A remark on conceptual metaphor and scalarity

Rick Nouwen*

1 Introduction

It is cross-linguistically very common to use locative prepositions as modifiers of numerals in pre-nominal position. As noted by Corver and Zwarts (2006), combinations of prepositions and numerals typically involve prepositions that are compatible with the vertical axis. For instance, English uses *under n* and *over n* to be synonymous to *fewer than n* and *more than n*, respectively. Similarly, Romanian uses the locative *sub 20*, as in (2), from Corver and Zwarts (2006).

(1) John found over / under 50 typos in the manuscript.

(2) Au fost sub 20 de copii la petrecere.
Have been below 20 de-prep children at party
There were under 20 children at the party

Two questions arise from these observations. First, why do we see such a cross-linguistically stable association between quantity and space? Second, given this association, why is it realised cross-linguistically in such a specific way: so far, no language has been found that uses prepositions with an exclusive horizontal content to express *fewer* or *more*. That is, we do not find quantity expressions like *left of 50*, or *behind 50*. So, why do prepositions modifying numerals like those in (1) and (2) always convey spatial relations that are compatible with a vertical orientation?

Corver and Zwarts point to Lakoff and Johnson's conceptual metaphor *more is up;less is down* (henceforth, MULD) for the answer to both questions.[1] Lakoff and Johnson illustrate this metaphor with examples of the kind *the number is high*, *my income rose*, etc. (Lakoff and Johnson, 1980). According to this metaphor, we conceptualise quantity as a pile of stuff - more stuff means a pile that is taller, less stuff means a pile that is not as vertically pronounced. The examples in (1) and (2), it seems, are just further applications of the same conceptual metaphor. In this squib, I will show that there are compelling reasons to look more closely to the application of this conceptual metaphor in this domain. I will show that it makes sense to connect MULD with what in truth-conditional semantic traditions is called the *scalar semantics* of numerals. In a nutshell, the MULD conceptual metaphor can be connected to properties of the scales involved in the semantics of numerals. Once these properties change, the appropriate conceptual metaphor changes as well. In particular, I will propose a novel metaphorical condition on preposition use in the numeral domain. As I will show, there is considerable promise in such a proposal, but it also leaves important questions unanswered.

*Thanks are due to Lisa Bylinina, Ora Matushansky, Susan Rothstein and to several anonymous reviewers. I moreover gratefully acknowledge a grant from the European Research Council under the European Unions Seventh Framework Programme (FP/2007-2013) / ERC Grant Agreement no. 313502.

[1] One could at first sight perhaps imagine a different source as well. There is ample evidence in cognitive (neuro)psychology of the existence of a mental number line, a spatial representation of numerical values used for the cognitive operations that make up our number sense. (The most compelling evidence for this comes from the so-called SNARC: the spatial numerical association of response codes, Dehaene et al. 1993). It is unlikely, however, that this mental number line actively influences how we *talk* about quantity, given the fact that for most humans the line is horizontally oriented. (Typically, in fact, the mentioned SNARC effect is linked to writing direction.)

An indirect consequence of this squib is that brings together two quite distinct views on meaning: semantics from a *cognitive linguistics* perspective and the truth-conditional perspective often referred to as *formal semantics*. The general perception is often that these disciplines are scientifically disjoint by the fact that they intrinsically focus on different aspects of meaning. If my reasoning here is on the right track, then the domain I am considering here contains examples of where these differences are canceled by the very nature of the observations.[2]

2 The scalar semantics of numerals

In formal semantics, the meaning of a numeral is an abstract object, a number, that becomes meaningful because it is part of *a scale*. Scales are an important tool in formal semantics, since they allow to bridge parts of language that appear conceptually distinct, such as adjectival meaning, quantification, tense, etc. A semantic scale is an ordering of values that is associated with the meaning of a certain expression (see Solt, 2015, for a comprehensive overview). For instance, if we are comparing two students and say of them that one of them is *smart* but the other one is *very smart* then a very common way to make semantic sense of this is to assume that adjectives like *smart* map individuals to *measures of smartness*. In this case, the smartness measure of the first student is inferior to the measure of the second.

