A lot of hatred and a ton of desire: Intensity in the mereology of mental states*

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To appear in *Linguistics and Philosophy*

October 18, 2018

Abstract

Certain measurement-related constructions impose a requirement that the measure function used track the part-whole structure of the domain of measurement, so that a given entity or eventuality must have a larger measurement in the chosen dimension than any of its salient proper parts. I provide evidence from English and Chinese that these constructions can be used to measure the intensity of mental states like hatred and love, indicating that in the natural language ontology of such states, intensity correlates with part-whole structure. A natural language metaphysics of psychological intensity meeting this requirement is then developed and integrated into the semantics. Further complications arise when looking at attitudes like *want*, *wish*, and *regret*, which also permit measurements of intensity in the relevant constructions. To account for such attitudes, the ontology and semantics are then enriched in a way that integrates ordering and quantification over possible worlds into the part-whole structure of attitude states, so that even in these more complicated cases, the constructions at hand have a unified compositional semantics.

Keywords: mental states, attitudes, measurement, event semantics, mereology, natural language metaphysics, comparatives, monotonicity

*For their insights, many thanks to Lucas Champollion, Masha Esipova, Dan Finer, Kai von Fintel, Thomas Graf, Sabine Iatridou, Angelika Kratzer, Richard Larson, Maša Močnik, Friederike Moltmann, Milo Phillips-Brown, Philippe Schlenker, Roger Schwarzschild, Benjamin Spector, Ildikó Emese Szabó, Jiwon Yun, and audiences at the UMass Semantics Workshop, the MIT Syntax-Semantics Reading Group (LFRG), the Leibniz-Center for General Linguistics (ZAS), Institut Jean Nicod, and the LSA 2018 Annual Meeting. For extensive Chinese judgments, I am grateful to Lei Liu, Yaobin Liu, Hongchen Wu, and Chong Zhang. Comments from Regine Eckardt and two anonymous reviewers for *Linguistics and Philosophy* were extremely helpful. All remaining errors are my own.

1 Introduction

In model-theoretic semantics, progress is often made not only by delineating the mechanisms of semantic composition, but also by articulating features of the model used for interpretation. Bach (1986) refers to the latter sort of endeavor as *natural language metaphysics*, and characterizes it as the attempt to answer questions of the following kind:

> What do people talk as if there is?
> What kinds of things and relations among them does one need in order to exhibit the structure of meanings that natural languages seem to have?
> (Bach 1986: 573)

For instance, regardless of what one thinks about the literal existence of non-actual possible worlds, including them in the model of natural language interpretation has proved valuable in describing and explaining facts about intensionality. The same line of reasoning has been used to justify the inclusion of (neo-)Davidsonian eventualities (Davidson 1967), kinds (Carlson 1977), plural individuals (Link 1983), degrees (von Stechow 1984, Kennedy 1997, Beck 2011), and tropes (Moltmann 2009) as objects in our semantic model.

In this paper, I will motivate a natural language ontology of mental states—states of love, hatred, desire, etc.—in which the intensity of such a state correlates with its part-whole structure in a particular dimension.[1] Put simply, a more intense psychological state is "bigger" in a certain dimension than another, less intense psychological state. The reasoning underlying this is as follows. As I discuss in Section 2, there is a class of nominal and verbal measure constructions in which the measurement used must track part-whole relations within a particular domain; to use Schwarzschild's (2002, 2006) term, the measurement must be **monotonic**. This class of constructions includes pseudopartitives (*twelve ounces of gold*), the measurement idioms *out the wazoo* and *in spades*, adverbial measure phrases (*Chuck ran a lot yesterday*), and nominal and verbal comparatives. As an example, consider the verbal comparative in (1):

(1) Dee ran more than Evan did.

Depending on context, (1) can serve as a comparison of the distance of Dee's and Evan's running, or of temporal duration. However, it cannot serve as a comparison of the *speed* of Dee's and Evan's running. If Dee ran one mile in four minutes, while Evan

[1] A disambiguation: Throughout this paper, I use "state" in a neo-Davidsonian sense, rather than in the sense commonly used in the literature on dynamic semantics and epistemic modals. In other words, I mean "state" in the sense of "stative," and not in the sense of "information state."

ran three miles in thirty minutes, (1) is simply false, even though Dee ran faster than Evan did. The reason for this, as observed by Wellwood et al. (2012) and Wellwood (2014, 2015), is that distance and temporal duration respect the part-whole relations of running events in a way that speed does not: a running event covers more distance and time than any of its proper parts, but it will not have a greater speed than all of its proper parts.

To the extent that this monotonicity requirement for verbal comparatives is robust, it provides an argument for a connection between psychological intensity and the part-whole structure of mental states, as mental state verbs can appear in verbal comparatives in which intensity is measured. This is illustrated with transitive psychological verbs in (2), and with the attitude verbs *want*, *wish*, and *regret* in (3):

(2) a. Fiona likes football more than she does baseball.
b. Gavin fears clowns less than he does sharks.
c. Helen hates country music as much as she does rap.
d. Ina respects her teachers more than she does her friends.
e. Jorge admires the CEO less than he does his co-workers.
f. Kwame trusts the poor as much as he does the rich.
g. Marvin loves biology more than he does history.

(3) a. Jo wants to leave more than Ben wants to stay.
b. Stan wished he'd won more than he wished he'd stayed healthy.
c. Paul regrets buying his car more than Nora regrets selling hers.

However, one could just as easily argue that the availability of intensity as a means of comparing mental states results not from a natural language metaphysics connecting intensity to part-whole structure, but rather from a grammatical distinction between comparatives like (1) and those in (2–3). If such a structural distinction exists between intensity comparatives and other verbal comparatives, then it is possible that whatever imposes the monotonicity requirement on comparatives like (1) is absent in the case of intensity comparatives.

In fact, as discussed in Section 3, Chinese overtly shows such a structural distinction between "normal" verbal comparatives and intensity comparatives. However, I will argue that this distinction does not suffice as a counterargument to a view in which intensity of mental states is monotonic, for two reasons. First, in English, the intensity of mental states can be measured using not only verbal comparatives, but all five of the normally monotonicity-requiring constructions discussed in Section 2, requiring the positing of a wide-ranging structural distinction—with no overt evidence in its favor—across all five constructions. Second, Chinese has at least two other normally monotonicity-requiring measure constructions that can be used to

measure intensity of mental states, and the structural distinction in verbal comparatives that motivated the counterargument to begin with disappears in these constructions. With this in mind, I show at the end of Section 3 that a proposal in which intensity correlates with part-whole relations of mental states can readily account for the similarities and differences across languages and constructions, while a view in which intensity is non-monotonic faces an uphill battle.

The rest of the paper will then be dedicated to developing a natural language metaphysics of psychological intensity and a semantics of mental state verbs that makes the use of such verbs in monotonicity-requiring constructions unexceptional on a compositional level. Out of a desire to keep things succinct but concrete, I will use verbal comparatives as an exemplar of a monotonicity-requiring construction, with the understanding that the significance of the proposal lies more in the establishment of monotonicity than in the semantics of any one monotonicity-requiring construction in particular.

In Section 4, I provide those details about the denotations of mental state verbs, the semantics of verbal comparatives, and the natural language metaphysics of intensity that are sufficient to account for the simpler case of the transitive mental state verbs in (2). In short, the proposal is that in addition to the "horizontal" dimension of time, mental states also extend into a "vertical" dimension along which intensity is measured. This, in conjunction with certain reasonable assumptions about the internal structure of the domains of mental state verbs, suffices to capture the data in (2). After setting forth the basic proposal, I discuss some semantic predictions made by this analysis, as well as evidence suggesting that these predictions are correct.

In Section 5, I turn to the more complicated case of the attitude verbs in (3). In the Hintikkan tradition of attitude semantics (Hintikka 1969), attitudes like these are assigned denotations involving quantification over possible worlds. While a great deal of ink has already been spilled over whether and how gradable intensionality can be fully captured in a quantificational approach to modals and attitudes (see Kratzer 1981, 1991, 2012; Villalta 2008; Portner 2009; Lassiter 2011a,b, 2017; Katz et al. 2012; Klecha 2014; Portner & Rubinstein 2016; Pasternak 2016), the monotonicity of intensity means that whatever analysis of gradable intensionality we choose must then be integrated into the part-whole structure of attitude states. I show that by toying with the way in which worlds are ordered by their preferability to the experiencer, such integration can be effected in a broadly Hintikkan semantics. While this is initially demonstrated within the confines of von Fintel's (1999) Kratzerian semantics for *want*, I also show that there is a significant extent to which the core proposal is theory-independent, as the same ideas extend equally well to Heim's (1992) analysis, in spite of notable differences in terms of predicted entailments in the clausal complements of *want* and similar attitudes. Finally, some concluding remarks and lines for potential future inquiry are offered in Section 6.

2 Monotonicity in nominal and verbal measurement constructions

This section serves to introduce the notion of a **monotonic** measure function (i.e., one that tracks salient part-whole relations), as well as several syntactic constructions for which information about the (non-)monotonicity of a measure function affects grammaticality and the (un)availability of various readings.

2.1 Monotonic measure functions

There are many ways one can measure a chunk of gold: by volume, weight, temperature, purity, density, etc. But there is a fundamental difference between weight and purity, for example. If a given chunk of gold weighs twelve ounces, we know for certain that if we chip off a piece of that chunk and weigh it, it will weigh less than twelve ounces. But if the purity of that chunk of gold is eighteen carats, it is not guaranteed that by chipping off a piece, we will end up with a chunk of a lesser purity. It is not impossible, as we might happen to be left with a particularly impure bit of the gold, but importantly, it is not guaranteed.

Similar facts hold, for example, of the volume and temperature of a collection of water. If I start with three liters of water and pour some out, I am certain to be left with less than three liters of water. But if my water is 30° Celsius, then there is no guarantee that after pouring some out, I will be left with water with a lower or higher temperature than 30°. If anything, the smart money would be on still having water that is 30°.

Now consider the case of the depth of a collection of snow. There is a sense in which depth is like weight and volume, and a sense in which it is not. Let's say that Baltimore got two feet of snow, with each part of Baltimore having received the same amount of snow. It is not the case that if we remove any bit of snow, we are guaranteed to be left with snow that is less than two feet deep: if we remove all and only the snow in East Baltimore, the remaining snow will still have a depth of two feet. However, if we are only allowed to remove snow in "sheets", removing thin layers of snow that cover the whole area of Baltimore, then it will indeed be the case that by removing some snow, we will be left with snow of a depth less than two feet. An illustration of these two ways of removing snow can be seen in Figure 1.

Rather than speaking in terms of measuring, removing a portion, and remeasuring, we can instead talk about these measure functions in terms of whether they track certain part-whole relations. Weight tracks part-whole relations of gold, since a bit of gold necessarily weighs more than any of its proper parts; purity, however, does not, since a chunk of gold will not necessarily be purer than a given proper part of it. Similarly, volume tracks part-whole relations of water, while temperature does not. Meanwhile, depth tracks some, but not all, part-whole relations of snow. If the

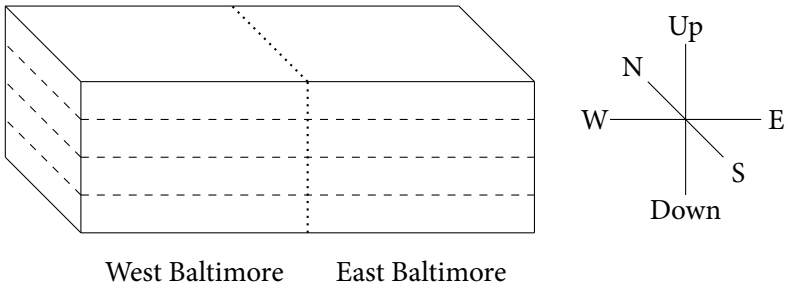

Figure 1: Illustration of two ways of removing snow from Baltimore: "chopping off" the snow from East Baltimore (dotted line), and slicing off layers (dashed lines).

part-whole relation under question is that between the snow in West Baltimore and the snow in all of Baltimore, depth does not track part-whole relations. But depth does track the part-whole relations between layers of snow and their sums, since the sum of two layers of snow is guaranteed to have a greater depth than each of those layers individually.

It will be useful to refer to measure functions like weight, volume, and depth as members of a single class that excludes, e.g., temperature and purity. Several ways of doing this have been proposed in the literature; I will use Schwarzschild's (2002, 2006) notion of a **monotonic** measure function, formally defined in (4):[2]

(4) Let μ be a measure function, A a domain of entities, and $\sqsubseteq^c$ a contextually salient part-whole relation. μ is **monotonic** on $\sqsubseteq^c$ in A iff for all $x, y \in A$, $x \sqsubset^c y$ entails that $\mu(x) < \mu(y)$.

Notice that by the definition in (4), a measure function is not monotonic (or non-monotonic) *simpliciter*, but rather is (non-)monotonic *on* a salient part-whole relation, *in* a domain. So μ_{weight}, which takes an entity and returns the degree that is its weight, is monotonic on pretty much any part-whole relation in ⟦gold⟧, while μ_{purity} is not; *mutatis mutandis* for $\mu_{\text{volume}}/\mu_{\text{temperature}}$ and ⟦water⟧. As for μ_{depth}, whether or not it is monotonic on a part-whole relation in ⟦snow⟧ depends on the part-whole relation. But if $\sqsubseteq^c$ is the part-whole relation between layers of snow and their sums, then μ_{depth} is indeed monotonic on $\sqsubseteq^c$ in ⟦snow⟧. All this being said, in cases where the part-whole relation and domain are clear or irrelevant, I will frequently refer to a measure function as simply being (non-)monotonic.

In the rest of this section, we will see that not only is monotonicity cognitively and formally significant, but it is also directly encoded in the grammar, as various syntactic constructions have semantic requirements related to the monotonicity (on

[2] See also Krifka's (1989) reference to *extensive measure functions*, as formally defined in Krantz et al. 1971. Champollion (2015) defines a notion of *stratified reference*, used to a similar effect.

a part-whole relation, in a domain) of the measure function(s) used.[3]

2.2 Pseudopartitives

One example of the grammatical relevance of monotonicity is pseudopartitives like *twelve ounces of gold* (Krifka 1989; Schwarzschild 2002, 2006; Brasoveanu 2009). As an illustration, consider the sentences in (5):

(5) a. i. Louise bought twelve ounces of gold.
ii. # Louise bought eighteen carats of gold.
b. i. Max poured three liters of water into the tub.
ii. # Max poured 30°C of water into the tub.
c. i. Baltimore got two feet of snow.
ii. # Baltimore got 20°F of snow.

The examples with monotonic measure functions—weight in (5a-i), volume in (5b-i), and depth in (5c-i)—are all acceptable, while those with non-monotonic measure functions—purity in (5a-ii), and temperature in (5b-ii) and (5c-ii)—are out.

In the examples in (5), all of the measure phrases unambiguously denoted a particular degree on a particular scale. But this needn't necessarily be the case, as pseudopartitives with vague measure phrases like *a great deal*, *a lot*, and *a ton* (on a non-literal interpretation) are all permissible:

(6) a. Nevin bought {a great deal/a lot/a ton} of coffee.
b. Baltimore got {a great deal/a lot/a ton} of snow last week.

In these cases, the measure phrases are not only vague, but also capable of denoting degrees on distinct scales: *a lot* can denote a degree of volume in (6a) and a degree of depth in (6b). This flexibility in interpretation can be further illustrated by fixing the measure function (and thus the scale) by means of *in terms of NP*, where *NP* is a type of measurement:

[3] It has been observed that the requirement is actually stronger for these constructions, as the measure function must be **non-trivially monotonic**, where μ is non-trivially monotonic on $\sqsubseteq^c$ in A iff μ is monotonic on $\sqsubseteq^c$ in A, *and there exist some* $x, y \in A$ *such that* $x \sqsubset^c y$. For example, the pseudopartitive in (i) is well-formed with the plural *pebbles*, but deviant with the singular *pebble*.

(i) Becca bought a half pound of {pebbles/#pebble}.

As Schwarzschild (2002, 2006) observes, if $[\![\text{pebble}]\!]$ only includes atomic pebbles and not their sums, weight is trivially monotonic in $[\![\text{pebble}]\!]$, since no pebble is a proper part of any other pebble. Wellwood et al. (2012) and Wellwood (2014) make similar observations with respect to nominal and verbal comparatives, building on work by Nakanishi (2007) and Bale & Barner (2009). However, for our purposes this strengthened requirement is irrelevant, as it will always be obeyed in the case of intensity comparatives given the natural language metaphysics of mental states proposed in this paper.

