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Cross-World Comparatives for Modal Realists

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Divers (2014) argues that a Lewisian theory of modality which includes both counterpart theory and Modal Realism cannot account for the truth of certain intuitively true modal sentences involving cross-world comparatives. The main purpose of this paper is to defend the Lewisian theory against Divers's challenge by developing a response strategy based on a degree-theoretic treatment of comparatives and by showing that this treatment is compatible with the theory.

Key words

Comparatives, counterpart theory, David Lewis, John Divers, modal realism, modality

1 Divers's Challenge to a Lewisian Theory of Modality

My aim in this paper is to answer a challenge for Lewis's theory of modality, consisting of modal realism plus counterpart theory,[1] which has recently been raised in Divers (2014).

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[1]For the main statement and defence of modal realism, see Lewis (1986), for counterpart theory, see in particular Lewis (1968), Lewis (1983c), and Lewis (1986), chapter 4, pp. 192ff.

The basis of Divers's objection are certain intuitively true sentences containing modal comparatives such as:

(1) It is true of the tallest actual thing that it might have been taller.

(2) It is true of the fastest actual thing that it might have been faster.

(3) It is true of the actually longest lasting thing that it might have lasted longer.

I will focus on (1) from now on, but the crucial claims made throughout the paper generalize. According to counterpart theory, (1) is true if, and only if, the tallest actual thing has a counterpart which is even taller. This counterpart can either be an object which exists in the actual world or one which exists in a merely possible world. There is no actual thing taller than the tallest actual thing, so the required counterpart must exist in a merely possible world. This can, argues Divers, not be the case, since i) two objects need to be spatiotemporally related in order for them to stand in the 'taller than'-relation and ii) modal realism rules out spatiotemporal relations between objects that exist in different possible worlds. This is a problem, since the Lewisian theory is supposed to respect established 'pre-philosophical' opinions about what is possible.[2]

It is crucial to Divers's challenge that the comparisons in (1-3) involve spatiotemporal magnitudes. Comparisons not involving them, such as for example, 'It is true of the longest poem authored by a human that it might have been longer', are not subject to Divers's claim i): The magnitude involved here is that of the number of words or of letters in a poem and there is no reason to think that two poems which are comparable in this manner have to stand in spatiotemporal relations. For this reason, this and similar cases do not give rise to Divers's challenge. As Divers himself points out, this means that a natural response to his challenge is to deny i) (lemma b in Divers (2014)), i.e. the claim that modal comparisons of the sort drawn in (1-3) require the compared objects to stand in spatiotemporal relations.

According to Divers, friends of the Lewisian theory of modality who make this move have to face three difficulties. First, Divers suggests that this response might require extensive and deep revisions of their adopted metaphysics of spacetime and modality, second, it might give rise to revenge problems, and third, and finally, it appears that Lewis himself explicitly objected to a particularly natural response strategy which makes this move. (See Divers (2014), p.577.) The core idea of this response-strategy is that 'we might simply instate inequalities between numbers in place of relations between

[2]See Divers (2013), p. 186.

non-numerical things. So x being taller than y requires 'only' that there be numbers n and m such that ... and n is greater than m.' (ibid.) My main aim in this paper is to argue that, even assuming a relatively orthodox Lewisian perspective, none of these three difficulties pose a genuine problem for a response strategy of this sort. I will do that by developing a particular version of the strategy, which I will in the following call the *Degree Strategy*.[3]

2 The Degree Strategy: The Basic Idea

The main aim of the Degree Strategy is to deliver satisfiable counterpart theoretic translations of Divers's (1) and similar comparative sentences which involve comparisons between degrees instead of objects. To make this clearer, let me introduce a counterpart-theoretic rendering of (1) to give an example of how this might be done:

(D1) $\exists v(Aa \wedge Tav \wedge \forall w \forall x((Aw \wedge w \neq a \wedge Twx) \rightarrow x < v) \wedge \exists y(\exists z Cza \wedge Tzy \wedge v < y))$

Here, a is a singular term,[4] Cxy says that x is a counterpart of y, Txy says that x is tall to degree y, Ax says that x is actual, and $<$ is the *greater than*-relation for degrees. In words, (D1) hence says that there is a degree of tallness v, such that it is the degree of tallness of the actual thing a which is larger than the degree of tallness of any other actual thing, but that there is a counterpart of a which has a higher degree of tallness. The example reflects the two core ideas of the Degree Strategy: First, that comparisons of objects in terms of their spatiotemporal magnitudes can always be spelled out in the language of counterpart theory in terms of comparisons between degrees corresponding to these magnitudes. Second, that the resulting counterpart theoretic-sentences do not require the objects whose magnitudes are being compared to be in the same possible world. Both of these ideas, modulo their application in counterpart theory, are well-known from the existing literature on the semantics of modal comparatives. (See e.g. Cresswell (1990), ch. 5.)[5]

[3] For a different response to Divers's challenge, see Noonan and Jago (2017).

[4] The official language of counterpart theory as introduced in Lewis (1968) contains no singular terms, but rather treats names as definite descriptions in the manner described in Russell (1905). The Russellian method requires one to fix the scope of the relevant descriptions in modal contexts, as Lewis points out (ibid, pp. 120f). Regarding the counterpart-theoretic sentences discussed in this paper, these descriptions can be assumed to take wide scope under the modal operator as discussed on p. 121 of ibid, since they correspond to de re modal claims. Officially, (D1) should hence be read as an abbreviation of the respective singular-term-free rendering.

[5] Note that (D1) is based on a simplistic implementation of a degree-based semantics for comparatives and that I make no claim that this implementation lives up to the best available linguistic theories of

Note that in producing this translation of (1), I did not rely on the manual for translating first-order modal logic into counterpart theory provided in Lewis (1968). Instead of first translating (1) into first order modal logic and then into counterpart theory, I rather directly relied on the resources of counterpart theory to produce (D1). I assume that this is a legitimate move from an orthodox Lewisian perspective, for two reasons.