Such measures of smartness – that is, the points on the scale – are often referred to as *degrees*. Generally, then, scalar semantics has two crucial ingredients: (i) a scale of degrees; (ii) a way of connecting entities / individuals with such degrees. (See, for instance, Kennedy 2007 for a details of how to work out such a semantics.)

As I already hinted at above, while scales are most prominently associated with gradable adjectives, since these typically concern properties that hold of entities to a certain degree, it is clear that the verbal and the nominal domain host scalar semantics too. One clear example of scalar semantics outside the adjectival domain is the semantics of quantity. Numerals and quantifiers like *many* and *few* address a measure of *amount* and thus require a semantic scale of quantity. That is, the relevant scale is an abstract ordering of quantity, i.e. a line of numbers. We map (groups of) entities to this scale by counting, estimating, etc. For instance, the effect of a truth-conditional scalar semantics for a sentence like (3) is that this sentence is true if and only if the *measure* in (4) is *many* / *four*.

(3) John found many / four typos in the manuscript.

(4) the number of typos that John found in the manuscript

We can simply think of the scale of quantity as the rational numbers paired with their standard ordering, which I will write as $>_q$. This allows a neat parallel between adjectival scalarity and the scalarity involved in quantity. For instance, it in principle allows for a uniform treatment of *more* in (5) and (6).

(5) John is more beautiful than Mary.

(6) John ate more biscuits than Mary.

Both sentences involve mapping John and Mary to two measures and then comparing the position of these on the relevant scale. In (5), we are interested in degrees of beauty, while in (6) we are interested in counting the number of biscuits eaten.

All this is a very roundabout way of saying that, from a formal semantic point of view, numerals correspond to numbers. This may appear almost a trivial result. However, the scalar machinery guarantees that these numbers are not just isolated points, but by their very scalar nature connected to other numbers via the ordering $>_q$. It is exactly this connection to a scale that I

[2] I am definitely not the first person to identify such common ground: see, for instance, Jaszczolt 2006.

propose is crucial in understanding the conceptual metaphor for quantity.
On the one hand, scales of the kind I have been discussing here are obviously not inherently spatial. They are completely abstract objects. Yet, I will claim that the link to space is to be found in the structural properties of these scales. In a nutshell, I will propose that the quantity scale in natural language semantics has properties that only coincide with properties of the vertical spatial axis; it is structurally different from the lateral (left-right) and the frontal (front-back) axis.
Of course, one could at this point object that the assumption that such (formal semantic) scales play a role is unnecessary. The comparison involved in sentence like (5) and (6) could be thought of in conceptual terms, without alluding to abstract objects like degrees. In fact, a few paragraphs ago, I described the semantic process involved in these sentences as determining the *position* on a scale. Clearly, scalarity is a notion that itself is metaphorically conceptualised to a considerable degree. Indeed, I have not and will not give reasons why a purely conceptual characterisation of scalarity should not be pursued. This is because, using the formal semantic notion of a scale will allow me to connect to well-studied properties of measurement, which is what I turn to in the next section.

3 Connecting properties of scales to properties of spatial axes

As I explained in the previous section, *scalarity* is an essential component in the formal semantics of quantity. Scales are ordered sets of measurements. Such orderings can differ in a number of important respects. Measurement theory (Stevens, 1946) distinguishes three kinds, or *levels*, of scales.[3] The simplest one is the ordinal scale. This is an ordering of elements that traces only their relative positions. There is for instance no notion of distance between the elements. Ordinal numbers are the most natural examples of an ordinal scale. By telling you who came 1st, 2nd and 3rd in a race, I am only conveying order. We cannot extract any information about distances between the participants in the race.
Interval scales carry more information: they are ordered sets of elements that trace distance. An example is clock time. The ordering tells us that 9pm comes after 8pm and 11am is before 2pm. However, on top of that it includes a notion of distance. The "amount" of time between 1pm and 2pm is exactly the same as the "amount" between 2pm and 3pm.
The most involved notion of a scale are *ratio orders.* Like *interval scales*, ratio scales trace the distance between ordered elements. In addition, however, they allow for multiplication. An example is the weight scale. Obviously, the difference between 2kg and 3kg is 1kg and the difference between 4kg and 5kg is also 1kg. But we also know that 4kg is twice as heavy as 2kg. In contrast, this is unavailable for clock time: it would be odd to say that midnight is twice as late as noon. Or that 7am is twice as late as half past three at night. (What would be twice as late as 11pm?) This is not to say that time is never measured on a ratio scale. Duration, for instance, is ratio. If you waited 7 hours for your connecting flight, then you waited twice as long as the person who waited 3 and a half hours.
What is at stake for the difference between interval and ratio scales is the availability of a non-arbitrary 0. On a clock there are only arbitrary starting points. We could say that a day starts at midnight, but that point on the scale does not play any significant role on the scale. The same goes for the 0 on a thermometer. In celcius, we assign the freezing point of water to 0, but this is of course arbitrary. We can measure temperature in many different ways; for instance, using Fahrenheit, the 0 will be somewhere completely different. In other words, there is no natural 0 for temperature.[4]