(7) In terms of volume, Owen ate a lot of pudding. But in terms of weight, he didn't eat very much.

(7) essentially means that Owen ate pudding that was not very dense: there was a large volume of it, but it did not weigh very much.

When looking at vague measure phrases like these, it can be a bit tricky to check for monotonicity requirements, since unlike in (5), the predicted difference is in available readings, rather than acceptability. Of course, one way to check would be by virtue of truth value judgments. For example, if Nevin bought a small volume and weight of coffee, but the coffee was exceptionally dark, (6a) is straightforwardly false, presumably because darkness is non-monotonic on part-whole relations in ⟦coffee⟧. Similarly, if Baltimore only got an inch of snow last week, but the snow was exceptionally cold, (6b) is still false. However, given that the choice of measure function is sensitive to context, it is conceivable that non-monotonic measure functions like temperature are not ruled out by the grammar itself, but are strongly dispreferred for pragmatic reasons, so that a great deal of contextual setup has to take place in order for such readings to be sufficiently salient. Ideally, then, we would have a test in which the difference is in acceptability, rather than truth conditions, so that we could rule out the possibility of a dispreferred but nonetheless available reading with a non-monotonic measure function.

Fortunately, such a test exists. As mentioned above, *in terms of NP* can be used to fix the choice of measure function. Therefore, if we try to use *in terms of NP* to force the use of a non-monotonic measure function, the result is predicted to be odd. As can be seen in (8), this prediction is in fact borne out:

(8) a. In terms of {volume/??darkness}, Nevin bought a lot of coffee.
b. In terms of {depth/??coldness}, Baltimore got a ton of snow.
c. In terms of {weight/??viscosity}, Owen ate a great deal of pudding.

So in cases with a vague measure phrase, we now have two ways to test whether a particular measure function is available. The first is by means of standard truth value judgments. The second is to see whether the sentence remains felicitous when trying to force a reading with that measure function by means of *in terms of NP*.

Since it will be relevant later, it is worth noting that pseudopartitives can be used to measure not only entities, but eventualities, as can be seen in (9) with the deverbal nominalizations *driving* and *acceleration*:

(9) a. i. Otto did {twenty minutes/ten miles} of driving yesterday.
ii. # Otto did thirty miles per hour of driving yesterday.
b. i. Nell's car only managed {three seconds/five miles per hour} of acceleration before breaking down.

ii. # Nell's car only managed 5°F of acceleration before breaking down.

Once again the measure functions used must be monotonic. A driving event covers more distance and time than its proper parts, but is not necessarily faster, so (9a-i) is acceptable, while (9a-ii) is not. As can be seen in (9b-i), the unacceptability of (9a-ii) is not because measurements involving speed are somehow bad in and of themselves. After all, while speed is not a monotonic measure of driving events, the change in speed of an object *is* a monotonic measure of acceleration events, since a bigger acceleration event will lead to a greater change of speed than any of its proper parts. Hence, a pseudopartitive in which the change of speed (or temporal duration) of an acceleration event is measured is acceptable. Meanwhile, as illustrated in (9b-ii), measuring the change in *temperature* of the object undergoing acceleration is not permissible in a pseudopartitive, even if the acceleration is assumed to be the direct cause of the change in temperature. This is because accelerating does not entail heating up, so it is not the case that an event of acceleration will always involve a greater increase in temperature than any of that event's proper parts; in other words, change of temperature is not monotonic in the domain of ⟦acceleration⟧.

2.3 *Out the wazoo* and *in spades*

In addition to pseudopartitives, English has a variety of idioms used to indicate a large amount of something, such as *NP out the wazoo* and *NP in spades*. Naturally-occurring examples of these expressions retrieved from the Internet can be seen in (10) and (11) (emphasis my own):

(10) a. Right now, most of Texas has water out the wazoo.[4]

b. We have snow out the wazoo and all I have is some Bridgestone all season tires on our vehicles.[5]

c. Soon, we had milk out the wazoo, and I had to figure out what to do with all of it.[6]

(11) a. Behana Gorge delivers rainforest beauty and…water in spades.[7]

b. They have snow in spades![8]

[4] http://www.tribtalk.org/2015/06/08/the-texas-drought-is-over-but-what-about-the-next/
This and all subsequent URLs last accessed Sep. 7, 2018.

[5] http://bobistheoilguy.com/forums/ubbthreads.php/topics/2114123/Snow_shoes_for_the_Thunder(sno

[6] http://www.ourcoop.com/ourcoop08/headlines/viewNews.aspx?artID=3433

[7] http://www.aussiedrifterz.com.au/
Slight revision made for illustrative purposes only.

[8] http://stuebysoutdoorjournal.blogspot.com/2012/12/head-for-high-country-to-find-snow-plan.html

c. I had extra milk in spades, so she mixed it [in] her food.[9]

The same monotonicity requirement seen in pseudopartitives arises here as well. For example, if Texas only has a small amount of water, but that water is very pure or cold, (10a) is false; what is required is that Texas have a very large amount of water, by depth or by volume. In the case of (10b) and (10c), it is necessary that there be a significant amount of snow or milk, rather than a very hot, cold, viscous, tasty, or nutritious portion.

Similar facts hold for *NP in spades* as for *NP out the wazoo*: (11a) requires that Behana Gorge have a large amount of water, and cannot mean that it has particularly hot or cold water. Furthermore, (11b) and (11c) again disallow measurements based on temperature, viscosity, etc. In other words, both *out the wazoo* and *in spades* require the use of measure functions that are monotonic in the domain of the modified NP.

2.4 Adverbial measure phrases

In Section 2.2, we saw that the monotonicity requirement for pseudopartitives extended to cases where the noun denoted a set of events, as illustrated in (9) above. This extension from entities to events is further exemplified by the use of vague measure phrases like *a lot* as VP (or *v*P) adjuncts, as in (12):

(12) a. Mara swam {a great deal/a lot/a ton} yesterday.
b. It rained {a great deal/a lot/a ton} in London last week.

If Mara swam for two seconds at breakneck speed, (12a) is false, since she has to have swum a great distance or for a long time in order for (12a) to be true. Similarly, if a small amount of rain fell in London over a small amount of time, but that rain was highly acidic, (12b) is false. Once again, this correlates with the (non-)monotonicity of the chosen measure function, since speed of swimming and acidity of rain are not monotonic measure functions.

The *in terms of NP* test used for pseudopartitives with vague measure phrases provides further evidence that these adverbial measure phrases only allow monotonic measure functions. As can be seen in (13), *in terms of NP* can be used to fix the measure function used:

(13) a. In terms of time, Mara swam a lot yesterday. But in terms of distance, she only swam an average amount.
b. In terms of time, it rained a great deal in London last week. But in terms of amount, it didn't rain all that much.

[9] http://www.reddit.com/r/JUSTNOMIL/comments/4frtoy/yes_mil_i_know_my_boobs_are_bigger/

(13a) means that Mara swam slower than average, as she covered an average distance in a large amount of time. (13b) would likewise be true if there was a light drizzle in London that lasted for a long time. Importantly, when trying to use *in terms of NP* to force a non-monotonic measure function, the result is once again odd.

(14) a. ?? In terms of speed, Mara swam a lot yesterday.
b. ?? In terms of acidity, it rained a great deal in London last week.

So it appears that adverbial measure phrases, much like their pseudopartitive counterparts in the nominal domain, impose a monotonicity requirement on the measure function used.

2.5 Nominal comparatives

As noted by Schwarzschild (2002, 2006), Wellwood et al. (2012), and Wellwood (2014, 2015), nominal comparatives also exhibit a monotonicity requirement. As an example, consider (15) below:

(15) Baltimore got more snow than Williamstown did.

(15) can be interpreted as comparing depth or overall volume of snow, but not coldness. The fact that both depth and overall volume are available means of comparison can be seen in (16), which makes use of *in terms of NP*.

(16) In terms of depth, Williamstown got more snow than Baltimore did, but in terms of overall volume, Baltimore got more snow than Williamstown did.

As before, the unavailability of coldness as a choice of measurement can be shown in two ways. The first is by truth value judgment: if the depth and overall volume of the snow in Williamstown exceed those of the snow in Baltimore, but the snow in Baltimore is colder than that in Williamstown, then (15) remains simply false. Second, the *in terms of NP* test once again differentiates between depth and volume on the one hand, and temperature on the other:

(17) ?? In terms of coldness, Baltimore got more snow than Williamstown did.

The same sort of reasoning can be applied to (18), which allows for a comparison of weight or volume, but not viscosity, of pudding:

(18) Pauline ate more pudding than Owen did.

As can be seen in (19), both weight and volume can be specified by *in terms of NP*. (20) further shows that trying to use *in terms of NP* to force a reading in which viscosity is compared leads to oddity.

(19) In terms of weight, Owen ate more pudding than Pauline did, but in terms of volume, Pauline ate more pudding than Owen did.

(20) ?? In terms of viscosity, Pauline ate more pudding than Owen did.

Finally, just like with pseudopartitives, where the monotonicity requirement extended to nouns with eventive denotations, nominal comparatives involving such nouns again retain the monotonicity requirement, as seen in (21) and (22):

(21) In terms of time, Otto did more driving yesterday than Rhonda did, but in terms of distance, Rhonda did more driving than Otto did.

(22) ?? In terms of speed, Otto did more driving yesterday than Rhonda did.

2.6 Verbal comparatives

We saw earlier that a monotonicity requirement in a particular nominal measurement construction (pseudopartitives) extended to a seemingly structurally parallel verbal measurement construction (adverbial measure phrases). Along similar lines, Wellwood et al. (2012) and Wellwood (2014, 2015) observe that the monotonicity constraint seen in nominal comparatives also arises in the case of verbal comparatives. Consider (1) from before, repeated below:

(1) Dee ran more than Evan did.

In the introduction, it was noted that (1) could serve as a comparison of time or distance of running, but not of speed, based on truth value judgments: if Dee ran for less time and less distance than Evan, but she ran faster, (1) remains false. The same restriction can be illustrated by means of the *in terms of NP* test:

(23) ?? In terms of speed, Dee ran more than Evan did.

The same story plays out with *rain*. As the *in terms of NP* test confirms, both temporal duration and amount of rain are available for *rain* comparatives, while acidity is not:

(24) In terms of amount, it rained more in London than it did in Paris, but in terms of time, it rained more in Paris than it did in London.

(25) ?? In terms of acidity, it rained more in London than it did in Paris.

Yet again, a restriction to monotonic measure functions gets the facts right here: the monotonic measure functions (time and distance in the case of *run*, time and amount in the case of *rain*) are permissible, while the non-monotonic measure functions are not.

2.7 Summary

In this section, we have seen that a variety of measurement constructions, including pseudopartitives, the measurement idioms *out the wazoo* and *in spades*, adverbial

measure phrases, and nominal and verbal comparatives, have a requirement that the measure function used must be monotonic. In the next section, we will see what such monotonicity requirements have to tell us about the way that intensity is manifested in the natural language metaphysics of mental states.

3 Intensity is monotonic (in spite of Chinese)

Consider again the intensity comparatives in (2) and (3), repeated below:

(2) a. Fiona likes football more than she does baseball.
b. Gavin fears clowns less than he does sharks.
c. Helen hates country music as much as she does rap.
d. Ina respects her teachers more than she does her friends.
e. Jorge admires the CEO less than he does his co-workers.
f. Kwame trusts the poor as much as he does the rich.
g. Marvin loves biology more than he does history.

(3) a. Jo wants to leave more than Ben wants to stay.
b. Stan wished he'd won more than he wished he'd stayed healthy.
c. Paul regrets buying his car more than Nora regrets selling hers.

Given the monotonicity requirement for verbal comparatives discussed above, the fact that (2) and (3) involve comparison of intensity lends plausibility to a proposed natural language metaphysics in which intensity is a monotonic measure of mental states.

But suppose that out of a desire to constrain the metaphysics, one wishes to deny that intensity is monotonic, while still accounting for the facts seen in Section 2. This would entail positing some structural or lexical difference between intensity comparatives and, say, *run* comparatives: whatever is responsible for the monotonicity requirement in the latter is somehow absent in the former. Perhaps the simplest account would be to claim that for *run*-type verbs, there is a separate morpheme—call it MUCH, following Wellwood (2014, 2015)—that is responsible for introducing the degree argument, imposing a monotonicity requirement in the process. As a result, $[\![\text{run}]\!]$ will have the degreeless denotation in (26a), $[\![\text{MUCH}]\!]$ will be defined as in (26b) (where μ^c is a contextually-determined measure function), and the combination of $[\![\text{run}]\!]$ and $[\![\text{MUCH}]\!]$ will look like (26c).[10] Note that I follow Kratzer (1996) in sev-

[10] It is worth noting that Wellwood (2014, 2015), whose analysis of verbal comparatives I adopt in this paper, defines $[\![\text{MUCH}]\!]^c$ differently from (26b): for her, $[\![\text{MUCH}]\!]^c$ simply denotes the contextually determined measure function μ^c. For our purposes this difference is immaterial, and either definition of MUCH is compatible with the basic analysis in this paper.

ering the external argument from the verb: while internal arguments are semantic arguments of the verb, the external argument (such as the agent in the case of *run*) is added by a separate voice head v.

(26) a. $[\![\text{run}]\!] = \lambda e.\ \text{run}(e)$

b. $[\![\textsc{much}]\!]^c = \lambda P \lambda d \lambda e.\ P(e) \wedge \mu^c(e) \geq d$

(Presupposition: μ^c is monotonic on $\sqsubseteq^c$ in P)[11]

c. $[\![\textsc{much}]\!]^c([\![\text{run}]\!]) = \lambda d \lambda e.\ \text{run}(e) \wedge \mu^c(e) \geq d$

(Presupposition: μ^c is monotonic on $\sqsubseteq^c$ in $[\![\text{run}]\!]$)

As for the intensity verbs, one could avoid the monotonicity requirement by simply building a degree argument directly into their denotations, so that while *run* is made gradable by the inclusion of MUCH, a verb like *hate* simply *is* gradable. A definition of *hate* along these lines can be seen in (27), where μ_{int} is the intensity measure function, and $\text{Thm}(e, x)$ is true iff x is the theme of e (in this case, the object of hatred):

(27) $[\![\text{hate}]\!]_{\text{deg}} = \lambda x \lambda d \lambda e.\ \text{hate}(e) \wedge \text{Thm}(e, x) \wedge \mu_{\text{int}}(e) \geq d$

Since MUCH is what imposes the monotonicity requirement, building a degree argument directly into mental state verbs is a means of side-stepping this requirement, providing a loophole for those who wish to avoid a view of intensity as monotonic. I will refer to this potential means of avoiding a monotonic account of intensity as the **lexical gradability hypothesis (LGH)**.

In fact, there is overt evidence from Chinese suggesting the plausibility of LGH. For verbal comparatives measuring something other than intensity, Chinese requires the inclusion of *duo* ('much'), along with a concomitant particle *de*. This is demonstrated with *pao* ('run') in (28), which has the same range of meanings as the English (1).

(28) Zhangsan bi Lisi pao *(de duo).
Zhangsan than[12] Lisi run *(DE much)
Zhangsan ran more than Lisi.

With adjectival comparisons, on the other hand, *duo* is absent:

[11] Given that the monotonicity requirement seems unable to be accommodated or locally satisfied in the same way as other presuppositions, it perhaps might be more accurate to refer to this requirement as a condition on definedness or well-formedness. I stick to the term "presupposition" for convenience.

[12] While I follow Liu (1996) and Xiang (2003) in glossing *bi* as 'than', the syntactic category (and thus the proper gloss) of *bi* remains unclear; Liu (1996) and Xiang (2003) analyze it as a preposition, Erlewine (2007) argues that it is a functional verbal head, and Erlewine (2017) proposes that it is a semantically asymmetric conjunction.

(29) Zhangsan bi Lisi gao.
Zhangsan than Lisi tall
Zhangsan is taller than Lisi.

Importantly, intensity comparatives pattern with adjectival comparatives, and not with other verbal comparatives: they lack *duo*, as can be seen in (30) with *xiang* ('want').

(30) Zhangsan bi Lisi xiang likai.
Zhangsan than Lisi want leave
Zhangsan wants to leave more than Lisi does.

