Rate abuse: a reply to Olson

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Olson (2009) argues that time does not pass because (i) if it did it would have to pass at some rate, and (ii) there is no rate at which it could pass. This, he avers, refutes the 'dynamic view' according to which 'the passage of time is a genuine process of change in the temporal properties of times, events, or persisting objects' (2009: 4). Moreover, since all tensed views of time entail the dynamic view, they must be abandoned too.

Let us grant that Olson is right that passage must occur at some rate. If so, he is also right that only one rate is possible; if time passes, it passes at one second per second. His reason for thinking that this is unacceptable is quite wrong. It is this:

> One second per second is one second divided by one second. . . . when you divide one second by one second you get one. . . . And *one* is not a rate of change. (2009: 5)

Precisely this objection is made by Price (1996: 13). Maudlin (2002: 262) supplies the right response. Units in a rate do not cancel out as if we were reducing a fraction to its simplest terms. A rate is a *ratio of two quantities*, a relation one quantity bears *to* another. One second divided by one second is one, and one is not a rate of change, just as Olson says. But one second *per* second is not one second *divided* by one second, and it is not equal to one. One second *per* second is a ratio of time to unit time, a relation between two amounts of time, whereas neither one second divided by one second nor one is a ratio or relation of quantities.

It is easy to be misled here. Fractions or quotients can sometimes be used to *express* ratios (and rates), at least as long as we know what it is we are expressing. But ratios are not fractions. A fraction is simply one number divided by another. Thus, $n/n = 1$, where $n \neq 0$. In contrast, a ratio, $n{:}m$, is *the relation* one quantity bears *to* another. It does not equal one even if $n = m$.[1]

Maudlin uses an example to demonstrate the point. Suppose we are exchanging square feet (of tile) for feet (of liquorice). Any rate of exchange

1 Though the *Oxford English Dictionary* is quite clear on these points, mathematical dictionaries are not always helpful. Witness: 'The ratio of two numbers r and s is written r/s, where r is the numerator and s is the denominator. The ratio of r to s is equivalent to the quotient r/s' and likewise, 'The term "quotient" is most commonly used to refer to the ratio $q = r/s$ of two quantities r and s, where $s \neq 0$' (Weisstein 2009: entries on 'Ratio' and 'Quotient', respectively). There is absolutely nothing wrong with using these terms so defined but in the present context it is crucial to realize that rates of passage are not quotients.

Analysis Vol 69 | Number 3 | July 2009 | pp. 503–505 doi:10.1093/analys/anp075

we agree upon will be a rate of square feet per foot. Such exchanges are everyday. Yet, if Olson were right we could demonstrate that the exchange of tile for liquorice was impossible. For by his logic we could cancel out feet and give the rate as n feet. And, of course, n feet is not a rate.

Olson might object to Maudlin's example that the units when fully expressed are square feet *of tile* and feet *of liquorice*, and go on to insist that *these* cannot be cancelled. It is easy to finesse the objection. Imagine a tile exchange where tiles of different colours are traded. Rates are expressed in terms of square feet of colour c_1 per square foot of colour c_2. So far no ill-conceived 'cancelling' is even tempting. However, a little reflection suffices to show that it is essential for the operation of any realistic exchange that there is an exchange rate for tiles of the same colour. To keep things simple assume that this is a rate of one square foot per square foot.

Why do we need such a rate? Well imagine Tyler has a large $4' \times 4'$ blue tile and wishes to exchange it for eight small $1' \times 1'$ red tiles and the difference in small $1' \times 1'$ blue tiles. Red tiles trade at two square foot of red per square foot of blue. Thus, with his 16 square foot blue tile, Tyler can acquire the eight small red tiles he wants and still have 12 square foot of blue tile left over. How many small $1' \times 1'$ blue tiles can he acquire for this remainder? The answer is obvious: 12. The reason, as a 'tile exchange theorist' might put it, is, of course, that the exchange rate for blue tiles is one square foot of blue tile per square foot of blue tile.[2]

Again, if Olson were right, this would be nonsense. There could be no such rate, for it would be equal to one, and one is merely a dimensionless number not a rate. But Olson has misunderstood rates. His argument leaves the dynamic theorist in no worse a position than the tile exchange theorist. No doubt there are powerful theoretical reasons to question the passage of time. This is not one.

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2 Lee Walters reminded me of the supermarket coin exchange machines which exchange coins for notes at the rate of, say, £0.70 in notes for every £1 in coins. Such a machine might also offer change for notes. A likely mode of operation of such a machine would be for money to be put in (in whatever form) and then the desired output selected (i.e. coins or notes). Either by accident or by design (say, to rid themselves of a dirty note) someone might put in notes and take notes out. How much they receive back will depend on the rate, a rate of pounds sterling (in notes) per pound sterling (in notes). Cf. Maudlin 2002: 240.

References

Maudlin, T. 2002. Remarks on the passing of time. *Proceedings of the Aristotelian Society* 102: 259–74.

Olson, E. 2009. The rate of time's passage. *Analysis* 69: 3–9.

Price, H. 1996. *Time's Arrow and Archimedes' Point*. Oxford: Oxford University Press.

Weisstein, E.W. 2009. *MathWorld – A Wolfram Web Resource*. http://mathworld.wolfram.com/. Last accessed 8 May 2009.

Correction

David Dolby, The Reference Principle: a defence. *Analysis* 69: 286–96.

Insert the following on p. 288 above proposition (2b):

The difference between referential and non-referential occurrences of referring terms is marked by the possibility or impossibility of forming corresponding generalizations and questions.* 'Spain', in (2a), is a specification of the generalization:

*[Footnote] The possibility of forming an appropriate generalization distinguishes referential from non-referential uses of referring terms: it does not show that a position is referential as opposed to predicative or adverbial positions, since generalizations into other sorts of position are also possible, e.g. 'He succeeded somehow'.

Analysis Vol 69 | Number 3 | July 2009 | p. 505 doi:10.1093/analys/anp066