First, the translation manual in Lewis (1968) was not intended to fix a general methodology for the use of counterpart theory, according to which the one and only way to arrive at Counterpart-Theoretic renderings of a modal sentences is to first translate them into the language of first-order modal logic and then to translate this first translation into the language of counterpart theory. Rather, Lewis introduced the translation manual to make an important point about the expressive strength of the language of counterpart theory: 'If the translation scheme I am about to propose is correct, every sentence of quantified modal logic has the same meaning as a sentence of counterpart theory, its translation; but not every sentence of counterpart theory is, or is equivalent to, the translation of any sentence of quantified modal logic. Therefore, starting with a fixed stock of predicates other than those of counterpart theory, we can say more by adding counterpart theory than we can by adding modal operators.' (Lewis (1968), p. 117.) This point is part of his sales pitch for counterpart theory to philosophers who follow the standard approach to the formal treatment of modal sentences in terms of first-order modal logic.[6] A Lewisian who insisted that any translation of a modal sentence of natural language into the language of counterpart theory must proceed via the translation manual, would undermine Lewis's efforts in this direction, since this procedure would preclude counterpart theorists from relying on the additional expressive resources of-

comparatives. (D1) should however serve the purposes of this paper well, since linguistically more sophisticated implementation of the Degree Strategy would have to face the same metaphysical questions which I will focus on in this paper.

[6]This reading is strongly suggested by the first two paragraphs of the paper: *'We can conduct formalized discourse about most topics perfectly well bv means of our all-purpose extensional logic, provided with predicates and a domain of quantification suited to the subject matter at hand. That is what we do when our topic is numbers, or sets, or wholes and parts, or strings of symbols. That is not what we do when our topic is modality: what might be and what must be, essence and accident. Then we introduce modal operators to create a special-purpose, nonextensional logic. Why this departure from our custom? Is it a historical accident, or was it forced on us somehow by the very nature of the topic of modality?*
It was not forced on us. We have an alternative. Instead of formalizing our modal discourse by means of modal operators, we could follow our usual practice. We could stick to our standard logic (quantification theory with identity and without ineliminable singular terms) and provide it with predicates and a domain of quantification suited to the topic of modality. That done, certain expressions are available which take the place of modal operators. The new predicates required, together with postulates on them, constitute the system I call counterpart theory.' (Lewis (1968), p. 113.)

fered by their theory. The second reason is that Lewis himself later explicitly expressed a preference for working directly with the language of counterpart theory.[7]

A crucial question about the Degree Strategy is what degrees are. I will here assume that they are either numbers of whichever sort are semantically required, or in some more complicated cases, such as comparisons of e.g. similarity, ordered or unordered sets of (sets of ...) numbers.[8] I will also assume that comparative predicates which take degrees as at least one of their relata implicitly specify a particular measurement scale. Since Divers's challenge is based on comparative sentences involving simple comparisons which can be accounted for by single numbers instead of e.g. sets of them, I will for the most part focus on such cases. Further details of the Degree Strategy will be spelled out in the following subsections in direct response to Divers's three worries.[9]

3 Does the Degree Strategy Require Deep Revisions of Lewisian Metaphysics?

Divers's first worry is that response strategies which are based on a denial of i) may 'require extensive or deep revision' (Divers (2014), p. 577) of Lewisian metaphysics of spacetime or modality. To address this worry for the Degree Strategy, we have to first make clear which metaphysical requirements this strategy imposes. Its three crucial metaphysical requirements are that a) it must accommodate the view that de re-ascriptions of predicates like 'being tall' to possible objects involve a degree of tallness, that b) degrees are comparable across different possible worlds via the 'is (strictly) greater than'-relation $<$, and finally, that c) the ordering of degrees induced by $<$ tracks the ordering of the objects to which they are assigned relative to the relevant dimension of comparison. I take it that any substantial or extensive revision of Lewisian metaphysics which the Degree Strategy might require could be traceable to one or more of these three requirements.

[7] '*What is the correct counterpart-theoretic interpretation of the modal formulas of the standard language of quantified modal logic? – Who cares? We can make them mean whatever we like. We are their master. We needn't be faithful to the meanings we learned at mother's knee – because we didn't. If this language of boxes and diamonds proves to be a clumsy instrument for talking about matters of essence and potentiality, let it go hang. Use the resources of modal realism directly to say what it would mean for Humphrey to be essentially human, or to exist contingently.*' (Lewis (1986), p. 12-3.) See also the initial passage in Lewis (1993a), p. 69.

[8] See Balcerak Jackson and Penka (2017) for a critical discussion of this assumption in the context of linguistic theories utilising degrees.

[9] Note that Schwarzschild and Wilkinson (2002) argue that a linguistically adequate semantics for comparatives requires intervals, rather than degrees, but I will, for the sake of simplicity, stick with degrees. Since intervals are just sets of numbers, all points I am going to make about the degree-based version could easily be generalized to an intervals-based version.

From an orthodox Lewisian perspective, requirement a) poses no special metaphysical problem, since it indeed perfectly matches Lewis's own view of 'properties that admit of degree' (Lewis (1986), p. 53.), for which he suggests a bifurcated treatment: There are both 'families of plain properties: the various lengths, the various masses' and 'relations to numbers, such as the mass-in-grams relation that (a recent temporal part of) Bruce bears to a number close to 4,500' (ibid.). Accordingly, if an object has a mass, then it both has a plain mass-property and stands in various relations to numbers, each of which specifies its mass on a certain measurement scale. This means that proponents of the Degree Strategy can help themselves to relational properties which are already present in Lewis's ontology. Even the more complicated cases at which I hinted, which require degrees to e.g. be sets of numbers pose no problem in this regard. Lewis of course allowed sets of numbers in his ontology and relations between them.[10] Requirement a) imposed by the degree theory hence entails no deviation from standard Lewisian metaphysics.