[3]Stevens distinguishes a fourth level of measurement, the *nominal* level. However, this is a kind of measurement where there is no ordering at all.

[4]Note that this is so despite of the fact that from a scientific point of view, the temperature scale does come with an absolute zero value. This kind of scientific knowledge does not impact our folk understanding of

There *is* a natural 0 for length, for instance. Here too, we could measure using different conventions. What is 2.5 centimeters in the metric system is just under 1 inch using the imperial unit. However, 0 centimeter is the same length as 0 inch: the 0 for length is clearly not arbitrary. So, length in contrast to temperature is a ratio scale.

Quantity scales are clearly ratio orderings too. We do not have systems of counting quantities that start at a dozen or at a pair: 0 designates the absence of stuff; in this sense, it is an unmovable non-arbitrary starting point.

Now here comes the crucial observation. Take an arbitrary point in the everyday space we inhabit. Only the vertical axis will give us a fixed second position to compare this point with, namely the ground underneath it. If we divide the space up in a lateral (left-right) axis, a frontal (front-back) axis and a vertical axis, then arguably only the latter has this kind of non-arbitrary 0. Engrained in our notion of space is a notion of *ground*.The vertical dimension of space starts just below our feet. In the horizontal dimension there is no comparable point. We could take our *self* as a reference point, but this does not correspond to a fixed spatial position; it moves when we move. It is thus useless as a zero-ground for an absolute objective notion of ratio-level measurement. In this sense, a vertical spatial axis, but not a horizontal one, has the crucial property needed to constitute a ratio scale.

4 The scalar metaphor condition

It is now time to return to our actual focus: prepositional numeral modification. The observation I started out with is that a certain kind of use of numerals turns out to be consistently modified only by prepositions compatible with a vertical orientation. The numerals I am talking about are pre-nominal indicators of *quantity*, such as *forty* in (7).

(7) Sue found forty typos in my manuscript.

The observation is that, cross-linguistically, such numerals can be modified by prepositions capable of expressing location along a vertical dimension, but not my numerals that are incompatible with such an orientation. So, *forty* in (7) can felicitously be substituted with *under forty* and *over forty* but not with *behind forty* or *to the right of forty*.[5]

As I indicated above, for Corver and Zwarts (2006), who first made this observation, it is natural to explain this restriction using the MULD conceptual metaphor. Given the discussion in the previous section, however, we could go one step further and claim that there is an intrinsic non-conceptual semantic reason why this conceptual metaphor is applicable: MULD provides conceptual content to the necessary scalar properties of quantity. Since quantity is ratio scalar, we can only conceptualise it using a metaphor that includes a notion of ground.

If this reasoning is on the right track, we should be able to apply it beyond cases like (7). In particular, we should be able to apply it to occurrences of numerals that are not expressions of quantity. If we do, we would need to posit a condition requiring the alignment of metaphor and scalar properties more generally. Here is a proposal for such a condition:

(8) **The scalar metaphor condition:** expressions that function on a scale S can only be metaphorically used on a scale S' if S is at least as high a level of measurement as S', where the relevant hierarchy of levels is: ordinal $<$ interval $<$ ratio.

