'it is once the case that: x was present, and y is present'] is *the adequate defining predicate* for 'x is before y'. Hence, if one leaves tenses out of consideration, one loses the very meaning of 'x is before y', and therefore throws away the indispensable means of knowing whether m is before m', or m' before m, notwithstanding one is still able to know that m is B-before m', m' A-before m, and that the degree of entropy in m is smaller than in m'. And, if one leaves tenses out of consideration, one has no way of finding out what is 'the direction of time'.

All that is left is arbitrary stipulation — stipulation that is not so arbitrary after all. For the criteria thrown out at the front door sneak back in again by the rear door, that is, by tacitly motivating the stipulation. Why, for example, is the direction of entropic increase (direction B) fastened upon as being the direction of time? Why not the direction of entropic decrease (direction A)? Why are events with lower entropy said to be (on the whole) before events with higher entropy? Why not vice versa? The reasons are:

(1) The direction of entropic increase is *de facto* the direction of temporal flux.
(2) If events x and y are such that x is of lower entropy than y, then (normally, but quite contingently) it is once the case that: x is present, and y is future; and vice versa.

A final remark: While 'For all x and y: x is before y iff it is once the case that: x is present, and y will be present' is a definitional, hence analytical truth, *T5 is not*; it is a synthetical, [analytically] contingent truth. Hence '$\forall x, y(xR'y \equiv x$ is before $y)$' is a contingent truth, too [or in other words: Beforeness contingently coincides extensionally with B-Beforeness]. This means that Beforeness is irreflexive, since B-Beforeness is analytically irreflexive (being analytically asymmetric). But Beforeness could be *not irreflexive* (what neither A-Beforeness nor B-Beforeness could be): Suppose 'the wave of the present' once upon a time suddenly retreats for a while (into direction A) instead of advancing (into direction B), and then resumes again advancing. This falsifies P7 (we have to conclude that in the case considered there is no [uniform] direction of time), and guarantees that some events are before themselves, since it is once the case that they are present, and will be present.

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