If *duo* is what I have been referring to as MUCH, then the facts in (28)–(30) follow nicely from LGH: adjectives and mental state verbs, which carry their own degree argument, do not combine with *duo* to form comparatives, while other verbs must combine with *duo*, which both introduces a degree argument and imposes a monotonicity requirement.[13]

In addition, mental state verbs, like gradable adjectives and unlike other verbs, can be directly modified by degree modifiers like *feichang* ('very'):

(31) Zhangsan feichang gao.
Zhangsan very tall
Zhangsan is very tall.

(32) # Zhangsan feichang pao (-le).
Zhangsan very run (-PERF)

(33) Zhangsan feichang xiang likai.
Zhangsan very want leave
Zhangsan wants to leave very much.

If *feichang* can only combine with something that carries a degree argument, this is again expected under LGH: the degree-carrying gradable adjectives and mental state verbs accept modification by *feichang*, while other verbs do not.

However, I will argue in this section that the similarities and differences between Chinese and English are best accounted for by positing that intensity is, in fact, a monotonic measure of mental states. Starting with English, I show in Section 3.1 that the use of an apparently monotonicity-requiring construction to measure intensity of psychological states is not restricted to verbal comparatives, and actually extends to all of the constructions discussed in Section 2. As a result, proponents of using

[13] Here and throughout, I assume that if the presence of *duo* corresponds with the presence of MUCH, it is because *duo is* MUCH. However, the argument in this section goes through just as well if MUCH is instead a covert element that requires the additional presence of *duo*.

LGH as a counterproposal to a monotonic account of psychological intensity must strengthen their claim, so that a distinction in the presence or absence of MUCH must be posited across all of these constructions. In Section 3.2, I turn back to Chinese and show that when we look beyond verbal measurement constructions, the contrast between intensity and (other) monotonic measure functions evaporates: where *duo* appears, it appears across the board, even when measuring intensity. I then show that while LGH struggles to account for these facts, a monotonic proposal faces no difficulty in doing so.

3.1 Intensity in the other English constructions

In Section 2, five English constructions were shown to have monotonicity requirements: pseudopartitives, the measurement idioms *out the wazoo* and *in spades*, adverbial measure phrases, and nominal and verbal comparatives. Examples (2) and (3) already showed that verbal comparatives allow for measurements of intensity of mental states. Adverbial measure phrases, the other verbal measurement construction, can also be used to measure mental states, as illustrated in (34) with *hate*, *respect*, and *want*:

(34) a. Zelda hates Yoshi a great deal.
b. In that moment, Waldo respected Xavier a ton.
c. At the end of the meeting, Vince wanted the CEO to be fired, and he wanted it a lot.[14]

As can be seen in (35), these adverbial measure phrases are measuring the same thing as what is measured in the case of verbal comparatives, i.e., intensity:

(35) a. Zelda hates Yoshi a great deal, while Claire only hates him a little bit. #But Claire hates him more than Zelda does.
b. Waldo respected Xavier a ton, while Charlotte only respected him a little bit. #But Charlotte respected him more than Waldo did.
c. As for firing the CEO, Vince wanted it a lot, while Tabby only wanted it a little bit. #But Tabby wanted it more than Vince did.

So both of the monotonicity-requiring English verbal measurement constructions can be used to measure the intensity of mental states. What about the other three constructions? For those, we will switch from the verbs *hate*, *respect*, and *want* to the nouns *hatred*, *respect*, and *desire*. First, pseudopartitives:

[14] The reason for the somewhat cumbersome wording here is that English has a preference for low adjunct attachment, so the preferred reading of *Vince wanted the CEO to be fired a lot* is one in which *a lot* modifies *be fired*, rather than *want the CEO to be fired*. The inclusion of *at the end of the meeting* is to prevent a reading involving the frequency, rather than intensity, of Vince's desire.

(36) a. Zelda has a great deal of hatred for Yoshi.
b. Waldo had a ton of respect for Xavier.
c. There was a lot of desire on Vince's part for a change in leadership.

The examples in (36) are all well-formed and mean what one would expect: for instance, that Vince had an intense desire for a change in leadership. The fact that the adverbial measure phrases in (34) and the pseudopartitives in (36) use the same measure function is made clear by the contradictory nature of the sentences in (37):

(37) a. Zelda has a great deal of hatred for Yoshi, #but she doesn't hate him a great deal.
b. Waldo had a ton of respect for Xavier, #but he didn't respect him a ton.
c. There was a lot of desire on Vince's part for a change in leadership, #but he didn't want it a lot.

Turning next to the measurement idioms, (38) and (39) provide cases where *out the wazoo* and *in spades* (respectively) are felicitously used to measure the intensity of states of hatred, respect, and desire:

(38) a. Zelda has hatred out the wazoo for Yoshi.
b. Waldo had respect out the wazoo for Xavier.
c. Vince had desire out the wazoo for a change in leadership.

(39) a. Zelda has hatred in spades for the newly formed government.
b. Waldo had respect in spades for anyone who would risk their own life to save someone else's.
c. I love her phrase, too, "a desire to know more and still more." As a therapist, I've got that desire in spades.[15]

Again, the fact that the examples in (38) involve intensity measurements can be seen in (40). (The same is true of the sentences in (39).)

(40) a. Zelda has hatred out the wazoo for Yoshi, #but she doesn't hate him very much.
b. Waldo had respect out the wazoo for Xavier, #but he didn't respect him very much.
c. Vince had desire out the wazoo for a change in leadership, #but he didn't want it very much.

Last but not least, in (41) we see that nominal comparatives also allow for the measurement of psychological states in terms of intensity:

[15] http://www.psychologytoday.com/blog/headshrinkers-guide-the-galaxy/201208/got-curiosity

(41) a. Zelda has more hatred for Yoshi than Claire does. (#But Claire hates him more than Zelda does.)

b. Waldo had more respect for Xavier than Charlotte did. (#But Charlotte respected him more than Waldo did.)

c. There was more desire on Vince's part than on Tabby's part for a change in leadership. (#But Tabby wanted it more than Vince did.)

In summary, all five of the English constructions discussed in Section 2 can be used to measure the intensity of psychological states. Since each of these constructions normally imposes a monotonicity requirement, this means that in order for LGH to be viable as a counterproposal to a monotonic account of intensity, nouns like *desire* and *hatred* need to be gradable in the same way that *want* and *hate* allegedly are, and the distinction in the presence or absence of the monotonicity-introducing MUCH needs to cut across all five constructions. As a result, LGH becomes a much stronger hypothesis than it was when looked at solely through the lens of verbal comparatives, especially given that there is no overt evidence in English for such a widespread structural distinction.

3.2 Back to Chinese

By placing more demands on LGH, we also place more demands on what Chinese has to look like in order to constitute overt evidence in favor of LGH. If by hypothesis *duo* ('much') is what adds the degree argument and imposes the monotonicity requirement, then by LGH any normally monotonicity-requiring construction with *duo* should be *duo*-less when used to measure psychological intensity, for the same reason that *duo* was absent in the intensity comparative (30). I will show that this is not the case, based on evidence from a nominal measure construction roughly analogous to the pseudopartitive, as well as from nominal comparatives.

Jiang (2009) observes that in Chinese, pre-nominal measure phrases have different syntactic properties depending on whether the measure function is monotonic or not. When the measure function is monotonic, there is an option to include or exclude the particle *de* between the measure phrase and the noun, as in (42a). When the measure function is not monotonic, as in (42b), *de* is obligatory.

(42) a. si sheng (de) shui
four liter (DE) water
four liters of water

b. si du *(de) shui
four degree *(DE) water
four-degree water

With this in mind, consider (43), in which *duo* is necessary, while *de* is optional:

(43) Zhangsan mai -le hen *(duo) (de) kafei.
Zhangsan buy -PERF very *(much) (DE) coffee
Zhangsan bought a lot of coffee.

hen duo (de) kafei is interpreted like the pseudopartitive *a lot of coffee* in that the degree is vague and the measure function is context-dependent, with a requirement for monotonicity. A natural broad-strokes analysis of (43) that fits with the assumptions underlying LGH is that *duo*, as speculated above, introduces a degree argument and simultaneously imposes a monotonicity requirement. Because *duo* brings a degree argument with it, modification by *hen* ('very') becomes permissible, and since the result must be monotonic, *de* is optional, as per Jiang's observation.

We now have another Chinese measurement construction that imposes a monotonicity requirement, seemingly by means of *duo*. Thus, the prediction of LGH is that if intensity of mental states is measurable in this construction, then it should be measurable without *duo*, as the noun should come with its own degree argument. However, this turns out not to be the case. Consider the examples of love and respect. As can be seen in (44), the verbs *ai* ('love') and *zunjing* ('respect') pattern with *xiang* ('want') in being directly modifiable by *feichang* and appearing in verbal comparatives without *duo*:

(44) a. Zhangsan {feichang / bi Lisi} ai Chong.
Zhangsan {very / than Lisi} love Chong
Zhangsan loves Chong {very much/more than Lisi does}.
b. Zhangsan {feichang / bi Lisi} zunjing jingli.
Zhangsan {very / than Lisi} respect manager
Zhangsan respects the manager {very much/more than Lisi does}.

But when we turn to *hen duo (de)*, what we see is that just like in (43), *de* is optional, while *duo* is required.

(45) a. Zhangsan dui Chong you hen *(duo) (de) ai.
Zhangsan to Chong have very *(much) (DE) love
Zhangsan has a lot of love for Chong.
b. Zhangsan dui jingli you hen *(duo) (de) jingyi.
Zhangsan to manager have very *(much) (DE) respect
Zhangsan has a lot of respect for the manager.

Since the examples in (45) allow for—in fact, prefer—a reading in which what is measured is the intensity of love/respect, this spells trouble for the strengthened LGH. If *duo* brings monotonicity with it as LGH predicts, then the contrast between (44)

and (45) leads to the awkward prediction that intensity of love and respect both is and is not monotonic.

Similar facts can be gleaned from nominal comparatives, which in Chinese also impose a monotonicity requirement (as in English), and also require *duo*:

(46) Zhangsan bi Lisi mai -le geng *(duo) (de) kafei.
Zhangsan than Lisi buy -PERF GENG[16] *(much) (DE) coffee
Zhangsan bought more coffee than Lisi did.

Once again, LGH makes the prediction that when switching from coffee to love and respect, *duo* should disappear. But again, this prediction fails, and *duo* is obligatory:

(47) a. Zhangsan bi Lisi dui Chong you geng *(duo) (de) ai.
Zhangsan than Lisi to Chong have GENG *(much) (DE) love
Zhangsan has more love for Chong than Lisi does.

b. Dui jingli Zhangsan bi Lisi you geng *(duo) (de) jingyi.
to manager Zhangsan than Lisi have GENG *(much) (DE) respect
Zhangsan has more respect for the manager than Lisi does.

To summarize, both *hen duo (de)* and nominal comparatives generally require that the measure function used be monotonic, and for both constructions, *duo* appears across the board, including when psychological intensity is measured. This does serious damage to the claim that Chinese provides overt evidence for a version of LGH strong enough to oppose a monotonic account of intensity. In order to keep LGH afloat, one would have to abandon the claim that *duo* imposes a monotonicity requirement; otherwise, (45) and (47) go unaccounted for. But then the whole explanation for the difference between (28) and (30)—the verbal comparatives—goes out the window, and it is back to square one. This, of course, is not to say that an LGH-based account is impossible, as the right combination of covert elements can no doubt bring about the desired result. But the ensuing proposal would be no less stipulative than it would have been for English, and the distribution of *duo* becomes a mystery.

Meanwhile, if intensity *is* taken to be a monotonic measure of mental states, then the facts in this section are readily accounted for. Let us start with English. Intensity comparatives in English are not overtly distinct from other verbal comparatives, so they can be analyzed as composing in the same way: neither type of verb carries its own degree argument, so MUCH always introduces the degree argument and adds the monotonicity requirement. Since the intensity measure function μ_{int} is monotonic, an intensity comparative reading can arise. The same holds of nominal measurement

[16] Much like with *bi*, how *geng* should be glossed is not obvious. I leave it unglossed, but see Krasikova 2008 for arguments that it is an intensifier like English *even* or *still*.

constructions: nouns like *desire*, *love*, etc. do not carry their own degree argument, and so they compose just like other nouns in these measure constructions. The result is that on a compositional level, there is no difference in English between measurements of intensity and other monotonic measurements.

A monotonic proposal can also account for the Chinese data, while simultaneously preserving the intuition that *duo* adds a degree argument and brings monotonicity with it. In the nominal realm, where measurements of intensity do not stand out from other monotonic measurements, Chinese looks just like English: nouns like *ai* ('love') and *jingyi* ('respect') do not have their own degree argument, and as a result they compose like other nouns. This accounts for (45) and (47): both contain *duo* because *duo* is needed to add the degree argument, and both have intensity readings because intensity is monotonic. As for mental state verbs, we can take a page from the LGH book and simply say that they come with a built-in degree argument. The rest plays out just like in LGH, with the pre-existing degree argument obviating the need for *duo* and enabling direct modification by *feichang*. So while the English verb *respect* will have the degreeless denotation in (48a), the analogous Chinese verb *zunjing* will look like (48b):[17]

(48) a. $[\![\text{respect}]\!] = \lambda x \lambda e.\ \text{respect}(e) \wedge \text{Thm}(e, x)$

b. $[\![\text{zunjing}]\!] = \lambda x \lambda d \lambda e.\ \text{respect}(e) \wedge \text{Thm}(e, x) \wedge \mu_{\text{int}}(e) \geq d$

In this proposal we see that a monotonic view of intensity is not inherently at odds with a view in which there is variation across verbs (and across languages) in the presence or absence of a degree argument. After all, a denotation along the lines of (48b) can still conform to a monotonic account if μ_{int} is monotonic. The difference is that under a monotonic account, the predictions are more lax on the compositional level, since the LGH predicts universal presence of a built-in degree argument for mental state verbs and nouns, while a monotonic account is agnostic about its presence or absence for a given lexical item. Of course, this begs the question of *why* certain verbs should look like (48b), but not others. Though this is without a doubt an important question to address, I will hold off on any speculation here, leaving a resolution for future work.

The rest of this paper will be devoted to exploring the relationship between the semantics of mental state verbs and the natural language metaphysics of the mental

[17] Krasikova (2008) and Erlewine (2017) argue, following the pioneering work of Beck et al. (2004) on similar phenomena in Japanese, that degrees do not enter the compositional semantics of Chinese comparatives like they do in English. In particular, they argue that while English permits lambda-abstraction over degrees in the manner specified by von Stechow (1984), Heim (1985, 2000), and others, Chinese does not, leading to certain notable differences in interpretation between Chinese and English comparatives. If this is true, then the denotations of *duo* and mental state verbs may have to be tweaked accordingly.

states that they describe. Throughout this analysis, I will be looking specifically at English, with the result being that mental state verbs will be defined like (48a), rather than (48b). However, given that the core of this proposal does not rely specifically on the absence of a degree argument in the denotations of mental state verbs, there is no reason to believe that the analysis in this paper should not readily extend to Chinese.

4 Intensity and two-dimensional states

We have seen that there is reason to believe that in an adequate natural language metaphysics, intensity is a monotonic measure of mental states. In this section, I will articulate the basic features of the proposed natural language ontology of psychological intensity, as well as the semantics of the non-attitude mental state verbs in (2). This section will also serve as a foundation for the discussion in Section 5 of the more complex case of attitude verbs. As mentioned in the introduction, I will use verbal comparatives to illustrate the interaction between the semantics and the mereology of mental states, with the understanding that the results in this paper are not specific to that construction.

4.1 Semantic assumptions

Before delving into those aspects of the analysis that are specific to mental state verbs, it is worth going over the general semantic assumptions at play. As mentioned previously, I assume that internal arguments are semantic arguments of the verb, while the external argument is introduced by a higher voice head v (Kratzer 1996). The denotations of VPs and vPs will then be predicates of eventualities, with the predicate denoted by the vP subsequently being existentially quantified over by a higher head. For example, the denotation of *Ann hates Bill* will be as in (49), where $\text{Exp}(e, \text{ann})$ is true iff Ann is the experiencer of e.

(49) $[\![\text{Ann hates Bill}]\!] = 1$ iff $\exists e[\text{Exp}(e, \text{ann}) \wedge \text{hate}(e) \wedge \text{Thm}(e, \text{bill})]$

Note that for simplicity's sake I treat matrix clauses as tenseless and extensional, though when I turn to the attitudes in the next section, the complement will of course be intensional.