What about requirement b), the requirement that degrees are $<$-comparable across different possible worlds? As just pointed out in response to the analogous question about requirement a), the degree theory is conservative regarding orthodox Lewisian ontology, in the sense that it does not require the introduction of new objects which do not already exist according to Lewis. This means that the question can simply be answered by showing that orthodox Lewisian metaphysics satisfies requirement b), i.e. that it entails that degrees are $<$-comparable accross different possible worlds. Or equivalently, and this is the way I will go here, by showing that Lewisian metaphysics cannot fail to meet the requirement. How could it fail to do so? By allowing for at least one of two kinds of variance, first, variance in which numbers, and sets (of sets ...) of them, are available from the perspective of different possible worlds, or second, variance regarding which mathematical relations hold between them in different possible worlds.

We can immediately rule out that orthodox Lewisian metaphysics allows for variance with respect to which degrees/numbers exist from the standpoint of possible worlds, since Lewis himself explicitly accepts that numbers are 'necessary beings.' (Lewis (1983a), p. 198.) By this, he doesn't mean that they exist in every possible world. Rather, according to Lewis, 'numbers [...] inhabit no particular world but exist alike from the standpoint of all worlds, just as they have no location in time and space but exist alike from the standpoint of all times and places.' (Lewis (1973a), p. 39.) Since degrees are numbers, or sets of them, the first kind of variance which could undermine requirement b) is not

[10] They correspond to properties of numbers and relations which hold between properties of numbers respectively. See Lewis (1986), p. section 1.5, pp. 50ff.

allowed by Lewisian metaphysics.[11]

So what about variance regarding the mathematical relations in which degrees, or sets of them, stand from the perspective of different possible worlds? In case of single degrees, the relevant mathematical relation is of course $<$, the (strictly) greater than-relation. By Lewis's lights, $<$ is an internal relation between degrees, a relation which supervenes on the internal properties of its relata. This means that there can be no variance in whether two degrees are $<$-related between worlds. Let me explain this in a bit more detail.

To make this point, we need to look at Lewis's definition of an internal relation. According to Lewis, a diadic relation, i.e. an ordered set with two elements in his ontology, is internal if, and only if, 'whenever *a* and *a'* are duplicates (or identical) and *b* and *b'* are duplicates (or identical), then both or none of the pairs $\langle a, b\rangle$ and $\langle a', b'\rangle$ stand in the relation.'[12] For our purposes, it is the identity-version of the definition which is relevant. This is so, because, as mentioned earlier, Lewis assumes that numbers don't exist in possible worlds, but rather outside of them. (See Lewis (1973a), p. 39.) Since he nonetheless assumes that they should be available in all possible worlds, Lewis stipulates that with respect to each possible world, each number acts as its own unique counterpart, thereby making it de re necessary of them that they exist. (See Lewis (1973a), p. 40.) Since a duplicate of an object is either a distinct object in the same world or a counterpart in a different world which shares all of the object's perfectly natural properties, (see Lewis (1986), p. 61) this uniqueness assumption entails that the only duplicate of a number is that number itself.

Based on this explanation, we can apply the definition to the $<$-relation to show that it

[11] In his later writings Lewis (1991) and Lewis (1993b), Lewis argues that, given 'some hypotheses about the size of Reality' (Lewis (1993b), p. 3), mathematical entities and the whole of mathematics can be reduced to megethology, that is, mereology plus plural quantification. There is one aspect of the resulting view which might seem to threaten the Degree Strategist's ability to fulfil requirement b), namely Lewis's neutrality regarding the question of whether sets and in particular the empty set, which serves as the basis for set-theoretical constructions of numbers, are spatiotemporally located (see Lewis (1993b), p. 13). A Lewisian who adopts Lewis's view should hence be prepared to at least seriously consider the idea that the empty set and with it also the numbers are in spacetime. Indeed, Lewis seriously considers, if not endorses, the idea of identifying the empty set with an arbitrary elementless object, e.g. with the fusion of all ordinary objects in a world. (see Lewis (1993b), p. 9) Does this not mean that there are different empty sets and therefore also different numbers and different degrees in different possible worlds and does this not threaten the Degree Strategy? Not if the Lewisian also follows Lewis in adopting a structuralist view of mathematics (ibid. p. 15-7). On this view, the same mathematical structure, e.g. that of the rational numbers, might indeed be instantiated by different objects in different possible worlds, but since the structure remains the same across all possible worlds, degrees nonetheless remain cross-world comparable.

[12] Lewis (1983b), p. 356, footnote 16. Note that Lewis switched from using the term 'intrinsic relations' in this definition to 'internal relations' in Lewis (1986); I follow the latter usage.

is satisfied. It tells us that for any two numbers n and m and any pair of their duplicates n' and m', $<$ is an internal relation with respect to n and m them if, and only if, either $n < m$ and $n' < m'$ hold or neither of $n < m$ and $n' < m'$ holds. Since we have just seen that n and n' and m and m' are identical, this is trivially the case, since m is either strictly greater than n, or not. So $<$ qualifies an an internal relation between numbers because whether two numbers actually (or possibly) stand in $<$ settles once and for all whether they stand in the relation with respect to all possible worlds. This of course rules out the problematic cross-world variance in whether degrees are $<$-related.

An important question is still left unanswered, namely whether this mathematical ordering between degrees successfully tracks the relevant dimension of comparison. This is exactly the question at issue regarding requirement c). To meet this requirement, Lewisians have to ensure that e.g. an actual object associated with a height-degree higher up in the $<$-ordering than an object in a non-actual world also has a greater (plain) height than the non-actual object.

According to Lewis's view, deviant cases in which this is not the case can only arise in case there is a mismatch between the object's relevant plain measurable property and at least one of its corresponding relational properties involving numbers. Degree strategists can therefore avoid the problem by ruling out such deviant cases. They have at least two different ways to do this, one more and one slightly less orthodox.