---

temperature, or at least not that part of our understanding that informs how we *talk* about temperature. Someone who is unaware of the scientific facts about temperatures is not suddenly going to change the way they talk about temperature, once they learn there is nothing below 273.15 $^{\mathrm{o}}$C. In other words, what matters is not our scientific understanding, but our non-scientific conceptualisation.

[5] A seeming exception may be *north* and *south*, as in *He earns north/south of 100.000 a year.* It seems to me however, that such examples could be explained away, since in a two dimensional representation of wind directions, north points up and south points down. I know of no language that allows *east/west of $100.000*.

For spatial conceptual metaphors, this condition boils down to the requirement that horizontal metaphors can only be used for interval or ordinal scales. The vertical axis, with its dedicated 0 element, can be used for every kind of scale. As such, vertical scalar metaphors are expected to dominate in natural language. Yet, in specific cases, horizontal metaphors should be available. In the next section I will put this proposal to the test.

5 The scalar metaphor condition at work

One conceivable option is that a language adopts the scalar metaphor condition by generalising to the worst case. Since there will always be ratio scales in language (quantity, for instance), vertical spatial metaphors will be adopted for these as well as for other, lower-level scales. While this definitely remains an option, it is more interesting to note that there clearly are languages that match scale and metaphor more finely.

As I mentioned above, clock time constitutes an interval scale. This makes it, in principle, compatible with horizontal spatial metaphors. Indeed, this is exactly what Haspelmath (1997) found: "The cross-linguistic evidence overwhelmingly confirms the view that time is conceptualized in terms of space, more particularly in terms of the frontal axis. A large number of languages from a wide variety of families show this association either synchronically or diachronically." (p. 56, see also Hill, 1978, page 524).

For instance, in Dutch, the preposition *voor* has both a frontal spatial use and a use for clock time:

(9) Jan stond voor zijn huis.
Jan stood *voor* his house.
'Jan stood in front of his house'

(10) Jan valt normaalgesproken voor 11 uur in slaap.
Jan falls normally *voor* 11 hour in sleep.
'Normally, Jan falls asleep before 11 o'clock.'

In fact, Dutch neatly picks frontal spatial expressions for clock time and vertical prepositions, like *onder* (under), for quantity, including lengths of time. That is, there is no way to make sense of a sentence like (12), which I indicate using a hash tag.

(11) Jan's hond slaapt onder de tafel.
Jan's dog sleeps under the table.

(12) #Jan valt normaalgesproken onder (de) 11 uur in slaap.
Jan falls normally *onder* the 11 hour in sleep.

Note that while the scalar metaphor condition accounts for why (10) is felicitous, it does not account for why (12) would be infelicitous. If vertical prepositions are more general than non-vertical ones, it may be expected that there is the option of using them for non-ratio scales, but apparently there are external factors that block such combinations.

As soon as we move from clock time to *duration time*, and hence from an interval scale to a ratio scale, the vertical metaphor is available again and (crucially) the horizontal one is not:

(13) Deze printer is opgewarmd in #voor / onder de 24 seconden.
This printer is warmed-up in *voor* / *onder* the 24 seconds.
'This printer warms up in fewer than 24 seconds'

The scalar metaphor condition accounts for the contrast between (13) and (10): scalar properties of different uses of numerals set pre-conditions on the use of conceptual metaphor. Further support for this view comes from examples of horizontal metaphors applying to cases of *ordinal* scales. In Dutch, *voor* can express pure relative order, as in (14), which discusses the outcome of a public vote on the best pop song of all time.

(14) Imagine van John Lennon eindigde op nummer 1 voor nummer 2, Bohemian Rapsody van Queen.
Imagine of John Lennon ended on number 1 *voor* nummer 2, Bohemian Rapsody of Queen.
'John Lennon's imagine ended up on number 1; number 2 was Queen's Bohemian Rapsody'

What I have not found, however, is any evidence that the temperature scale is ever addressed using a horizontal metaphor. Given the scalar metaphor condition and the case of, for instance, Dutch *voor* for clock time, one could expect to find such prepositions in combination with temperatures too. However, in Dutch, and many other languages I checked, temperatures are strongly associated with the vertical scales, despite their interval nature.