Moving on to verbal comparatives, I will adopt what is essentially a notational variant of Wellwood's (2014, 2015) proposal. I will not concern myself with the compositional details of the analysis (see Wellwood's work for a full implementation), instead sticking to simple templatic representations. With this in mind, a formal definition of *Ann* VP_1 *more than Matt* VP_2 can be seen in (50), where Θ is the thematic relation of the external argument:

(50) $[\![\text{Ann VP}_1 \text{ more than Matt VP}_2]\!]^c =$

a. Assertion:
$\exists e[\Theta_1(e, \text{ann}) \wedge [\![\text{VP}_1]\!](e) \wedge \mu^c(e) > \max(\{d \mid \exists e'[\Theta_2(e', \text{matt}) \wedge [\![\text{VP}_2]\!](e') \wedge \mu^c(e') \geq d]\})]$

b. Presuppositions:
$\forall e, e' \in [\![\text{VP}_1]\!][e \sqsubset^c e' \rightarrow \mu^c(e) < \mu^c(e')]$
$\forall e, e' \in [\![\text{VP}_2]\!][e \sqsubset^c e' \rightarrow \mu^c(e) < \mu^c(e')]$

In short, given a context c, the assertion of the sentence *Ann VP_1 more than Matt VP_2* will be true iff there is an eventuality of Ann VP_1ing that exceeds by μ^c any eventuality of Matt VP_2ing. In addition, the monotonicity requirement—that μ^c is monotonic on salient part-whole relations in the domains of $[\![\text{VP}_1]\!]$ and $[\![\text{VP}_2]\!]$—is presupposed. Note that while the inclusion of two separate presuppositions is necessary for cases like *Ben ran more than Jen swam*, in cases where the two VPs are identical or sufficiently similar this double-presupposition may become redundant.

As an illustration, the *run* comparative (1) will have the denotation seen in (51), where $\text{Agt}(e, x)$ is true iff x is the agent of e. Since the VPs in the matrix clause and the comparison clause are identical—both the matrix VP and the ellided VP are simply *run*—the two VP monotonicity presuppositions collapse into a single requirement about the domain of running events.

(51) $[\![\text{Dee ran more than Evan did}]\!]^c =$

a. Assertion:
$\exists e[\text{Agt}(e, \text{dee}) \wedge \text{run}(e) \wedge \mu^c(e) > \max(\{d \mid \exists e'[\text{Agt}(e', \text{evan}) \wedge \text{run}(e') \wedge \mu^c(e') \geq d]\})$

b. Presupposition:
$\forall e, e' \in [\![\text{run}]\!][e \sqsubset^c e' \rightarrow \mu^c(e) < \mu^c(e')]$

The assertion of (51) is that there is an event of Dee running that exceeds by the contextually-determined measure function μ^c any event of Evan running. The presupposition is that μ^c is monotonic on $\sqsubseteq^c$ in $[\![\text{run}]\!]$. Because of this presupposition, the temporal duration measure function μ_{dur} and the distance measure function μ_{dist}, which are monotonic measures of running events, are permissible values for μ^c, while the non-monotonic speed measure function μ_{speed} is not.

Similarly, by straightforward substitution into (50) the intensity comparative in (52) will have the denotation in (53), given a context c.

(52) Ann hates Bill more than Matt hates Jeff.

(53) a. Assertion:
$\exists e[\text{Exp}(e, \text{ann}) \wedge \text{hate}(e) \wedge \text{Thm}(e, \text{bill}) \wedge \mu^c(e) > \max(\{d \mid \exists e'[\text{Exp}(e', \text{matt}) \wedge \text{hate}(e') \wedge \text{Thm}(e', \text{jeff}) \wedge \mu^c(e') \geq d]\})]$

b. PRESUPPOSITIONS:
$\forall e, e' \in [\![\text{hate}]\!](\text{bill})[e \sqsubset^c e' \rightarrow \mu^c(e) < \mu^c(e')]$
$\forall e, e' \in [\![\text{hate}]\!](\text{jeff})[e \sqsubset^c e' \rightarrow \mu^c(e) < \mu^c(e')]$

Since the monotonicity requirement is checked with respect to the denotation of each VP, there are two presuppositions at play: (I) that μ^c is monotonic on salient part-whole relations in hating-Bill states, and (II) that it is monotonic on salient part-whole relations in hating-Jeff states. This "double-checking" again has no noticeable effect here, so I will often refer to the presupposition in (53) as simply requiring that μ^c be monotonic on salient part-whole relations in the domain of hatred states, and *mutatis mutandis* for other mental state verbs.

Obviously, for the comparatives dealt with in this paper, μ^c will generally be μ_{int}, the function from mental states to degrees of intensity. Our task is now to devise a natural language metaphysics of mental states in which μ_{int} is a monotonic measure function.

4.2 The ontology of intensity: Going vertical

In order to make μ_{int} monotonic, I will treat mental states as extending in two dimensions. The first, "horizontal" dimension is time; the fact that such states exist in time is intuitively obvious, as well as necessary for the interpretation of tense and aspect. The second, "vertical" dimension will be the one along which intensity is measured.

Before talking about two-dimensional states, it will help to clearly establish the ontology and terminology of the more commonly discussed horizontal dimension of time. In most implementations, a timeline is an ordered pair $\langle T, \leq_{\text{T}} \rangle$, where T is a set of **moments** in time, and $\leq_{\text{T}}$ is a dense ordering on T, usually with no minimal element (i.e., no "first moment") or maximal element. Events can then be situated on this timeline. For example, let's say that Dee's running event e occupies the bit of timeline seen in Figure 2:

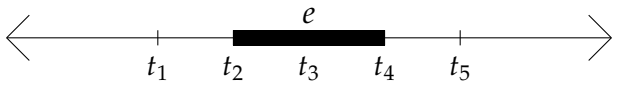

Figure 2: Dee's running event, situated in time

The set of moments that e spans is the closed interval $[t_2, t_4]$, which is traditionally referred to as e's **temporal trace** ($\tau(e)$). Notice that τ is *not* a measure function on events. A measure function takes an entity or eventuality and returns a degree; τ, on the other hand, takes an eventuality and returns a set of moments. For example, if t_2 is 2PM, and t_4 is 4PM, then $\tau(e)$ is the set of moments from 2PM to 4PM, inclusive. The temporal measure function μ_{dur}, on the other hand, returns the degree denoted by

the measure phrase *two hours*. That being said, there is a clear relationship between τ and μ_{dur}: if $\tau(e')$ is the same as $\tau(e)$, then $\mu_{\text{dur}}(e') = \mu_{\text{dur}}(e)$ (= two hours), and if $\tau(e')$ is the set of moments from 2PM to 3PM (inclusive), then $\tau(e') \subset \tau(e)$, and $\mu_{\text{dur}}(e') < \mu_{\text{dur}}(e)$.

We thus have at our disposal three ways of talking about time: moments (e.g., t_1), intervals ($[t_2, t_4]$), and degrees of duration (two hours). In moving from one- to two-dimensional eventualities, each of these notions will have an analog in the vertical dimension.

In the same way that the (horizontal) timeline was a pair $\langle T, \leq_{\text{T}} \rangle$, the vertical analog to a timeline will be an ordered pair $\langle K, \leq_{\text{K}} \rangle$, where K is a set of **altitudes**, and $\leq_{\text{K}}$ is a dense ordering over K such that $k_a \leq_{\text{K}} k_b$ iff k_b is at least as high an altitude as k_a. However, I will assume two important distinctions between moments (and their ordering) and altitudes (and their ordering). First, whereas $\leq_{\text{T}}$ was taken to have no minimum, I will assume that there is in fact a minimum, "sea level" altitude k_0. Second, whereas eventualities can start and end at arbitrary times, mental states will always start at k_0 and extend upwards. The reason for these stipulations is for the sake of clarity. In the horizontal dimension of time, we have a very clear idea of what it means for two events to start at different times, but have the same duration, such as if one event goes from 1–3PM, and another goes from 2-4PM. In the vertical dimension of intensity, on the other hand, it is less obvious what it would mean for two mental states to start and end at different altitudes, but have the same intensity. I will therefore side-step this issue by stipulating that mental states simply start at k_0, and leave the exploration of alternative possibilities for another time.

Since mental states are two-dimensional objects, they occupy spaces in a two-dimensional coordinate system of moments and altitudes. Hence, the temporal trace function τ can be replaced by the more general function π, which takes a psychological state and returns the set of pairs (t, k) of a moment t and altitude k such that e occupies k at t. τ can then be redefined based on π as in (54a), in which τ takes an eventuality and returns the set of times such that that eventuality occupies some altitude at that time. Similarly, $\kappa(e)$—e's **vertical span**, the vertical analog to its temporal trace—can be defined as in (54b).

(54) a. $\tau(e) = \{t \mid \exists k[(t, k) \in \pi(e)]\}$
b. $\kappa(e) = \{k \mid \exists t[(t, k) \in \pi(e)]\}$

Note that κ, like τ, is not a measure function, since neither returns a degree. But much like the aforementioned relationship between τ and μ_{dur}, I assume a close-knit relationship between κ and μ_{int}: if two mental states e_1 and e_2 start at k_0, with e_1 extending up to k_1 and e_2 reaching k_2 (where $k_1 <_{\text{K}} k_2$), then $\mu_{\text{int}}(e_1) < \mu_{\text{int}}(e_2)$.

It will help to consider an example. Figure 3 illustrates a psychological state e that grows more intense, reaches a peak, and then rapidly dissipates. In this exam-

ple, $\tau(e) = [t_2, t_4]$, since e occupies every moment from t_2 to t_4. Similarly, $\kappa(e) = [k_0, k_2]$, since for every altitude k in that range, there is some t such that $(t, k) \in \pi(e)$. As stated above, at each moment the state starts at k_0 and extends upward. As for $\mu_{\text{int}}(e)$, what matters is not what we label the degree assigned to it, but rather that μ_{int} and κ are related in a manner parallel to μ_{dur} and τ, as discussed above.

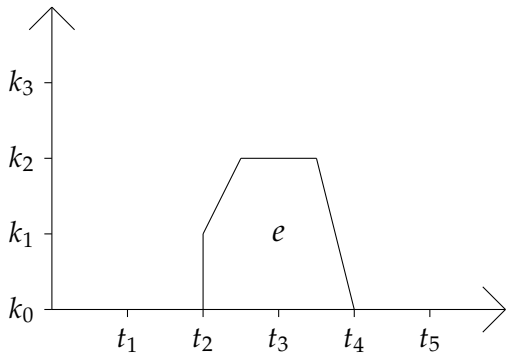

Figure 3: A sample mental state, situated horizontally and vertically

Finally, some remarks are in order about the relationship between mental states and their proper parts. If there is a state of Ann hating Bill, and that state goes from 1PM to 3PM, then clearly the part of this state from 1PM to 2PM is also a state of Ann hating Bill, as are the parts from 1:10PM to 1:11PM and from 1:10:12PM to 1:10:13PM. In other words, mental state ascriptions appear to obey some version of the subinterval property (Bennett & Partee 1972), at least down to a certain granularity. How fine the granularity is is not obvious, but I will assume that at least for statives (of which mental state ascriptions are exemplars) the subinterval property extends down even to individual moments. This should be interpreted more as a simplifying assumption than as an independently motivated claim; a coarser-grained version of the subinterval property would do just as well for our purposes.

More importantly, in switching to two-dimensional mental states, I will extend the subinterval property to the vertical dimension as well, so that if e is Ann's state of hating Bill, and $\kappa(e) = [k_0, k_2]$, then the portion of e from k_0 to k_1 (where $k_1 <_K k_2$) will also be a state of Ann hating Bill. The result of combining the horizontal and vertical versions of the subinterval property is that any part of a state of Ann hating Bill will itself be a state of Ann hating Bill. I will refer to this property of mental states as **two-dimensional subdivision**.

Two-dimensional subdivision is a claim about what can be inferred about the parts of a mental state, given certain information about the whole. Similar inferences can be made in the opposite direction as well. If e_1 is a state of Ann hating Bill that goes from 1PM to 2PM, and e_2 is an Ann-hating-Bill state going from 2PM to

3PM, then clearly $e_1 \sqcup e_2$, the sum of e_1 and e_2, is also a state of Ann hating Bill. This is the familiar trait of **cumulativity** (Krifka 1989), which holds of a property iff it is closed under mereological sum. Like two-dimensional subdivision, I will assume that cumulativity is not restricted to the horizontal dimension, but is also true vertically: the sum of two "stacked" Ann-hating-Bill states is also a state of Ann hating Bill.

The conjunction of two-dimensional subdivision and cumulativity leads to a biconditional constraint that I will refer to as **mental state homogeneity**, defined in (55) (where $v\mathrm{P}_{\mathrm{men}}$ is a vP whose verb is a mental state verb).

(55) MENTAL STATE HOMOGENEITY:
$[\![v\mathrm{P}_{\mathrm{men}}]\!](e) \leftrightarrow \forall e' \sqsubseteq e[[\![v\mathrm{P}_{\mathrm{men}}]\!](e')]$

Thus, mental state homogeneity requires that a state is a state of Ann hating Bill if and only if all of its substates are states of Ann hating Bill.

4.3 Back to comparatives

With the ontology of intensity now in place, we can see how the semantics of verbal comparatives interacts with the part-whole structure of mental states in order to derive readings in which intensity is compared. The sentence under consideration will be (52), *Ann hates Bill more than Matt hates Jeff*. For our example, e_{a} will be Ann's (maximal) state of hating Bill, so that $\mathrm{Exp}(e_{\mathrm{a}}, \mathrm{ann})$, $\mathrm{hate}(e_{\mathrm{a}})$, and $\mathrm{Thm}(e_{\mathrm{a}}, \mathrm{bill})$ are all true. Similarly, e_{m} will be Matt's state of hating Jeff, with $\mathrm{Exp}(e_{\mathrm{m}}, \mathrm{matt})$, $\mathrm{hate}(e_{\mathrm{m}})$, and $\mathrm{Thm}(e_{\mathrm{m}}, \mathrm{jeff})$ all being true.

In (56) I repeat the denotation for (52) provided in (53), except making explicit the fact that the contextually determined measure function will be the intensity measure function μ_{int}.

(56) $[\![\text{Ann hates Bill more than Matt hates Jeff}]\!]^c =$

a. ASSERTION:
$\exists e[\mathrm{Exp}(e, \mathrm{ann}) \wedge \mathrm{hate}(e) \wedge \mathrm{Thm}(e, \mathrm{bill}) \wedge \mu_{\mathrm{int}}(e) >$
$\max(\{d \mid \exists e'[\mathrm{Exp}(e', \mathrm{matt}) \wedge \mathrm{hate}(e') \wedge \mathrm{Thm}(e', \mathrm{jeff}) \wedge \mu_{\mathrm{int}}(e') \geq d]\})]$

b. PRESUPPOSITIONS:
$\forall e, e' \in [\![\mathrm{hate}]\!](\mathrm{bill})[e \sqsubset^c e' \rightarrow \mu_{\mathrm{int}}(e) < \mu_{\mathrm{int}}(e')]$
$\forall e, e' \in [\![\mathrm{hate}]\!](\mathrm{jeff})[e \sqsubset^c e' \rightarrow \mu_{\mathrm{int}}(e) < \mu_{\mathrm{int}}(e')]$

Consider the scenario in which e_{a} and e_{m} are as diagrammed in Figure 4. (While I place the states side by side, these states should be thought of as simultaneous.) As can be seen from the diagram, $\kappa(e_{\mathrm{a}}) = [k_0, k_2]$, while $\kappa(e_{\mathrm{m}}) = [k_0, k_1]$, where $k_1 <_{\mathrm{K}} k_2$. Hence, $\kappa(e_{\mathrm{a}}) \supset \kappa(e_{\mathrm{m}})$, so given the relationship between μ_{int} and κ, $\mu_{\mathrm{int}}(e_{\mathrm{a}}) > \mu_{\mathrm{int}}(e_{\mathrm{m}})$. The assertion in (56) is thus true: the highest degree of intensity manifested

in a state of Matt hating Jeff is $\mu_{\text{int}}(e_{\text{m}})$, and there is a state of Ann hating Bill that exceeds e_{m} in intensity, namely e_{a}.