Let me introduce the slightly less orthodox solution first. It requires one to build a further factor into the degree-based semantics for gradable adjectives, a factor which enforces the required harmonious relation between the degrees associated with the compared object and their corresponding intrinsic properties. This factor could for example be a relation which maps equivalence classes of possible objects to sets of numbers which capture their relevant dimensions on different scales. Height for example would then be treated as a relational property of an object which both involves a degree and a scaling relation, a mapping of all objects of the same height to the relevant degrees, all of course relative to a particular measurement scale. To give an example, if a is an object with e.g. a height of three meters, this would mean that the relational property salient to evaluating the truth of a sentence comparing a's height to another possible object would involve the number representing a's degree-in-metres and a scaling relation which maps a set of possible objects which have the same intrinsic height-property as a (i.e. its height-duplicates) to the same number representing its degree-in-metres, which in the given example would be 3. In this modified framework, the deviant cases which degree strategists have to rule out would involve a mismatch between the scaling relations involved in the relational properties involved in their analysis of the relevant comparative sentences. Such cases could therefore be ruled out by stipulating that only those comparisons are apt to be true which involve the relevant relational properties which involve the same scaling relation.[13]

This modification of the Degree Strategy also requires no deep revisions of Lewisian metaphysics. The scaling relations on which it relies are metaphysically innocent in the sense that they are just regular relations whose availability is guaranteed by the Lewisians commitment to an abundant view of relations. This means that the further relativization of gradable properties to scaling relations poses no special metaphysical problem over and above those posed by the relativization of gradable properties to degrees, a relativization which is already built into Lewisian metaphysics. Since the same holds for the doubly-relativized properties, Lewisians who rely on the Degree Strategy can meet requirement c) without having to revise their fundamental metaphysics in any significant way. Why then did I call this variant of the Degree Strategy slightly less orthodox? Because it requires degree theorists to rely on relations which, while ontologically unproblematic, are not the simple relations between material objects and numbers which Lewis officially accepts. (See again Lewis (1986), p. 53.)

The second, more conservative, way to rule out deviant cases leaves the original degree-theoretic semantics as it is and lets the counterpart relation do all the work. In various places, Lewis relies on an ordering of possible worlds regarding their similarity to the actual world. (See e.g. Lewis (1973a).) Such an ordering can be used to restrict the set of relevant counterparts with respect to a particular comparative sentence to those which exist in worlds which are closest to the actual world regarding the measurement structure of the relevant intrinsic quantitative properties. Accordingly, the objects whose degrees are compared in a Degree Strategic translation of such a sentence are always guaranteed to be in worlds which agree on the scaling between the degrees to which they have the relevant spatiotemporal magnitude and their corresponding intrinsic properties. More

[13] One might worry that there is a threat to this approach from possible worlds which are very different from the actual world regarding the quantitative properties of the objects existing in those worlds. A simple example of such a world is one in which all height-properties have always been exactly double that of the actual height-properties. This case is e.g. discussed in Dasgupta (2013). One might argue that height-comparisons between objects in this and the actual world might undermine the proposed modification of the Degree Strategy, since e.g. an actual object and an object from this 'height-doubled' world might be scaled to the same height-in-metres, giving rise to cases in which the latter object has a lower height-in-metres but has a larger intrinsic height than the actual object. A simple way to address potential problem cases of this sort is to invoke a similarity ordering between possible worlds of the sort used to formulate the theory of counterfactuals in Lewis (1973a). The idea would be to rule out that objects from worlds of this sort can enter into comparisons with actual objects.

could of course be said about this and the preceding proposal, but this brief sketches together with what was just said about requirements a) and b) should suffice to illustrate that Lewisians have more than enough resources to implement a version of the Degree Strategy without deeply or extensively revising their metaphysics.

4 A Revenge-Problem?

Divers's second worry is that the problem illustrated by (1) and similar comparative sentences could be reinstated for the degree-strategist's surrogate-relation $<$, the *(strictly) greater than*-relation. In the background again is Divers's assumption i), which says that any two objects need to be spatiotemporally related in order to give us a true instance of a comparative predicate like 'is taller than'.

The degree-strategy explicitly denies that objects need to be spatiotemorally related in order for them to be comparable regarding their spatiotemporal magnitudes. But it does say that the corresponding degrees have to stand in a comparative relation such as $<$. In order to address this second worry, it still needs to be shown that this latter claim does not entail that the object and its counterpart involved in a (1)-like comparative sentence have to be in the same possible world. This entailment could hold in two cases: First, that two degrees are $<$-related could imply that they have to exist in the same world. Second, that they are so related could imply that the objects to which they stand in a particular magnitude-on-a-particular-scale-relation have to exist in the same world. I will go address both versions of the worry in turn.

Let us first focus on the idea that the fact that the two degrees of lengths, velocities, heights, and so on which are associated with two comparable objects are $<$-related implies that the degrees have to be located in the same spacetime. This first version of the worry can easily be dismissed. Given the assumption that degrees are numbers, they are not in spacetime at all and can hence themselves not stand in spatiotemporal relations. (See again Lewis (1973a), pp. 39-40.)

But what about the compared objects, i.e. what about the second version of the worry? That e.g. the height-degree associated with one object is higher up on the $<$-ordering than the height-degree associated with another indeed implies that each of the two objects is in spacetime. This is so, simply because only an object which is in a spacetime can have e.g. the intrinsic mass-property which it has in addition to being related to a certain numbers via a relation such as mass-in-grams. (See again Lewis (1986), p. 53.) Accordingly, the Degree Strategy cannot completely stay clear of metaphysical claims about the compared objects themselves. That however does not mean that Divers's second worry amounts to a genuine problem for the Degree Strategy. One of the core ideas of the strategy is that while each compared object has to be in a spacetime, this need not be *the same* spacetime for each of the objects. This is illustrated by degree theoretic translations such as (D1). The Degree Strategy is hence not subject to the second version of the worry either.