(15) Bij een lichaamstemperatuur #voor / onder de 35 graden krijg je het moeilijk.
By a body temperature *voor* / *onder* the 35 degrees get you it difficult.
'You'll have a hard time once your body temperature drops below 35 degrees.'

There are several possible explanations of this.[6]. One of these is that it is actually not uncommon to treat the temperature scale as if it were a ratio scale, typically with 0 degrees celcius as the non-arbitrary 0 point. For instance:

(16) Temperatures in the south will be almost twice as warm as the seasonal average, but it will be cold and wet in the north. *(The Independent, 20/2/2016)*

(17) Phew!.. Twice as warm as Corfu! [...] [W]hile the Greek holiday spot could only manage a paltry 8C (46F), Britons basked in the sun as temperatures reached 16C (60F) yesterday. *(The Mirror, 12/3/2007)*

(18) Scotland and northern parts of the England will not be quite as warm as southern areas, but most places are likely to be hotter than the average March temperature of 9C, with some twice as warm as average. *(The Telegraph, 7/6/2016)*

Another reason may be that temperature, more than clock time, is much more exclusively linked to numerals. For time, we have expressions like *noon*, *midnight*, *monday*, *spring* etc. Such a rich non-numerical vocabulary is unavailable for temperature. As such, it may be that the modifiers used for talking about temperature are those used for the domain where numerals are used most, viz. the domain of quantity.
Importantly, however, the use of vertical metaphor for temperature is still fully in line with the scalar metaphor condition I outlined above. While I have not given an explanation of why horizontal metaphors are more rare than perhaps expected, the condition does explain the abundance of vertical metaphors, simply because whenever measurement is at stake, a vertical axis is due to its structure more metaphorically applicable than a horizonal one.

6 Conclusion

In summary, I am proposing that the source of vertical metaphors for expressing information about amounts is to be found in the scalar properties shared by the vertical axis and the quantity scale. The scalar metaphor condition predicts that the vertical axis is more generally applicable as a basis for a metaphorical mechanism than either of the horizontal axes are, since only the vertical axis comes with a non-arbitrary zero and is thus structurally similar to the highest level

[6]Again, I do not believe one of them could be that from a purely scientific point of view, temperature *is* a ratio scale, given the existence of an absolute zero. See footnote 4.

of measurement, that of a ratio ordering.
The condition also predicts that horizontal metaphors should at times be applied in cases that involve lower-level measurement scales, and this is confirmed by the not uncommon use of frontal axis prepositions to address clock time. It is not immediately clear however why horizontal metaphors do not have a wider distribution, for instance to address temperature. Yet, this somewhat limited distribution could also simply point to the worst case strategy reasoning I alluded to above: the default spatial metaphor is vertical, since it is fully general in its compatibility.

References

Corver, N. and J. Zwarts (2006). Prepositional numerals. *Lingua 116*(6), 811–836.

Dehaene, S., S. Bossini, and P. Giraux (1993). The mental representation of parity and number magnitude. *Journal of Experimental Psychology: General 122*(3).

Haspelmath, M. (1997). *Indefinite Pronouns.* Oxford: Clarendon Press.

Hill, C. A. (1978). Linguistic representation of spatial and temporal orientation. *Berkeley Linguistics Society 4*, 524–538.

Jaszczolt, K. (2006). Where cognitive and truth-conditional semantics meet: The case of concept shift. In W. Oleksy and P. Stalmaszczyk (Eds.), *Cognitive Approaches to Language and Linguistic Data*, pp. 205–223. Peter Lang.

Kennedy, C. (2007). Vagueness and grammar: The semantics of relative and absolute gradable predicates. *Linguistics and Philosophy 30*(1), 1–45.

Lakoff, G. and M. Johnson (1980). *Metaphors We Live By.* University of Chicago Press.

Solt, S. (2015). Measurement scales in natural language. *Language and Linguistics Compass 9*(1), 14–32.

Stevens, S. S. (1946). On the theory of scales of measurement. *Science 103*, 677–680.

Word count: 3700