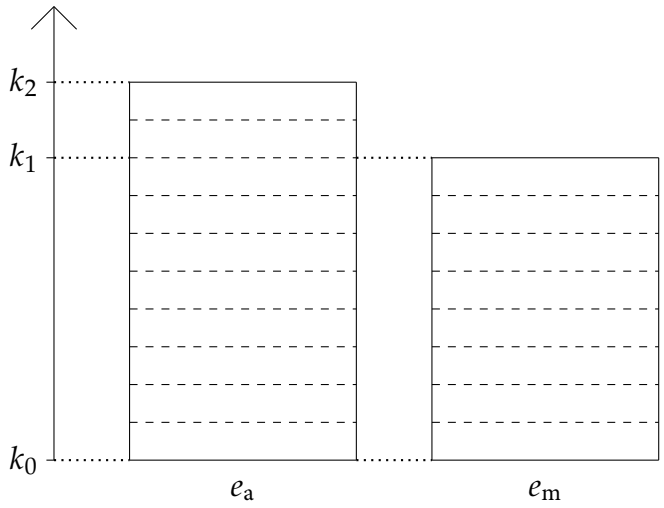

Figure 4: Diagram of Ann's state of hating Bill and Matt's state of hating Jeff

In addition, the monotonicity presupposition is satisfied as well, so long as the salient part-whole relation is set in the right way. Recall that the monotonicity requirement states that for any two elements of $[\![\text{hate}]\!](\text{bill})$ that stand in a contextually salient proper part-whole relation, there is a corresponding difference in intensity, and likewise for elements of $[\![\text{hate}]\!](\text{jeff})$. Now consider what happens when we look at horizontal "strips" of e_{a} and e_{m}—indicated in Figure 4 by dashed lines—and their sums. Courtesy of mental state homogeneity, each strip of e_{a} will itself be a hating-Bill state, so each strip will be a member of $[\![\text{hate}]\!](\text{bill})$. Furthermore, just like the thin layers used to measure the depth of snow, the sum of any two strips of e_{a} will have a greater measurement in the vertical dimension than each of its parts. Thus, μ_{int} is indeed monotonic on such a part-whole relation.

Naturally, the same sort of analysis extends to sentences with adverbial measure phrases like *Ann hates Bill a lot*, with the difference being that the degree of comparison is not the degree to which Matt hates Jeff, but the degree denoted by the measure phrase *a lot*. A plausible out-of-the-box denotation for *Ann VP MeasP* (where MeasP is a measure phrase) can be seen in (57).

(57) $[\![\text{Ann VP MeasP}]\!]^c =$

a. Assertion:
$\exists e[\Theta(e, \text{ann}) \wedge [\![\text{VP}]\!](e) \wedge \mu^c(e) \geq [\![\text{MeasP}]\!]^c]$

b. Presupposition:
$\forall e, e' \in [\![\text{VP}]\!][e \sqsubset^c e' \rightarrow \mu^c(e) < \mu^c(e')]$

Again by straightforward substitution, *Ann hates Bill a lot* will have the denotation in (58):

(58) $[\![\text{Ann hates Bill a lot}]\!]^c =$

a. Assertion:
$\exists e[\text{Exp}(e, \text{ann}) \wedge \text{hate}(e) \wedge \text{Thm}(e, \text{bill}) \wedge \mu^c(e) \geq [\![\text{a lot}]\!]^c]$

b. Presupposition:
$\forall e, e' \in [\![\text{hate}]\!](\text{bill})[e \sqsubset^c e' \rightarrow \mu^c(e) < \mu^c(e')]$

Since intensity is monotonic, setting μ^c to μ_{int} obeys the monotonicity presupposition of adverbial measure phrase constructions, meaning that (58) can be interpreted as a claim that Ann has a very intense hatred of Bill.

What we see, then, is that our two-dimensional ontology, together with a salient part-whole relation along the lines illustrated in Figure 4, renders intensity a monotonic measure of mental states. Notice that the contextually salient part-whole relation plays a crucial role here: it determines which measurements are or are not monotonic, thereby constraining the class of available readings. Thus, while we rightly predict the existence of intensity readings for mental state verbal comparatives, we do not necessarily predict that this is the *only* reading available, as a different salient mereological relation could enable different interpretations. In fact, we will later see evidence of precisely this sort of context-sensitivity.

4.4 Some consequences

Before moving on to attitudes, let's take a moment to explore some of the semantic predictions of the proposal so far, beyond monotonicity of psychological intensity. First and foremost is that, given the semantics of verbal comparatives adopted here, the truth of *α VP*$_1$ *more than β VP*$_2$ is predicted to entail the truth of *α VP*$_1$. After all, the comparative simply adds another conjunct within the scope of the matrix clause's existential quantifier over events, with the result being that if the comparative is true, the non-comparative must be true as well. I will call this predicted entailment the *positive entailment*.

For non-intensity comparatives, the positive entailment is clear: if Dee ran more than Evan did, she has to have done at least some running. With transitive psychological verbs like *admire* this seems to hold as well. For example, suppose that Jill considers the president to be absolute scum, and that Jack's opinion of the chairman is only slightly less miserable. In this case, (59) is false (or odd), even though Jack's opinion of the chairman is less negative than Jill's opinion of the president.

(59) Jack admires the chairman more than Jill admires the president.

Similar facts can be shown for attitude verbs. Suppose that Lana and Sterling are both happily alive, and both want to continue living. Furthermore, suppose that Sterling's desire not to die is stronger than Lana's. In spite of the fact that Lana's views on death are less negative than Sterling's, each of the examples in (60) is false (or odd):

(60) a. Lana wants to die today more than Sterling does.
b. Lana wishes she was dead more than Sterling does.
c. Lana regrets being alive more than Sterling does.

If positive entailment holds of attitude comparatives, it is a problem for many theories of intensional comparison. For example, Kratzer (1981, 1991, 2012) defines p as being a better possibility than q iff, roughly speaking, worlds in which p holds are better than worlds in which q holds. Villalta (2008) takes this idea for modality and extends it to attitudes, meaning that for α to want p more than q is for α to rank p worlds as better than q worlds. This basic principle has also been adopted by some proponents of other, formally quite different proposals. Levinson (2003) and Lassiter (2011a), for example, reject Kratzer's direct comparison of p and q worlds, and propose replacing it with the decision-theoretic notion of expected utility. Nonetheless, they agree that to want p more than q is to in some sense view p as better than q; the real source of disagreement is on how this is determined.[18] But it is possible for p to be better (or less bad) than q without p actually being desirable, meaning that the positive entailment is not predicted under such an approach. Meanwhile, the positive entailment comes for free in the proposal at hand, not as a result of the semantics of *want*, *wish*, or *regret*—we don't even have definitions for these yet—but simply because attitude comparatives are just a subspecies of verbal comparatives.

While the truth of a *run* comparative like *Dee ran more than Evan did* entails that Dee ran at least a little bit (the positive entailment), it does not entail that Evan ran. This is illustrated by the non-contradictory nature of (61):

(61) Dee ran more than Evan did. In fact, Evan didn't run at all.

Our semantics will have to be slightly revised in order to actually derive this non-entailment. To see why, consider again (51), repeated below:

[18] Lassiter and Levinson take slightly different stances on what determines the relative desirability of p: for Lassiter it is its expected utility, while for Levinson it is the difference between the expected utility of p and that of its negation. Neither view predicts the positive entailment, since on either approach p can have a negative desirability (and thus be unwanted), but still have a "less negative" desirability than q.

(51) $[\![\text{Dee ran more than Evan did}]\!]^c$ =

a. Assertion:
$\exists e[\text{Agt}(e, \text{dee}) \wedge \text{run}(e) \wedge \mu^c(e) > \max(\{d \mid \exists e'[\text{Agt}(e', \text{evan}) \wedge \text{run}(e') \wedge \mu^c(e') \geq d]\})]$

b. Presupposition:
$\forall e, e' \in [\![\text{run}]\!][e \sqsubset^c e' \rightarrow \mu^c(e) < \mu^c(e')]$

If there is no event of Evan running, then the set of degrees fed to the max operator is the empty set, and so the output of the max operator is undefined. We can fix this by adding an additional disjunct inside the max operator, as follows (where $D_0(\mu^c)$ is the "zero degree" (i.e., minimum degree) of the scale that is the codomain of μ^c):

(62) $\max(\{d \mid d = D_0(\mu^c) \vee \exists e'[\text{Agt}(e', \text{evan}) \wedge \text{run}(e') \wedge \mu^c(e') \geq d]\})$

Defined this way, the minimal degree of μ^c will always be included in the set fed to the max operator, even if there is no event of Evan running. (61) then boils down to a claim that Dee ran a non-zero distance or time, depending on the choice of μ^c.[19]

As shown in (63), this non-entailment extends to intensity comparatives as well:

(63) a. Jack admires the chairman more than Jill does. In fact, Jill doesn't admire him at all.

b. Isabella regrets losing the competition more than Miguel does. In fact, Miguel doesn't regret it at all.

Thus, it appears that mental state verbal comparatives of the form *α VP_1 more than β VP_2* entail that *α VP_1*, but not that *β VP_2*. This is precisely what we predict if mental state verbal comparatives compose in exactly the same way as other, more pedestrian verbal comparatives.

Another prediction made by the proposal as it currently stands is that successful comparison of the intensity of mental states should not depend on the type of mental states being compared.[20] That is, while I have so far focused on comparing the intensity of one hatred state to that of another hatred state (for example), the fact that intensity constitutes a single dimension means it should be just as permissible to compare the intensity of a state of hatred to that of a state of love or respect. So far as I can tell, this seems to be the case:

(64) a. I will not skip Lola's wedding. I love her far more than I hate her fiancé.

[19] Note that while we want the zero degree to always be included for verbal comparatives, the same is not true of adjectival comparatives, since many adjectives are associated with scales that lack a zero degree. This can be resolved by introducing the zero degree via much, which appears in verbal comparatives but (arguably) not adjectival comparatives. See Pasternak 2018 for a similar proposal.

[20] I am grateful to an anonymous reviewer for raising this point.

b. Sandy fears her advisor, but she respects her even more.

c. I wanted to leave less than I would have hated myself for doing so.

However, if such universality of comparability does not hold, there is a relatively easy fix within the confines of the theory at hand: instead of a single dimension for mental state intensity, there may simply be multiple different intensity dimensions, with different types of mental state occupying different dimensions. If two types of state, such as hatred and love, are comparable, that indicates that they extend along the same intensity dimension, while two incomparable kinds of state extend along different intensity dimensions. This would then weaken the prediction of the proposal to mere transitivity of comparability: if, say, hatred and love are comparable, and love and respect are comparable, then hatred and respect must be comparable, as all three types of state must extend along the same dimension. That being said, I will for the rest of this paper adopt the stronger and simpler hypothesis that there is a single dimension for mental state intensity.

Finally, an anonymous reviewer observes an apparent problem for this proposal that warrants addressing. In all of the examples of non-intensity verbal measurement constructions that have come up so far, temporal duration has been available as the contextually determined measure function. As discussed above, this is predicted by a monotonicity-based account of measurement adjuncts and verbal comparatives. Moreover, mental state homogeneity predicts temporal duration to be a monotonic measure of mental states as well, so long as the salient part-whole relations are right. (More specifically, in the same way that defining the part-whole relations in terms of horizontal strips made vertical measurement monotonic in Figure 4, defining them in terms of vertical strips makes horizontal measurement monotonic.) But at least at first glance, it appears that such temporal readings do not arise for sentences like *Ann hated Bill a lot* or *Ann hated Bill more than Matt hated Jeff*. Thus, the proposal at hand has no means of differentiating between mental state verbal comparatives, which apparently lack a temporal reading, and other verbal comparatives for which it is available.

While I agree with the reviewer that there is a strong preference for mental state verbal comparatives to be interpreted in terms of psychological intensity, I think the claim that temporal duration readings are categorically unavailable is too strong. For instance, imagine that some psychologists are running a study in which subjects are sent into house parties, where they witness various pleasant and unpleasant scripted events. The subjects are given a remote with a single button, and told to hold down the button whenever they decide they want to leave, and let go of the button whenever they stop wanting to leave. The remote does not provide any way of indicating how intense their desire to leave is. Now suppose that Subject A held the button from 7PM to 10PM, while Subject B only held the button from 6 to 6:30 and from 9:30 to

10. Thus, Subject A was uncomfortable for a total of three hours, while Subject B was uncomfortable for just one. In this scenario, it seems reasonable for a psychologist looking at the recorded results to report the following:

(65) The results show that over the course of the evening, Subject A wanted to leave more than Subject B did.

In this context, the scientist can be right even if it turns out that Subject B's desire to leave was more intense. This suggests that an intensity reading is not the only reading available, and that a temporal reading is indeed possible, albeit dispreferred.[21]

But if temporal readings are available for these comparatives, why are they so hard to get? It seems like the best explanation is simply that for the most part, the intensity of someone's hatred, desire, love, or regret is more practically relevant than its temporal duration. If this explanation is correct, then we might expect that mental state verbs are not the only ones showing such a strong dispreference for temporal readings in the comparative. This is, in fact, the case. For instance, we observed earlier that when measuring events of acceleration, both temporal duration and the object's change of speed are monotonic: an event of acceleration will have a greater duration and involve a greater net change of speed than any of its proper parts. But the sentences in (66) have a very strong preference for using change in speed over temporal duration as the contextually determined measure function. Hence, if Nell's car only had a slight change in speed over a very long time, while my car had a large change in speed over a very short time, both (66a) and (66b) are interpreted as clearly false, except with a great deal of contextual work.

(66) a. Nell's car accelerated a lot.

b. Nell's car accelerated more than mine did.

Thus, the dispreference for a temporal duration reading of verbal comparatives with mental state verbs can be chalked up to pragmatic preferences for some grammatically available readings over others, rather than a bona fide grammatical distinction.

[21] The context provided is meant to prevent an alternative reading, observed by Wellwood (2014) and brought to my attention by two anonymous reviewers, in which what is compared is the *number of occasions* of wanting to leave, rather than temporal duration. Since Subject B has two contiguous states of wanting to leave, while Subject A only has one, (65) should be false on this reading. Nonetheless, it is worth noting that the two readings could converge if, say, each five-second-long substate of wanting to leave qualified as its own occasion. In this case, for (65) to be true on a number-of-occasions reading would be for A to have had more five-second-long occasions of wanting to leave, essentially equivalent to a duration reading. It is at present unclear to me how to further differentiate the two potential readings, though note that this problem also arises for more pedestrian cases like *run*, since running events can similarly be divided into five-second subevents.

5 Extension to attitudes

In Section 3, we saw a substantial body of evidence from English and Chinese suggesting that intensity is a monotonic measure of mental states, including attitudes. In Section 4, we saw that by adopting this view and treating intensity comparatives as run-of-the-mill verbal comparatives, we also generate a variety of accurate semantic predictions independent of the mereological claim of monotonicity. But there is another type of entailment highly relevant to the semantics of attitudes, which has historically been a topic of more comprehensive debate than the sorts of entailments discussed above: namely, in what contexts, and for which propositions p and q, does the truth of *α wants p* entail the truth of *α wants q*? While answering this question is not a goal of this paper, it is nonetheless the case that whatever this entailment pattern turns out to be, and whatever the best theory is for explaining it, my claims about the mereological basis of intensity had better be compatible with it.

With this in mind, the current section is dedicated to showing that the proposal put forward in Section 4 is fully compatible with a broadly Hintikkan semantics for attitudes, i.e., a semantics utilizing quantification over possible worlds. Of course, there is quite a diverse body of work in this general research program, and the large number of possible points of divergence precludes a full demonstration of compatibility for each candidate theory in the Hintikkan hypothesis space. That being said, one principle that unites nearly all of the theories in this tradition is that ⟦want⟧ makes use of an ordering relation over possible states of affairs that ranks them in terms of their preferability to the experiencer (see, e.g., Heim 1992; von Fintel 1999; Büring 2003; Villalta 2008; Anand & Hacquard 2008, 2013; Rubinstein 2012, 2017; Phillips-Brown 2018). It is this ranking of possibilities that will play the lead role in the analysis offered in this section, meaning that the basic tenets of my proposal extend to a wide variety of Hintikkan theories.

The rest of this section is structured as follows. After some preliminary discussion in Section 5.1 of the interaction between the semantics of *want* and the part-whole structure of desire states, in Section 5.2 I go over von Fintel's (1999) semantics for *want*, which due to its formal simplicity will serve as an ideal demonstration of my analysis. In Section 5.3 I discuss the fundamental problem that must be addressed: namely, how von Fintel's semantics for *want*, in conjunction with my own ontology of desire states, can account for cases in which a single experiencer wants different things with varying intensities. I propose an analysis in which the preference ranking of possible worlds is manipulated in a way that draws the necessary distinctions between desiderata. I also show that this solution works just as well when replacing von Fintel's semantics with that of Heim (1992), in spite of the fact that Heim's theory generates quite different predictions from von Fintel's with respect to entailments in the clausal complement of *want*. Finally, in Section 5.4 I extend the analysis to *wish*

and *regret*.