One might argue that this is not yet enough to comprehensively address Divers's second worry. So far, I have equated being in a possible world with being in a spacetime. But in Lewisian metaphysics, being in a spacetime is only a sufficient, but not a necessary condition for being in a possible world. A core idea of modal realism is that in order to form a possible world, a collection of (possible) objects needs to be 'glued together' by a special family of relations. Lewis is forced to reject the attractive idea that the 'glue'-role is played exclusively by the actual spatiotemporal relations, because he wants to allow possible worlds that are instead 'glued together' by relations other than them, such as for example the quasi-spatiotemporal relations of Newtonian physics. (See Lewis (1986), p. 74-6.) So there are possible worlds which are not spacetime in the sense of contemporary physics. (1)-like problem cases could therefore still arise if the Degree Strategic treatment of modal comparatives implied that the relevant objects stand in 'analogically spatiotemporal' (Lewis (1986), p. 76.), rather than spatiotemporal relations.

What does it take for a relation to be analogically spatiotemporal? According to Lewis, such relations have four characteristic properties, namely that of being natural, pervasive, discriminating and external. (See Lewis (1986), p. 75-6.) To address the objection, I will now argue that the relations between compared objects to which the Degree Strategy is committed do not conform to this characterization.

The first crucial point here is that $<$ itself is not analogically spatiotemporal, since it is, for the reason given in the previous section, an internal rather than an external relation between numbers. This means that the generalization of the first version of the worry to analogically spatiotemporal relations also fails to undermine the Degree Strategy.

This still leaves open the possibility that the Degree Strategy implies that an analogically spatiotemporal relation obtains between the compared objects themselves, instead of between their associated degrees. To address this generalization of the second version of Divers's worry, we first have to get clearer on what the Degree Strategy tells us about the relations which holds between compared objects. According to the strategy, to evaluate modal comparatives involving spatiotemporal magnitudes such as (1), one has to take into consideration the degrees to which the objects which exhibit these magnitudes are related. Since Lewisian metaphysics operates with an abundant conception of properties and relations, (see e.g. Lewis (1983b), p. 346) that the Degree Strategists is committed to the claim that the degrees associated with compared objects are <-related means that it is also committed to the claim that these objects themselves stand in a relation.

What sort of relation is this? Informally, it could best be described as the 'is associated with a degree higher up on the <-ordering than the degree associated with'-relation. Does this relation qualify as analogically spatiotemporal? One reason to think that this is not the case is that it is plausibly not a natural relation in Lewis's sense, since it does not 'carve reality at the joints' (Lewis (1983b), p. 346). This response might not satisfy all critics of the Degree Strategy, since it is based on an intuitive judgement about whether this relation is natural and such intuitive judgements are notoriously controversial.

Fortunately, there is a less intuition-dependent version of the response. According to Lewis, a relation can be denied the status of naturalness if positing its existence would be superfluous since 'we have the resources to introduce it by definition.' (Lewis (1986), p. 77) It is easy to see that the relation which the Degree Strategy requires to hold between two compared objects fails to be natural by this standard: As its name says, two objects stand in it if, and only if, the relevant degree associated with the first is higher up on the <-ordering than the relevant degree associated with the second object. This relation is fully definable in terms of the relation which holds between the degrees. It is therefore not natural and for that reason also not analogically spatiotemporal.[14]

[14]While Lewis himself somewhat hesitantly accepts naturalness as a necessary condition for analogical spatiotemporality in Lewis (1986), section 1.6, Bricker (1996) defends the view that the only constraint placed on 'world-glue'-relations is that they have to be external. If 'is associated with a degree higher up on the <-order than the degree associated with' is an external relation, then a degree strategist who accepted Bricker's view would be forced to admit that it can be a 'world-glue'-relation, i.e. analogically spatiotemporal. Degree strategists can simply reject Bricker's view and side with Lewis to avoid this potential problem, but perhaps there is an argument to be made that the 'is associated with a degree ... '-relation is not external. According to Lewis, external relations 'supervene on the intrinsic nature of the composite of the relata taken together.' (Lewis (1986), p. 62) As pointed out earlier, Lewis thinks that objects which e.g. have a size have both a non-relational size-property and stand in relations to numbers which give us their size on different measurement scales. (See Lewis (1986), p. 53.) Lewis seems to assume that the non-relational size-properties are internal (see e.g. Lewis (1983b), p. 355.), but it is clear that the relations between objects and the relevant numbers/degrees are not internal, since they do not supervene on the natures of the objects and numbers/degrees taken separately. To put it differently: it is not part of the internal nature of an object that it is associated with the degree of e.g. height-in-meters with which it is associated. This means that it is not part of the intrinsic nature of the composite of any two objects that they stand in the 'is associated with a degree ... '-relation, which in turn means that the relation is not

To summarize the argument of this section: Divers's worry is that the same problem which he illustrated using (1-3) might also arise based on the relations which the Degree Strategy requires to hold between either degrees associated with compared objects, or these objects themselves. A revenge-problem of this kind could arise if these relations implied that either the degrees or the objects involved have to be in the same possible world. The point made here is that neither the $<$-relation between degrees itself, nor the relation it induces between the objects associated with these degrees is a relation of the sort which could give rise to such a problem.

A possible objection one might raise against this conclusion is that the arguments provided fail to support it, since they focus on the wrong sort of relation. The idea of the objection is to insist that the relation which holds between two objects which we compare regarding e.g. their height must involve the intrinsic height-properties which objects have according to Lewis. (See e.g. Lewis (1986), p. 242.) But, the objection goes, the Degree Strategy completely ignores these intrinsic height-properties of objects and relies on a comparison by proxy via the $<$-relation.

I have two things to say in response to this objection. First, in one sense, it begs the question against the Degree Strategy. The basic idea of the strategy is exactly to provide a semantic analysis which does not involve the sort of relation which according to the objector, it should involve.