5.1 Semanticizing homogeneity

In Section 4, mental state homogeneity was posited as a constraint on the model used for interpretation, rather than being explicitly included in the denotations of verbs like *hate*. However, the additional complexities of attitude verbs will require a more intricate relationship between semantics and part-whole structure, so for these, homogeneity will be baked directly into the denotation of the verb: ⟦want⟧ will break up a desire state into very small parts and universally quantify over those parts. How small these parts are depends on how fine-grained one takes two-dimensional subdivision to be; since we are assuming an extremely fine-grained version, these parts will only occupy a single moment and a single altitude. I will refer to these tiny parts of a state e as **point-states** of e, with $\textsc{pt}(e)$ being the set of such point-states:

(67) $\textsc{pt}(e) = \{e/(t,k) \mid (t,k) \in \pi(e)\}$,
where $e/(t,k) = \iota e' \sqsubseteq e[\pi(e') = \{(t,k)\}]$[22]

Thus, if WANT is everything in the denotation of *want* other than this quantification over point-states, ⟦want⟧ will be as in (68), where p is the proposition denoted by the clausal complement of *want*:

(68) $\llbracket\text{want}\rrbracket = \lambda p \lambda e.\ \forall e' \in \textsc{pt}(e)[\text{WANT}(p)(e')]$

While the primary motivation for building homogeneity into the denotation of *want* is to provide a direct means of weaving the part-whole structure of desire states into the semantics, it is worth noting that independent evidence in favor of such breaking up and universal quantification can be found in the temporal relationship between matrix and embedded clauses. It has often been noted that *want* requires its embedded clause to be interpreted in the future relative to the desiring itself; to put it in Condoravdi's (2002) terms, *want* has a *future temporal orientation*. Thus, (69) is fully acceptable with *tomorrow* in the embedded clause, but replacing *tomorrow* with *yesterday* requires either a play on words or a time travel scenario:

(69) Heinrich wants to leave {tomorrow/#yesterday}.

Proposed explanations for this fact vary, but it has generally been taken for granted that the future-shifting of the embedded clause is relative to the temporal trace of the desire state in the matrix clause (though many of these proposals do not cash this intuition out in Davidsonian terms). (69) is thus predicted to be bad with *yesterday*

[22] I assume that the ι operator ends up being well-defined, i.e., each desire state has exactly one part occupying a given moment-altitude pair. If this is not the case, ι can be replaced with Link's (1983) σ operator, which would return the *maximal* such substate.

because the embedded clause must be future-shifted with respect to the temporal trace of Heinrich's current desire state, meaning that the embedded clause in (69) requires that Heinrich's potential leaving be both in the future and yesterday, a contradiction.

With this in mind, consider the sentence in (70):

(70) (At 8PM,) Heinrich wanted to leave immediately.

Here is a rough translation for (70): There was a desire state e (at 8PM), with experiencer Heinrich, that was a state of wanting to leave immediately after $\tau(e)$. The future-shifting takes place relative to $\tau(e)$, with *immediately* serving to relate the future-shifted time to $\tau(e)$ by adding a requirement that they be temporally proximate. Now consider (71):

(71) For three hours, Heinrich wanted to leave immediately.

Here is what (71) does *not* mean: There was a three-hour desire state e, with experiencer Heinrich, that was a state of wanting to leave immediately after $\tau(e)$. Such an analysis would predict (71) to be true in a scenario in which Heinrich's desire from 8PM to 11PM was that he leave right after 11PM, but in this scenario (71) is in fact false. Instead, what must be the case is that for each (near-)momentary substate e' of Heinrich's three-hour desire state, Heinrich's desire in e' is to leave immediately after $\tau(e')$, so that at 8 he wants to leave right after 8, at 9:30 he wants to leave right after 9:30, etc.

So the interpretation required for (71) is one in which the actual proposition desired changes over the course of Heinrich's three-hour desire state. A denotation like (68) allows this to happen in a composition-friendly manner, so long as the future-shifting of the embedded clause is relative to e' (the quantified-over substates), rather than e (the larger desire state). This phenomenon of shifting goalposts thus provides direct evidence in favor of quantifying over small substates, at least along the horizontal dimension; I take extending this analysis into the vertical dimension to be a harmless stipulation.[23]

[23] There is an alternative analysis that, to my knowledge, generates the same result in this regard. Say that $[\![\text{want}]\!]$ has the simpler denotation $\lambda p \lambda e.\ \text{WANT}(p)(e)$, and that it is only true of individual point-states to begin with. Hence, temporal shifting is only relative to point-states, rather than their sums, as desired. There could then be a higher head that contributes Link's (1983) * operator, closing the eventuality predicate under mereological sum, as would seem to be required for a durative adverbial like *for three hours* in (71). I will leave for future work a choice between (68) and this alternative; the proposal in this paper is compatible with either one.

5.2 Defining WANT: von Fintel 1999

Now that the basic interaction between ⟦want⟧ and the part-whole structure of desire states has been established, we can turn our attention to defining WANT. As mentioned previously, I will make use of von Fintel's (1999) theory, as the formal simplicity of his analysis makes it particularly well-suited to highlight the core contributions of this section. We will later see that the same ideas translate just as well to Heim's (1992) more complex theory.

von Fintel's (1999) semantics for *want* is modelled on Kratzer's (1981, 1991, 2012) influential theory of the semantics of modality, and in particular on her semantics for *must*. For Kratzer, deontic (i.e., obligational) *must* is true of a proposition p in a world w iff among those worlds circumstantially accessible from w, all of the best ones with respect to the fulfillment of obligations are worlds in which p is true.[24] This naturally extends to other "flavors" of root modality: a bouletic reading arises when worlds are ranked with respect to satisfaction of desires, a teleological reading arises when orderings are based on the achievement of goals, etc. But while Kratzer's theory is well-known for its goal of a unified semantics of *must* (and *can*), for our purposes we can pretend that her theory is only meant to analyze deontic modals. With this in mind, a (simplified) Kratzerian denotation for deontic *must* can be seen in (72), where $\text{Circ}(w)$ is the set of worlds circumstantially accessible from w, and $w_1 \lesssim^{\text{deo}}_w w_2$ iff w_1 is at least as ideal as w_2 with respect to the satisfaction of obligations.

(72) $\llbracket \text{must}_{\text{deo}} \rrbracket = \lambda p \lambda w.\ \forall w' \in \textsc{Best}(\text{Circ}(w), \lesssim^{\text{deo}}_w)[p(w')]$
(where $\textsc{Best}(\text{Circ}(w), \lesssim^{\text{deo}}_w) = \{w' \in \text{Circ}(w) \mid \neg\exists w'' \in \text{Circ}(w)[w'' \prec^{\text{deo}}_w w']\}$)

Following Kratzer, $\lesssim^{\text{deo}}_w$ is a preorder: it is reflexive and transitive, but not necessarily antisymmetric or connected, so distinct worlds can be equally or incomparably ideal. Strict ordering ($\prec^{\text{deo}}_w$), equivalence ($\sim^{\text{deo}}_w$), and incomparability ($\|^{\text{deo}}_w$) can be defined in the usual manner.

von Fintel (1999) takes Kratzer's semantics for (deontic) *must* and makes four revisions in order to define *want*. The first three are simple, and have fairly obvious motivations. First, an extra argument is added for the experiencer, since wanting obviously requires a wanter. Second, the deontic world-ordering $\lesssim^{\text{deo}}_w$ is replaced with $\lesssim_{x,w}$, which orders worlds based on their preferability to x in w.[25] Third, the set $\text{Circ}(w)$ of circumstantially accessible worlds is replaced with $\text{Dox}(x, w)$, the set of

[24] This presupposes what Lewis (1973) calls the *limit assumption*: that there is always a non-empty set of maximally ideal worlds. Kratzer offers a definition that avoids the limit assumption, in a fashion that translates just as well to von Fintel's semantics for *want*.

[25] This is a slight simplification: von Fintel follows Kratzer in using sets of propositions to generate an ordering over worlds (see also Lewis 1981), rather than simply stipulating a world-ordering $\lesssim_{x,w}$. Eliminating this extra step has no effect on the considerations at hand.

all worlds compatible with x's beliefs in w.[26] Thus, with all of the changes so far, von Fintel's semantics for *want* can be summarized as follows: *α wants p* is true iff p holds in all of those worlds compatible with α's beliefs that are ideal with respect to their priorities.

The fourth and final revision von Fintel makes to Kratzer's semantics is that he, like Heim (1992) before him, considers *α wants p* to presuppose that there are some p worlds and some $-p$ worlds among α's belief worlds, i.e., that both p and $-p$ are compatible with α's beliefs.[27] This presupposition is motivated by a problem originally noted by Stalnaker (1984). As Stalnaker observes, without a requirement along these lines, α's believing p is expected to entail α's wanting p, since p's holding in all of α's belief worlds entails its holding in all of α's *ideal* belief worlds. But this predicts that α's believing that her friend was murdered entails her wanting her friend to have been murdered, which it obviously does not. Adding the aforementioned presupposition resolves Stalnaker's problem: if α believes that her friend was murdered, the statement that she wants her friend to have been murdered is not true, but infelicitous. However, a desire to *solve* the murder, for example, is still possible, since whether or not the murder is solved remains up in the air, while the actual murder itself is not.

Adding all of this together, von Fintel's semantics for *want* comes out to (73):

(73) $[\![\text{want}]\!]_{\text{von Fintel}} = \lambda p \lambda x \lambda w : \exists w', w'' \in \text{Dox}(x, w)[p(w') \wedge \neg p(w'')]. \forall w' \in \textsc{Best}(\text{Dox}(x, w), \precsim_{x,w})[p(w')]$

In order to use von Fintel's denotation for *want* as our WANT, however, it needs to be of the right semantic type, a relation between a proposition and an eventuality. The result of this translation can be seen in (74), where $\text{Dox}(e)$ is the set of worlds compatible with the beliefs of the experiencer of e, and $\precsim_e$ is e's bouletic world-ordering. Note that the diversity presupposition, which is not relevant for our purposes, has been removed for simplicity's sake.

(74) $\text{WANT}_{\text{vF}} = \lambda p \lambda e.\ \forall w \in \textsc{Best}(\text{Dox}(e), \precsim_e)[p(w)]$

By combining (74) with the quantification over point-states in (68), we arrive at a semantics for *want* that is built around von Fintel's definition, but that is incorporated into the ontology and compositional semantics adopted in this paper:

(75) $\lambda p \lambda e.\ \forall e' \in \textsc{pt}(e)[\forall w \in \textsc{Best}(\text{Dox}(e'), \precsim_{e'})[p(w)]]$

[26] In actuality, von Fintel follows Heim (1992) in using the set of worlds compatible with what x believes to be true *regardless of x's actions*, a proper superset of $\text{Dox}(x, w)$. Rubinstein (2012, 2017), meanwhile, offers a von Fintel-style semantics for *want* in which there is a greater degree of flexibility on this front. This is irrelevant for our purposes, so I will stick to $\text{Dox}(x, w)$.

[27] A note on notation: I reserve $\neg$ for Boolean negation, and use $-$ for intensional negation. That is, $-p$ is the complement of p in the set W of all possible worlds: $-p = W - p$.

In short, for a state to be a state of wanting p is for all of its point-states to be such that all ideal belief worlds are p worlds.

5.3 Desires of varying intensity

We now have a Hintikkan semantics for *want* that is fully integrated with our two-dimensional ontology. I next turn to the problem of varying intensity of desire: given what we have so far, what does it mean for a single experiencer to want two propositions to differing extents? After discussing the problems faced by the present theory in generating a proper account, I will provide a rough sketch of what a solution to these problems might look like. I will then offer a formally explicit account along the lines previously sketched. Finally, I will illustrate the generality of this proposal by showing that it works just as well for Heim's (1992) quite different theory of the semantics of *want*. Thus, while my analysis is framed in terms of von Fintel's (1999) theory, the core proposal extends to a much broader space of possible theories for the semantics of *want*.

5.3.1 The problem

Suppose that Ron has three relevant desires that he believes to be mutually compatible: he wants to eat some peanuts (p), he wants to visit Quebec (q), and he wants to learn Russian (r). Naturally, in all of Ron's bouletically ideal belief worlds, all three happen. But this does not entail that Ron wants all three equally. It might be the case that while Ron wants (and believes that he can get) all three, his desire to learn Russian is stronger than his desire to visit Quebec, which is stronger than his desire to eat peanuts. There are thus two pressing questions to answer. First, since WANT_{vF} only cares about the set of bouletically ideal belief worlds, how can one proposition be wanted more than another if both hold in all ideal worlds? And second, how can this be handled in a way that makes intensity of desire a monotonic measure of desire states?

A tempting answer to the first question is to follow Kratzer (1981, 1991, 2012) in positing that Ron's three desires can be differentiated by widening our lens and looking at worlds that are less than ideal. For example, imagine that there are only eight worlds compatible with Ron's beliefs: w_{pqr}, where all three propositions hold, w_{qr}, where only q and r hold, and so on, for each combination of truth and falsehood of p, q, and r. Furthermore, imagine that Ron's bouletic ranking of worlds is as in (76), where (I) all r worlds are better than all $-r$ worlds, (II) q serves as a tiebreaker for r, and (III) p is a tiebreaker for q. (Of course, such a rigid ranking of priorities is something of an idealization, but it is a useful one for expository purposes.)

(76) $\underbrace{\underbrace{\underbrace{w_{pqr}}_{p} < \underbrace{w_{qr}}_{-p}}_{q} < \underbrace{\underbrace{w_{pr}}_{p} < \underbrace{w_{r}}_{-p}}_{-q}}_{r} < \underbrace{\underbrace{\underbrace{w_{pq}}_{p} < \underbrace{w_{q}}_{-p}}_{q} < \underbrace{\underbrace{w_{p}}_{p} < \underbrace{w_{\varnothing}}_{-p}}_{-q}}_{-r}$

As observed above, looking only at the singleton set of ideal worlds $\{w_{pqr}\}$ does not provide enough information to tell whether Ron wants p, q, or r more. However, notice that in the ordering in (76), the best world in which Ron learns Russian but does not go to Quebec (w_{pr}) is more ideal than the best world in which Ron goes to Quebec but does not learn Russian (w_{pq}). In this sense, it can be said that Ron wants to learn Russian more than he wants to go to Quebec: while any Russian-but-no-Quebec or Quebec-but-no-Russian world is less than ideal, Ron finds the best worlds of the former sort more tolerable than the best worlds of the latter sort. The same game can be played in comparing learning Russian and eating peanuts, or going to Quebec and eating peanuts: the best $r - p$ world (w_{qr}) outranks the best $p - r$ world (w_{pq}), so Ron wants to learn Russian more than he wants to eat peanuts, and the best $q - p$ world (w_{qr}) outranks the best $p - q$ world (w_{pr}), so he wants to visit Quebec more than he wants to eat peanuts.

Considering things in this way allows us to reframe our above questions. What we now need to find out is this: how can the semantics and/or ontology of desire be sensitive to the relative rankings of worlds that the experiencer considers sub-ideal, while at the same time retaining a definition of *want* in terms of the best-worlds quantification seen in WANT_{vF}? Or put another way, WANT_{vF} clearly incorporates a graded notion of preferability, since it utilizes a ranking of worlds in terms of their comparative preferability to the experiencer. Moreover, this graded preferability of worlds intuitively ought to correlate with which propositions are wanted more or less than others. But at the same time, WANT_{vF} is itself *non*-graded, and only uses a small amount of this preference information in order to determine which propositions are wanted or not. The question, then, is how we recover this lost information.

To shed some light on how to answer this question, it will help to take a brief detour and look at a formally similar problem faced by certain theories of gradable adjectives. Most contemporary theories of gradability take the basic meaning of a scalar adjective to be comparative in nature. The denotation of *tall*, for example, might take a degree and an individual as arguments and compare the individual's height to the degree:

(77) $[\![\text{tall}_1]\!]^c = \lambda d \lambda x.\ \text{height}(x) \geq d$

A positive use of *tall*, as in *Steph is tall*, then requires a silent morpheme to provide a degree of comparison that Steph's height must exceed in order to count as tall.[28]

[28] This silent morpheme is often called *pos*, following Cresswell (1976).

But what if we instead wish to make an adjective's *positive* interpretation its basic meaning, so that ⟦tall⟧ is just an $\langle e, t\rangle$-type predicate true of those individuals that qualify as tall?

(78) $[\![\text{tall}_2]\!]^c = \lambda x.\ x$ qualifies as tall by the standards in c

How can we derive from this the comparative interpretation that arises in *Steph is taller than Mark is*?

Here we start to see problems quite similar to those discussed above. After all, clearly this alternative definition of *tall* somehow has to be sensitive to the relative heights of the objects in its domain, much like how WANT_{vF} is sensitive to the preference rankings of possible worlds. But at the same time, this definition of *tall* is itself non-graded, only using that information about comparative heights that is required to tell us what counts as tall and what does not. Hence, if Steph and Mark both qualify as tall, then this "yes-or-no" denotation of *tall* does not differentiate between them, just as WANT_{vF} is incapable of differentiating between two propositions that both hold throughout all bouletically ideal worlds.

There are thus lessons to be learned from looking at those theories that endorse just such an $\langle e, t\rangle$-type semantics for gradable adjectives. While this particular cat has been skinned in many ways, I will use a simplified form of Kamp's (1975) proposal to illustrate the gist. In a given conversational context, an adjective like *tall* can be thought of as dividing its domain into three groups: those entities that definitely qualify as tall (the *positive extension*), those that definitely qualify as not tall (the *negative extension*), and those in the middle that qualify neither as tall nor as not tall (what Klein (1980) calls the *extension gap*). If x is in the positive extension, then $[\![\text{tall}]\!]^c(x) = 1$; if x is in the negative extension, then $[\![\text{tall}]\!]^c(x) = 0$; and if x is in the extension gap, then $[\![\text{tall}]\!]^c(x)$ is undefined. In contexts more precise than c, the members of the extension gap can be assigned freely to either the positive or negative extension, with the following caveat: if x is at least as tall as y, then y can only be in the positive extension of *tall* if x also is, and x can only be in the negative extension of *tall* if y is. Thus, the positive extension of *tall* in a given context will contain those individuals above a certain height, the negative extension those individuals below a certain (possibly lower) height, and the extension gap those individuals with heights between the bottom of the positive extension and the top of the negative extension. Given this constraint, we can say that for Steph to be taller than Mark is for there to be some context c such that Steph is in the positive extension of $[\![\text{tall}]\!]^c$, and Mark is in its negative extension. So long as there is a sufficiently large class of contexts, this will be the case if and only if Steph is indeed taller than Mark.

We therefore see that gradability of height can be captured while keeping a definition of *tall* that is simply a (partial) function from entities to truth values. The key is to allow ourselves to toy with the standards for what does or does not count as tall.

If x is taller than y, then there will be some way of setting the standard for tallness so that x is in the positive extension and y is in the negative extension. I will adopt a formally similar approach in accounting for desires of varying intensities: while WANT_{vF} will continue to just be a relation between propositions and point-states, the standard for what counts as desired will be lowered or raised to weed out differences between propositions. In order to do so, there are two further complications that need to be addressed. First, this raising and lowering of standards must somehow be integrated with the quantification over possible worlds seen in WANT_{vF}. Second, it must also be integrated with the mereology of attitude states adopted in this paper. I address these two problems in turn.

5.3.2 The nitpicker's guide to graded intensionality

As per the discussion of *tall* above, we need to find a way to appropriately manipulate the standard for the positive extension of WANT_{vF}. If the standard for WANT_{vF} is lowered, then every proposition that was previously WANTed needs to still be WANTed, with the possible addition of some newly-WANTed propositions. That is, the positive extension of WANT_{vF} must be a (possibly proper) superset of what it used to be. Naturally, the opposite must happen when raising the standard: the positive extension must become a (possibly proper) *subset* of what it used to be.

As far as integrating this with quantification over worlds, some recent work on gradability in the Kratzerian tradition of best-worlds quantification has exploited the fact that if $A \subset B$, then universal quantification over A is weaker than universal quantification over B. Put another way, the smaller the domain of world-quantification, the more propositions will hold in all worlds throughout that domain. Hence, if we generate a sequence of progressively shrinking domains of world-quantification, then as we go through the sequence, more and more propositions will hold throughout the modal domain, thereby lowering the standard for the positive extension of the world-quantifying operator. The relative importance of a proposition can then be tied to how early in the sequence that proposition starts to hold throughout the modal domain: propositions whose necessity is established early in the sequence are of greater importance than those that require further shrinking of the modal domain in order for their necessity to be established. Or on a more intuitive level, the more nitpicky we have to be in order to mandate p, the less important p is.

The *locus classicus* for this approach to weakening modal world-quantification is von Fintel & Iatridou's (2008) work on the contrast between so-called "weak" necessity modals like *should* and strong necessity modals like *must*. In short, the idea is that (deontic) *must* p is true iff p holds in all *acceptable* worlds, while *should* p is true iff p holds in all *ideal* worlds. Since all ideal worlds are acceptable worlds (but

not vice versa), more propositions will hold throughout all ideal worlds than will hold throughout all acceptable worlds. As a result, we rightly predict *should p* to be weaker than *must p*:

(79) a. You should do your homework, but it's not the case that you must.

b. # You must do your homework, but it's not the case that you should.

von Fintel & Iatridou formalize this idea roughly as follows. Say that there are in fact two world-orderings at play, $\preceq^1_w$ and $\preceq^2_w$ (where w is the world of evaluation). $\preceq^1_w$ serves to distinguish those worlds that are morally acceptable from those that are not: worlds are ranked with respect to weighty matters like whether murder is committed, basic safety standards are met, etc. Meanwhile, $\preceq^2_w$ only ranks worlds with respect to those lower-level priorities that distinguish ideal worlds from merely acceptable worlds, like whether waitstaff are properly tipped and people do not cut in line. In this case, *must* can be defined just like in (72), but sticking in the high-priority world-ordering $\preceq^1_w$.

(80) $[\![\text{must}]\!] = \lambda p \lambda w.\ \forall w' \in \textsc{Best}(\text{Circ}(w), \preceq^1_w)[p(w')]$

Since $\preceq^1_w$ only cares about important matters, *You must not commit murder* is predicted to be true, while *You must not cut in line* is false.

As for *should*, $\preceq^2_w$'s ranking of worlds based on little things like cutting in line and tipping waitstaff occurs in addition to, and not instead of, $\preceq^1_w$'s differentiation based on more important criteria. Thus, $[\![\text{should}]\!]$ is not simply the result of replacing $\preceq^1_w$ with $\preceq^2_w$ in $[\![\text{must}]\!]$. Instead, $[\![\text{should}]\!]$ takes the set of acceptable worlds as determined by $\preceq^1_w$, i.e., $\textsc{Best}(\text{Circ}(w), \preceq^1_w)$, and finds the best worlds among these as determined by the ordering $\preceq^2_w$, thereby deriving the set of ideal worlds:

(81) $[\![\text{should}]\!] = \lambda p \lambda w.\ \forall w' \in \textsc{Best}(\textsc{Best}(\text{Circ}(w), \preceq^1_w), \preceq^2_w)[p(w')]$

Since it is necessarily the case that $\textsc{Best}(A, \preceq) \subseteq A$, we derive the right entailment relations, as the domain of modal quantification for *should* will be a (usually proper) subset of that for *must*.

While I will retain the core intuition behind von Fintel & Iatridou's proposal—that weakening of world-quantification is due to lower-level priorities having their say in determining what counts as a more ideal world—I will formalize this intuition differently. The reason for this is that while von Fintel & Iatridou's formalism works fine for a best-worlds semantics like Kratzer's *must* or WANT_{vF}, there is no clear way to extend this analysis to theories that do not make reference to sets of ideal worlds, such as Heim's (1992) theory to be discussed later. Of course, if von Fintel is right and Heim is wrong, then this is not a problem at all. But as it turns out, the same basic idea can be accomplished without forcing us to make this choice.

More recent proposals in the tradition of weakening-by-domain-shrinkage have explored how much can be accomplished just by manipulating the world-ordering on its own (Katz et al. 2012, Portner & Rubinstein 2016, Pasternak 2016). That is, rather than first finding the $\precsim_w^1$-ideal worlds and subsequently feeding those to $\precsim_w^2$, we could instead combine $\precsim_w^1$ and $\precsim_w^2$ into a single ordering $\precsim_w^{1,2}$ that simulates $\precsim_w^2$ serving as a tiebreaker for $\precsim_w^1$. So if $\precsim_w^1$ just ranks murder-free worlds as better than murder-ful ones, as semi-formally diagrammed in (82a), and $\precsim_w^2$ only ranks no-line-cutting worlds above line-cutting ones as in (82b), then $\precsim_w^{1,2}$ will still rank all murder-free worlds as better than all murder-ful ones, but worlds with the same status with respect to murder are further differentiated based on the existence or non-existence of line-cutting, as seen in (82c).

(82) a. $-\text{murder} <_w^1 \text{murder}$

b. $-\text{cut} <_w^2 \text{cut}$

c. $\underbrace{\underbrace{-\text{murder}, -\text{cut}}_{-\text{cut}} <_w^{1,2} \underbrace{-\text{murder}, \text{cut}}_{\text{cut}}}_{-\text{murder}} <_w^{1,2} \underbrace{\underbrace{\text{murder}, -\text{cut}}_{-\text{cut}} <_w^{1,2} \underbrace{\text{murder}, \text{cut}}_{\text{cut}}}_{\text{murder}}$

We can then assign *should* the interpretation in (83):

(83) $[\![\text{should}]\!] = \lambda p \lambda w.\ \forall w' \in \textsc{Best}(\text{Circ}(w), \precsim_w^{1,2})[p(w')]$

In this case, we successfully weaken our quantification over worlds by manipulating only the world-ordering, since all of the $\precsim_w^{1,2}$-ideal worlds will be devoid of both murder and line-cutting, in contrast to $\precsim_w^1$.[29]

There is a sense in which $\precsim_w^{1,2}$ can be thought of as a "choosier" ordering than $\precsim_w^1$, in that it is the result of replacing certain equivalences with strict orderings. In general, we can say that an ordering $\precsim_a$ is *more fine-grained* than $\precsim_b$ if $\precsim_a$ is the result of taking some equivalences in $\precsim_b$ and replacing them either with strict orderings or incomparabilities. This is stated more formally in (84).

(84) a. If $\precsim_a$ and $\precsim_b$ are preorders over the same set of worlds, then $\precsim_a$ is **at least as fine-grained** as $\precsim_b$ iff the following two conditions hold for all worlds u and v in the domains of $\precsim_a$ and $\precsim_b$:

i. If $u <_b v$, then $u <_a v$.

ii. If $u \parallel_b v$, then $u \parallel_a v$.

[29] While I avoid the Kratzerian tradition of using sets of propositions to generate world-orderings, this ordering manipulation can be readily translated into a premise semantics. Recent proposals have provided means by which certain premises can serve as tiebreakers for others (see Katz et al. 2012; Reisinger 2016; Pasternak 2016, 2018). The idea would then be that premises are added to the bottom of the ranking, breaking ties while preserving the strict rankings and incomparabilities from higher-ranked premises.

b. $\precsim_a$ is **more fine-grained** than $\precsim_b$ iff $\precsim_a$ is at least as fine-grained as $\precsim_b$, but not vice versa.

c. $\precsim_a$ is **at least as coarse** as $\precsim_b$ iff $\precsim_b$ is at least as fine-grained as $\precsim_a$. $\precsim_a$ is **coarser** than $\precsim_b$ iff $\precsim_b$ is more fine-grained than $\precsim_a$.

(82) illustrates how increasing fine-grainedness can shrink the set of ideal worlds, thereby weakening the quantification over worlds seen in a best-worlds semantics. In fact, it turns out that if the fine-grainedness of the ordering over worlds is increased, then it will necessarily be the case that all of the propositions that used to be WANTed will still be WANTed, and often new propositions will join the ranks of the WANTed as well. To see this, note that the definition of WANT_{vF} in (74) is equivalent to that in (85):

(85) $\text{WANT}_{\text{vF}} = \lambda p \lambda e.\ \forall w \in \text{Dox}(e)[(\neg \exists w' \in \text{Dox}(e)[w' \prec_e w]) \rightarrow p(w)]$

This definition makes use specifically of the strict ordering relation ($\prec_e$), and moreover, this relation between worlds occurs in an upward-entailing environment. After all, the direction of entailment is twice reversed: the scope of negation and the antecedents of material implications are both downward-entailing environments, so embedding a negation in an antecedent leads to an upward entailing environment. Thus, retaining or expanding the set of strict ordering relations—which, by (84a-i), necessarily occurs when an ordering is made more fine-grained—will never render a previously WANTed proposition unWANTed, in much the same way that retaining or lowering the standard for tallness will never render a previously tall individual non-tall. What's more, increasing strict ordering relations can render previously unWANTed propositions newly WANTed, similar to how lowering the standard for tallness can make some individuals qualify as tall that hadn't previously qualified.

To make things more concrete, let us return to the Ron example. Ron's three desires can be differentiated by generating a series of increasingly fine-grained orderings, as in (86):

(86) STEP 1: $\underbrace{w_{pqr}, w_{qr}, w_{pr}, w_r}_{r} \prec_1 \underbrace{w_{pq}, w_q, w_p, w_\varnothing}_{-r}$

STEP 2: $\underbrace{\underbrace{w_{pqr}, w_{qr}}_{q} \prec_2 \underbrace{w_{pr}, w_r}_{-q}}_{r} \prec_2 \underbrace{\underbrace{w_{pq}, w_q}_{q} \prec_2 \underbrace{w_p, w_\varnothing}_{-q}}_{-r}$

STEP 3: (same as (76)) $\underbrace{\underbrace{\underbrace{w_{pqr}}_{p} \prec_3 \underbrace{w_{qr}}_{-p}}_{q} \prec_3 \underbrace{\underbrace{w_{pr}}_{p} \prec_3 \underbrace{w_r}_{-p}}_{-q}}_{r} \prec_3 \underbrace{\underbrace{\underbrace{w_{pq}}_{p} \prec_3 \underbrace{w_q}_{-p}}_{q} \prec_3 \underbrace{\underbrace{w_p}_{p} \prec_3 \underbrace{w_\varnothing}_{-p}}_{-q}}_{-r}$

Notice that for all three orderings, Ron learns Russian (r) in all ideal worlds. As for visiting Quebec (q), this happens in all ideal worlds with respect to $\precsim_2$ and $\precsim_3$,

but not $\precsim_1$, which has as ideal the Quebec-less worlds w_{pr} and w_r. Finally, the only one of these three orderings in which Ron eats peanuts (p) in all ideal worlds is $\precsim_3$. Unsurprisingly, as the standard for WANT_{vF} is lowered by making the ordering more fine-grained, more propositions become WANTed. Since r is wanted earliest—it is true in all ideal worlds with respect to the coarsest ordering—it is wanted most, followed by q, then p.

To summarize, we have seen that the standard for inclusion in the positive extension of WANT_{vF} can be altered by manipulating the coarseness of the ordering over worlds. Such manipulations allow us to tease apart desires with differing intensities while keeping WANT_{vF} as a relation between a proposition and an eventuality, in a similar fashion to how extension gap theories of adjectives like *tall* handle facts about gradability. The final question we must answer is how this raising and lowering of the standard for WANT_{vF} can be integrated with the mereology of states of desire.

5.3.3 Integration with the mereology: Downward Ordering Generation

The way in which the manipulation of fine-grainedness of orderings will be integrated into the mereology of attitude states will be by means of a natural language metaphysical principle relating world-orderings at various point-states. More specifically, the principle, which I refer to as **Downward Ordering Generation (DOG)**, states that world-orderings at lower and lower point-states get progressively more fine-grained. The formulation of this principle in (87) comes in two parts. (87a) imposes the requirement about fine-grainedness, while (87b) adds a requirement that the set of belief worlds does not change across altitudes.

(87) Downward Ordering Generation:
If $k_a \leq_{\text{K}} k_b$, and if $e_a = e/(t, k_a)$ and $e_b = e/(t, k_b)$ for some desire state e and moment $t \in \tau(e)$, then:
   a. $\precsim_{e_a}$ is at least as fine-grained as $\precsim_{e_b}$, and
   b. $\text{Dox}(e_a) = \text{Dox}(e_b)$.