Second, I nonetheless think that the objection points to a legitimate question which the Degree Strategy should acknowledge and try to answer, namely: Is it really unproblematic to exclusively rely on degrees instead of on the corresponding intrinsic properties when trying to account for the truth of sentences involving cross-world comparisons? A natural way of making this question more precise is to spell it out in terms of possible variances in the relation between e.g. intrinsic height-properties of objects and the relations to degrees of height on a certain scape in which they stand. I.e. so understood, the question is identical to the question regarding requirement c) which I have already addressed in the previous section. Either way, the objection fails to undermine the answer to Divers's revenge-worry given in this section.

external. Things would look different if we were talking about a relation which held between complexes involving both the relevant objects and their associated degrees, but the 'is associated with a degree ...'-relation is a relation which holds between objects, not between such complexes. Such complexes are also arguably not the kind of entities which are subject to the modal realists' ban on cross-world relations.

5 Lewis's Objection to Degree-Based Semantics for Modal Comparatives

Divers final worry refers to an explicit discussion of modal comparatives in Lewis (1986), p. 13. To see what to make of this final worry, we should take a closer look at what Lewis writes in the passage to which Divers refers. As will become clear shortly, it makes sense to quote this passage at length:

> In any case, modality is not all diamonds and boxes. Ordinary language has modal idioms that outrun the resources of standard modal logic, though of course you will be able to propose extensions. [...]
>
> There are modalised comparatives: a red thing could resemble an orange thing more closely than a red thing could resemble a blue thing. I analyse that as a quantified statement of comparative resemblance involving coloured things which may be parts of different worlds.
>
> For some x and y (x is red and y is orange and for all u and v (if u is red and v is blue, then x resembles y more than u resembles v))
>
> Try saying that in standard modal logic. The problem is that formulas get evaluated relative to a world, which leaves no room for cross-world comparisons.
>
> *Maybe you can solve the problem if you replace the original comparative relation '... resembles... more than... resembles... ' by some fancy analysis of it, say in terms of numerical measures of degrees of resemblance and numerical inequalities of these degrees. After that, you might be able to do the rest with boxes and diamonds. The fancy analysis might be correct. But still, I suggest that your solution is no fair. For that's not how the English does it. The English does not introduce degrees of resemblance. It sticks with the original comparative relation, and modalises it with the auxiliary 'could'. But this 'could' does not behave like the standard sentence-modifying diamond, making a sentence which is true if the modified sentence could be true.* I *think its effect is to unrestrict quantifiers which would normally range over this-worldly things.* The moral for me is that we'd better have other-worldly things to quantify over. I suppose the moral for a friend of primitive modality is that he has more on his plate than he thinks he has: other primitive modal idioms than just his boxes and diamonds. (Lewis (1986), p. 13-4; my italics.)

In the crucial italicized part of this passage, Lewis first objects to a semantics which introduces degrees into the language of first-order modal logic in order to account for modal comparatives and then argues that a semantics based on his theory of modality better captures the behaviour of modal comparatives in English. The discussion of both theories is not general, but rather focuses on particular modal comparative sentences, namely those involving comparisons of resemblance between colours. It is therefore not at all clear whether Lewis intended this passage to provide a general critique of degree-based semantics for modal comparatives. Based on the quoted passage alone, Divers's claim that 'the Lewisian who would do so [account for modal comparatives using inequalities between numerical degrees instead of relations between the compared objects] must take into account that Lewis (1986), p. 13 resists this approach to modal comparatives in general and why he does so' (Divers (2014), p. 577.) should therefore be taken with a grain of salt.[15]

While the textual evidence provided by Divers fails to conclusively settle the relevance of this passage to the Degree Strategy, there are two reasons to think that there is still something to Divers's worry and that Degree Strategists have to consider and address the points about degrees made in the italicized part of the quotation.

First, even if it were settled that Lewis did not intend this passage as a general critique of degree-based semantics for modal comparatives, the points he makes might of course still pose a problem for the Degree Strategy.

Second, one may argue that even though Lewis did not explicitly say so in this passage, he must have intended the objection to apply to all degree-based semantics of modal comparatives, since he himself proposed a rival semantics for comparatives at the end of his Lewis (1970). The semantics Lewis sketches there is a supervaluationist semantics which introduces a delineation-coordinate as an additional contextual parameter, 'a sequence of boundary-specifying numbers' (Lewis (1970), p. 65.), relative to which sentences are evaluated.[16] Crucially, this semantics does not rely on degrees.[17]

[15]Note that Forbes (1994), p. 39 also seems to accept that Lewis at least meant the 'that's not how the English does it'-part to apply to degree-based theories of comparatives in general.

[16]The basic idea of the semantics is that a comparative sentence of the form 'x is F-er than y.' is true if, and only if, the set of delineations relative to which y is F is a proper subset of the set of delineations in which x is F. See Lewis (1970), pp. 64-5.

[17]It should be noted however that von Stechow argues that Lewis (1970)'s semantics is 'virtually identical' (Von Stechow (1984), p. 10) to Seuren (1973)'s semantics of comparatives, meaning that the two semantic theories produce equivalent results. Seuren's semantics relies on extent variables which range over sets of degrees. This suggests that at least as far as the semantic analysis it produces is concerned, there is no substantial difference between Lewis's theory and a theory which (indirectly) relies on degrees.

The relevant part of the quote is the italicized passage immediately following Lewis's concession that a degree-based analysis might produce the right semantic results. This passage contains two claims which Degree Strategists should consider. The first claim is about the semantics of comparatives embedded under 'could', the second claim about the semantics of 'could' in this particular context. Both are linguistic claims about a particular language, namely English, but the second claim also clearly reflects a distinctive aspect of the Lewisian theory of modality. I will now discuss both claims in turn.

The first claim is a claim about the logical form of particular English claims containing modal comparatives. ('The English does not introduce degrees of resemblance. It sticks with the original comparative relation, and modalises it with the auxiliary "could".') Now while there are many interesting philosophical questions tied to a Lewisian approach to meaning in general (see for example Schwarz (2014), Weatherson (2013)), the most direct way to answer this particular complaint about degree-based treatments of modal comparatives is to reply in kind and to simply point out that it is falsified, both regarding its negative and its positive sub-claim, by recent work done on comparatives in linguistics. The degree-based approach, of which the Degree Strategy is a variant, is a proven standard approach to the semantics of comparatives in natural language semantics. (See e.g. Von Stechow (1984), Kennedy (2005), Schwarzschild (2008).) From the perspective of linguistics, a perspective invoked by Lewis himself in the quoted passage by referring to what 'the English' does, there is hence no good reason to accept his first claim. So even assuming that Divers's general reading of Lewis is correct, Degree Strategists would arguably be able to live with this departure from what in this case would be Lewisian orthodoxy.

This leaves Lewis's second claim in the italicized part of the quote. Like the first claim, it consists of a negative and a positive sub-claim.

The negative sub-claim is that in the particular comparative structure which Lewis discusses, 'could' does not behave like the possibility-operator; it does not introduce a possible world, relative to which a comparative phrase is to be evaluated. It should come as no surprise that Degree Strategists fully agree with this claim. After all, they too work with the language of Lewis's counterpart theory instead of the language of first-order modal logic.

The positive sub-claim is a claim about the functioning of 'could' in this context. Lewis writes about this modal auxiliary verb that 'its effect is to unrestrict quantifiers which would normally range over this-worldly things.' This is a generic claim about quantifiers, which strictly speaking leaves it open whether quantifiers which quantify into the 'original comparative relation' mentioned earlier by Lewis or more generally quantifiers involved in a semantic analysis are meant. If the more specific reading is correct, then Lewis's claim is simply irrelevant to the Degree Strategy, since Degree Strategists do not directly quantify into e.g. a taller-than relation which holds directly between two objects.

If we instead read it as a genuinely generic claim about the quantifiers involved in the semantic analysis of a modal comparative sentence of the sort discussed in the quote, then again, the degree strategist is in full agreement with Lewis. Quantifiers are per default unrestricted in counterpart theory, but can easily be restricted, e.g. to particular worlds. (See e.g. Lewis (1986), p. 113.) In Degree Strategic translations of modal comparative sentences, 'could' is indeed taken to act in the way envisaged by Lewis. Consider (D1) again:

(D1) $\exists v(Aa \land Tav \land \forall w \forall x((Aw \land w \neq a \land Twx) \rightarrow x < v) \land \exists y(\exists z Cza \land Tzy \land v < y))$

In (D1), the existential quantifier which binds the variable v ranges only over the degrees of tallness of actual objects in the first main conjunct, but then unrestrictedly over all degrees of tallness in the second conjunct, i.e. in the part which translates the 'could'-claim. So this Degree Strategic translation is perfectly in line with the positive part of Lewis's second claim.[18]

To sum up, Divers's third worry, the worry related to what Lewis writes about modal comparatives in Lewis (1986) on p. 13 does not substantially threaten the Degree Strategy. Putting interpretative problems aside for the moment, Degree Theories have to deviate from Lewis as Divers understands him regarding one of his two claims, but have

[18]It should be pointed out that (D1) is not the only translation of (1) available to proponents of the Degree Strategy. Since I assume, as pointed out in section 2, that Lewisians need not translate modal sentences from natural language into first-order modal logic in order to then translate the resulting sentence, using the schema provided in Lewis (1968), into the language of counterpart theory, they could for example instead settle for:

(D1*) $\exists u(Aa \land Tau \land \forall v \forall w((Av \land v \neq a \land Tvw) \rightarrow w < u) \land \exists x(\exists y Wy \land \exists z Izy \land Cza \land Tzx \land u < x))$

This alternative translation differs from (D1) in that its second conjunct now explicitly states, using Wx to say that x is a possible world and Ixy to say that x is in y, that there is a possible world which contains the counterpart of the actual largest thing a.

The alternative translation hence has the advantage of making it more explicit that the object and its counterpart may be in different possible worlds. This advantage is however not at all lost to Degree Strategists who stick to (D1). Given Lewis (1968)'s postulates P1, which says that nothing is in anything except a world, and P3, which says that all counterparts are in something, (D1*) is entailed by (D1). So they will still be able to use (D1*) in order to illustrate this aspect of their strategy.

a good reason to do so. The other claim also poses no problem since, depending on how one understands it, it is either partly irrelevant to and partly compatible, or wholly compatible with the Degree Strategy.

6 Two Further Questions About the Degree Strategy

While the previous section completes my response to Divers's three worries about degree-based responses to his objection to the Lewisian theory of modality, the particular example the particular example from the quote from Lewis (1986) discussed in the previous section raises two interesting questions about the scope of the Degree Strategy.[19]

Lewis's example is that of a modal comparison of resemblances between coloured objects. (See once again Lewis (1986), p. 13.) The first question tied to this example is of how degree strategists might handle comparisons of colour. The second, how they might handle comparatives like 'w resembles x more than y resembles z' which involve multiple dimensions of comparison, e.g. resemblance with respect to colour, shape, size, ...

The first question can be answered rather straight-forwardly: To compare colours, Degree Strategists can rely on regions in colours spaces as their degrees. Regions in colour spaces can be represented numerically by sets of tuples of numbers (e.g. in sRGB color space as 4-tuples involving real numbers representing values for red, green, blue, and specifying a white point) and the distances between them can be measured accordingly.[20] Degree strategists can then again rely e.g. on the similarity-relation between worlds in order to ensure comparability of colour-spaces across different possible worlds.

The second question however is much harder to answer: To be fully specific, a Degree Strategic treatment of comparisons of resemblance or more generally, comparative concepts which involve multiple dimensions of comparisons, would require an effective procedure to aggregate the relevant dimensions of comparison into a single ordering of the relevant degrees. Procedures of this sort are of crucial importance in several different philosophical contexts, including e.g the theory of social choice (see e.g. List (2013)), but notably also at a core junction in Lewis's own philosophy. The question of how to aggregate aspects of comparative similarity between possible worlds is an important question about his theory of counterfactuals which crucially relies on this notion of sim-

[19]Thanks to an anonymous referee for prompting me to discuss these questions.

[20]Representations of colour spaces of this sort play a major role in efforts to assure consistent colour representations across different display devices. For more information on this, see e.g. the website of the International Color Consortium http://www.color.org/

ilarity. Lewis discusses this question in several of his works, (see e.g. Lewis (1973a), section 4.2, pp. 91ff, Lewis (1973b), Lewis (1979); see also Kroedel and Huber (2013) and Morreau (2010)) but I will not attempt to begin to settle in how far Degree Strategists can make use of these discussions to help them answer the second question. Suffice it to say that while Degree Strategists still appear to have their work cut out for them, this further challenge is distinct from, and arguably goes beyond the challenge raised by Divers (2014) which is the main focal point of this paper.

7 Conclusion

To conclude, the Degree Strategy is not directly threatened by any of the three worries raised by Divers: It does not require deep or extensive revisions of Lewisian metaphysics, is not subject to a revenge problem induced by a relation between degrees or objects which are compared regarding e.g. their degrees of height, mass, or of another quantity, and is also not seriously threatened by Lewis's remark on the treatment of modal comparatives which Divers cites. The Degree Strategy is therefore a live option for Lewisians who are looking for a way to address the general question underlying Divers (2014)'s challenge, the question of whether they can account for the truth of counterpart-theoretic sentences involving comparisons between spatiotemporal magnitudes of material object in different possible world.[21]

References

Balcerak Jackson, B. and Penka, D. (2017). Number word constructions, degree semantics, and the semantics of degrees. *Linguistics and Philosophy*, 40(4):347–372.

Bricker, P. (1996). Isolation and unification: The realist analysis of possible worlds. *Philosophical Studies*, 84(2–3):225–38.

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Cresswell, M. J. (1990). *Entities and indices*, volume 41 of *Studies in Linguistics and Philosophy*. Dordrecht: Kluwer Academic Publishers, first edition.

Dasgupta, S. (2013). Absolutism vs comparativism about quantity. In Bennett, K. and Zimmerman, D., editors, *Oxford Studies in Metaphysics, Vol. 8*, volume 8, pages 105–50. Oxford: Oxford University Press.

Divers, J. (2013). The analysis of possibility and the extent of Possibility. *Dialectica*, 67(2):183–200.

Divers, J. (2014). An inconvenient modal truth. *Analysis*, 74(4):575–7.

Forbes, G. (1994). Comparatives in counterpart theory: Another approach. *Analysis*, 54(1):37–42.

Kennedy, C. (2005). Comparatives, semantics. In Brown, K., editor, *Encyclopedia of Language & Linguistics*, pages 690–4. Oxford: Elsevier, second edition.

Kroedel, T. and Huber, F. (2013). Counterfactual dependence and Arrow. *Noûs*, 47(3):453–66.

Lewis, D. (1970). General semantics. *Synthese*, 22(1–2):18–67.

Lewis, D. (1973a). *Counterfactuals*. Oxford: Blackwell Publishing, second, revised edition.

Lewis, D. (1973b). Counterfactuals and comparative possibility. *Journal of Philosophical Logic*, 2(4):418–46.

Lewis, D. (1979). Counterfactual dependence and time's arrow. *Noûs*, 13(4):455–476.

Lewis, D. (1983a). Extrinsic properties. *Philosophical Studies*, 44:197–200.

Lewis, D. (1983b). New work for a theory of universals. *Australasian Journal of Philosophy*, 61(4):343–77.

Lewis, D. (1983c). Postscript to "counterpart theory and quantified modal logic". In *Philosophical Papers Volume I*, pages 39–46. Oxford: Oxford University Press, first edition.

Lewis, D. (1986). *On the Plurality of Worlds*. Oxford: Blackwell Publishing, first edition.

Lewis, D. (1991). *Parts of Classes*. Oxford: Blackwell Publishing, first edition.

Lewis, D. (1993a). counterpart theory, quantified modal logic, and extra argument places. *Analysis*, 53(2):69–71.

Lewis, D. (1993b). Mathematics is megethology. *Philosophia Mathematica*, 1(3):3–23.

Lewis, D. K. (1968). counterpart theory and quantified modal logic. *Journal of Philosophy*, 65(5):113–26.

List, C. (2013). Social choice theory. In Zalta, E. N., editor, *The Stanford Encyclopedia of Philosophy*. Metaphysics Research Lab, Stanford University, winter 2013 edition.

Morreau, M. (2010). It simply does not add up: Trouble with overall similarity. *Journal of Philosophy*, 107(9):469–90.

Noonan, H. and Jago, M. (2017). Modal realism, still at your convenience. *Analysis*, 77(2):299–303.

Russell, B. (1905). On denoting. *Mind*, 14(56):479–93.

Schwarz, W. (2014). Against magnetism. *Australasian Journal of Philosophy*, 92(1):17–36.

Schwarzschild, R. (2008). The semantics of comparatives and other degree constructions. *Language and Linguistics Compass*, 2(2):308–31.

Schwarzschild, R. and Wilkinson, K. (2002). Quantifiers in comparatives: A semantics of degree based on intervals. *Natural Language Semantics*, 10(1):1–41.

Seuren, P. A. M. (1973). The comparative. In Kiefer, F. and Ruwet, N., editors, *Generative Grammar in Europe*, pages 528–564. Dordrecht: Reidel, first edition.

Von Stechow, A. (1984). Comparing semantic theories of comparison. *Journal of Semantics*, 3(1):1–77.

Weatherson, B. (2013). The role of naturalness in lewis's theory of meaning. *Journal for the History of Analytical Philosophy*, 1(10):1–19.