Note that (87a) and (87b) only impose constraints on simultaneous point-states; the relationship between beliefs and desires at different times is unconstrained. Note in addition that since the at-least-as-fine-grained relation is reflexive (i.e., each ordering is at least as fine-grained as itself), $\precsim_{e_a}$ and $\precsim_{e_b}$ are permitted to be identical.

As an illustration, Figure 5 shows a potential structure for Ron's desire state that obeys DOG. At the highest altitudes, point-states have the coarsest world-ordering $\precsim_1$, and at the lowest altitudes, worlds are ordered as in $\precsim_3$, the finest-grained of the three orderings. Because r holds in all ideal worlds with respect to all three world-orderings, the state as a whole is a state of Ron wanting r. Since q holds in all $\precsim_2$- and $\precsim_3$-ideal worlds, but not all $\precsim_1$-ideal worlds, only the bottom two-thirds of this state

is a state of Ron wanting q. And finally, just the bottom third of this state will be a state of Ron wanting p.

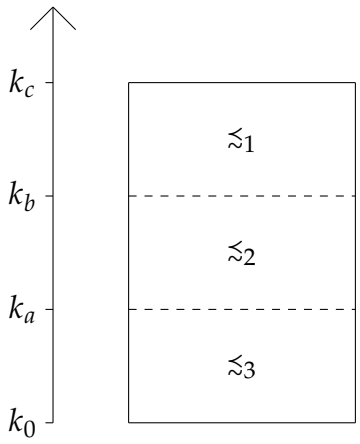

Figure 5: Ron's desire state

Assuming a structure like Figure 5 for Ron's desire state generates the correct predictions for both positive and comparative desire attributions. As far as positive desire attributions go, all of *Ron wants to learn Russian*, *Ron wants to visit Quebec*, and *Ron wants to eat peanuts* are rightly predicted to be true.

(88) $[\![\text{Ron wants to eat peanuts}]\!]^c = 1$ iff
$\exists e[\text{Exp}(e, \text{ron}) \wedge \forall e' \in \text{PT}(e)[\text{WANT}_{\text{vF}}(p)(e')]]$

After all, for each of these three propositions, there is a state of Ron wanting that proposition.

Turning to *want* comparatives, (90) is the predicted interpretation of (89) if our semantics for *want* is inserted into the template for verbal comparatives in (50), and the contextually determined measure function is set to μ_{int}. (For readability's sake, I exclude the zero-degree disjunct in (62).)

(89) Ron wants to learn Russian more than he wants to visit Quebec.

(90) a. Assertion:
$\exists e[\text{Exp}(e, \text{ron}) \wedge \forall e' \in \text{PT}(e)[\text{WANT}_{\text{vF}}(r)(e')] \wedge \mu_{\text{int}}(e) >$
$\max(\{d \mid \exists e''[\text{Exp}(e'', \text{ron}) \wedge$
$\forall e''' \in \text{PT}(e'')[\text{WANT}_{\text{vF}}(q)(e''')] \wedge \mu_{\text{int}}(e'') \geq d]\})]$

b. Presuppositions:
$\forall e, e' \in [\![\text{want}]\!](r)[e \sqsubset^c e' \rightarrow \mu_{\text{int}}(e) < \mu_{\text{int}}(e')]$
$\forall e, e' \in [\![\text{want}]\!](q)[e \sqsubset^c e' \rightarrow \mu_{\text{int}}(e) < \mu_{\text{int}}(e')]$

As discussed above, Ron's largest state of wanting r is the whole desire state, and his largest state of wanting q is the lower two-thirds of his desire state. Thus, the assertion in (90a) is true: there is a state of Ron wanting to learn Russian that exceeds in intensity (i.e., is larger than) any state of Ron wanting to visit Quebec. Naturally, the previously established monotonicity of intensity means that the presupposition is satisfied as well, so (89) is indeed true.

An interesting side effect of this proposal is that we predict it to be possible for two experiencers to want all of the same things, and to rank their desires in exactly the same way, but for the intensities of their desires to vary. An illustration of such a situation can be seen in Figure 6. In this scenario, both Ron and Rhonda want r more than q, which in turn they want more than p. But Ron's desire for p is more intense than Rhonda's is, his desire for q is exactly as intense as hers is, and his desire for r is less intense than hers is. While it is difficult to find compelling linguistic data that support or contradict this prediction, at least on an intuitive level it seems plausible that two people could be in exact agreement about what makes one world more desirable than another, while at the same time feeling those desires with differing intensities. But I must leave a more thorough exploration of this possibility for future work.

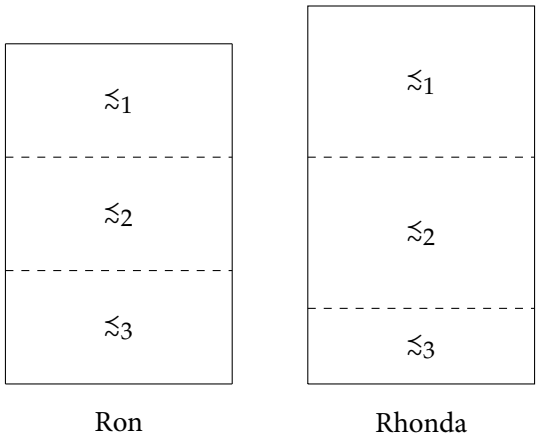

Figure 6: Ron and Rhonda's desire states

5.3.4 *Demonstration of flexibility: Extension to Heim 1992*

One notable property of the definition of *want* in (75) is that the clausal complement is predicted to be an upward-entailing environment. After all, if p holds in all ideal belief worlds (at all point-states), and $p \subseteq q$, then q will naturally also hold in all ideal belief worlds (at all point-states). Note that this is not technically true of von Fintel's

original definition of *want* in (73), due to the additional presupposition requiring diversity among the experiencer's belief worlds. With this presupposition, it is possible to want p without wanting q if q includes all of the experiencer's belief worlds, thereby violating the diversity requirement. Nonetheless, von Fintel notes that his definition is still what he refers to as *Strawson upward-entailing*: if α wants p, $p \subseteq q$, *and q satisfies all presuppositions*, then α is predicted to want q.

Whether or not the complement of *want* is actually a (Strawson) upward-entailing environment remains a controversial topic in the literature on the semantics of attitudes.[30] Thus, in order to illustrate the flexibility of the analysis in this paper, I will show that my proposal does not commit us to taking sides on this contentious issue: things go just as well if we swap out WANT_{vF} for a definition of WANT based on Heim's (1992) semantics of *want*, which is not (Strawson) upward-entailing. To demonstrate this, I will first discuss Heim's semantics for *want*, as well as how it can be transposed into the present framework. I will then show that altering the fine-grainedness of the ordering over worlds can be used to raise or lower the standard of WANT for Heim's theory just as well as it can for von Fintel's.

Heim's semantics for *want* is like von Fintel's in that it incorporates an ordering over worlds in terms of comparative preferability to the experiencer. However, it is unlike von Fintel's in that it also uses a *similarity* ordering relation along the lines proposed by Stalnaker (1968, 1975) and Lewis (1973) for conditionals. The long and short of Heim's definition is that *α wants p* is true iff for each world w' compatible with α's beliefs, those worlds most similar to w' in which p is true are better than those most similar to w' in which p is false. We also continue to presuppose that p is compatible with, but not entailed by, α's beliefs. A formal statement of this definition can be seen in (91), where $\text{Sim}_{w'}(p)$ is the set of p worlds most similar to w', and $A \prec_{x,w} B$ iff for all $w' \in A$ and $w'' \in B$, $w' \prec_{x,w} w''$.[31]

(91) $[\![\text{want}]\!]_{\text{Heim}} = \lambda p \lambda x \lambda w : \exists w', w'' \in \text{Dox}(x,w)[p(w') \wedge \neg p(w'')].$
$\forall w' \in \text{Dox}(x,w)[\text{Sim}_{w'}(p) \prec_{x,w} \text{Sim}_{w'}(-p)]$

The addition of the similarity relation makes Heim's definition of *want* not Strawson upward-entailing. As an illustration, consider the sentences in (92), adapted from Asher (1987):

(92) a. Nicholas wants to get a free trip on the Concorde.

[30] For discussion, see Asher 1987, Heim 1992, von Fintel 1999, Levinson 2003, Villalta 2008, Crnič 2011, Lassiter 2011a, Fara 2013, Condoravdi & Lauer 2016, and Phillips-Brown 2018.

[31] Heim later provides a slightly different definition in which the p and $-p$ arguments of $\text{Sim}_{w'}$ are replaced with $\text{Dox}(x,w) \cap p$ and $\text{Dox}(x,w) - p$, respectively. The predicted difference is in whether we care just about those *belief* worlds most similar to w' in which p is true (or false), or the most similar p worlds *simpliciter*. This is an interesting distinction, but not one that has any effect on the proposal at hand.

b. Nicholas wants to get a trip on the Concorde.

Suppose that Nicholas refuses to pay the exorbitant price for a ticket to ride the Concorde, but would gladly take a free trip on the off chance that it's offered. In this case, it may be that for some belief world w' of Nicholas's, the most similar worlds to w' in which Nicholas gets a ticket on the Concorde are bad due to the enormous price he pays, but the most similar worlds in which he gets a *free* ticket on the Concorde are highly desirable. Hence those ticket worlds most similar to w' (where Nicholas shells out the money) could be worse than the most similar non-ticket worlds (in which he doesn't), but the most similar free-ticket worlds would be better than the most similar no-free-ticket worlds. It is therefore quite plausible on Heim's definition of *want* that (92a) is true, while (92b) is false. Since all worlds in which Nicholas gets a free trip on the Concorde are worlds in which he gets a trip on the Concorde, this means that Heim's *want* is not Strawson upward-entailing.[32]

Naturally, the same process used to translate von Fintel's *want* into an event semantics can be done to Heim's proposal, resulting in (93). Note that the diversity presupposition is once again excluded for simplicity's sake.

(93) $\text{WANT}_{\text{H}} = \lambda p \lambda e.\ \forall w \in \text{Dox}(e)[\text{Sim}_w(p) \prec_e \text{Sim}_w(-p)]$

Plugging WANT_{H} into (68) results in (94).

(94) $\lambda p \lambda e.\ \forall e' \in \text{PT}(e)[\forall w \in \text{Dox}(e')[\text{Sim}_w(p) \prec_{e'} \text{Sim}_w(-p)]]$

We saw above that increasing the fine-grainedness of a world-ordering lowered the standard for WANT_{vF} because of two facts about WANT_{vF}: it makes use specifically of the strict ordering relation, and the strict ordering relation occurs in an upward-entailing environment. Since increasing fine-grainedness means that the new strict ordering relation will be a (perhaps proper) superset of the original one, the result is that every proposition that used to be WANTed still will be, and new ones may be WANTed as well, in effect lowering the standard for WANT_{vF}. But as it turns out, these two important facts about WANT_{vF} also hold for WANT_{H}. To see this, consider (95), which is equivalent to (93):

(95) $\text{WANT}_{\text{H}} =$
$\lambda p \lambda e.\ \forall w \in \text{Dox}(e)[\forall w' \in \text{Sim}_w(p)[\forall w'' \in \text{Sim}_w(-p)[w' \prec_e w'']]]$

Once again, the ordering relation used is the strict ordering relation $\prec_e$. Moreover, since $\prec_e$ only appears within the scope of various universal quantifiers, and since the scope of a universal quantifier is an upward-entailing environment, $\prec_e$ appears in an upward-entailing environment. Thus, in spite of the additional complexities of

[32] However, see von Fintel 1999 and Crnič 2011 for compelling arguments that examples like (92) are misleading, and that the complement of *want* really is Strawson upward-entailing.

Heim's analysis, it remains the case that increasing fine-grainedness can effectively serve to lower the standard for WANT.

What this exercise demonstrates is that the fundamental ideas espoused here are not restricted in their scope to best-worlds analyses of the sort endorsed by von Fintel (1999) and others. Rather, a DOG-based analysis works for a variety of possible theories for the semantics of *want*, encompassing a variety of possible predictions about entailments in *want*'s propositional argument.[33]

5.4 *Wish* and *regret*

Before wrapping up, let's see how this account extends to *wish* and *regret*. Traditionally, the locus for the distinction between *want* and *wish*/*regret* has been assumed to lie not in the ordering of worlds, which is still based on bouletic preferability, but in the choice of worlds that are ordered. Notice that whereas *want* presupposes that the experiencer's beliefs are compatible with, but do not entail the proposition denoted by the embedded clause, *wish* carries a presupposition that the experiencer's beliefs entail the negation of the embedded clause. That is, (96) presupposes that Stephanie believes that she did not lift weights this morning.

(96) Stephanie wishes she had lifted weights this morning.

If this is the case, then the set of belief worlds cannot be what is used for *wish*. Otherwise, it would not be possible to wish anything: (96) presupposes that none of Stephanie's belief worlds are weightlifting worlds, so Stephanie's *ideal* belief worlds cannot be weightlifting worlds. Instead, *wish* must use a proper superset of Stephanie's belief worlds—call it $\text{Dox}^{+}(e)$—including worlds that she believes are no longer attainable but were previously possible. In other words, whereas *want* is about ideal outcomes with respect to what *might be* the case, *wish* is about ideal outcomes with respect to what *might have been* the case.[34]

With this in mind, ⟦wish⟧ can be defined as follows. First, as was the case with *want*, ⟦wish⟧ will feature semanticized homogeneity in the form of universal quantification over point-states, with WANT being replaced by WISH:

[33] An interesting question is whether the same basic technique can be further extended to decision-theoretic analyses like those of Levinson (2003) and Lassiter (2011a,b). At first glance, it seems plausible that the decision theorist's utility function, which determines the desirability of a given world, can be manipulated in more or less the same way as the world-ordering is in a quantificational analysis. However, I must leave exploration of this possibility for future work.

[34] This domain extension can be thought of as parallel to counterfactual conditionals, where worlds that are not circumstantially accessible are introduced into an extended modal domain. See Heim 1992 for extensive discussion of this similarity from a semantic perspective, as well as Iatridou 2000 for crosslinguistic morphosyntactic parallels.

(97) $[\![\text{wish}]\!] = \lambda p \lambda e.\ \forall e' \in \textsc{pt}(e)[\text{WISH}(p)(e')]$

The definition of WISH will be derived from that of WANT in two steps. First, we replace in WANT all instances of Dox with Dox^+. (This extends to the diversity presupposition as well as to the assertive component of the denotation, but following previously established practice I will continue to leave the diversity presupposition to the side.) Second, we add a presupposition that the proposition denoted by the embedded clause holds in none of the experiencer's belief worlds, i.e., the experiencer believes the negation of the embedded clause. Obviously, both of these steps can be done for both WANT_{vF} and WANT_{H}, leading to WISH_{vF} and WISH_{H}:

(98) a. $\text{WISH}_{\text{vF}} = \lambda p \lambda e : \text{Dox}(e) \cap p = \varnothing.\ \forall w \in \textsc{best}(\text{Dox}^+(e), \lesssim_e)[p(w)]$

b. $\text{WISH}_{\text{H}} =$
$\lambda p \lambda e : \text{Dox}(e) \cap p = \varnothing.\ \forall w \in \text{Dox}^+(e)[\text{Sim}_w(p) \prec_e \text{Sim}_w(-p)]$

Using WISH_{vF} and translating the scenario from before, imagine that Ron never learns Russian, visits Quebec, or eats peanuts, and he is aware of this fact, so that each of the propositions p, q, and r satisfies the disbelief presupposition of *wish*. Furthermore, assume that the expanded set of worlds used for *wish* is as diverse in its range of possible outcomes as the set of belief worlds was in the *want* scenario above, and that the rankings of worlds are just like in Figure 5. In this scenario, (99a) and (99b) are predicted to be true for the same reason that (88) and (89) were before.

(99) a. Ron wishes he had {learned Russian/visited Quebec/eaten peanuts}.

b. Ron wishes he had learned Russian more than he wishes he had visited Quebec.

Similar facts hold for *regret*. Consider (100):

(100) Stephanie regrets that she didn't lift weights this morning.

There is no relevant difference in interpretation between (100) and (96). Both presuppose that Stephanie believes that she did not lift weights this morning, and both assert that in her ideal worlds with respect to the expanded modal domain, she did lift weights. But there is a difference in polarity between *wish* and *regret*, hence why the embedded clause has to be negated in (100) to derive the same meaning as (96). So in contrast to *wish*, *regret* presupposes that the experiencer believes the proposition denoted by the embedded clause to be *true*, and asserts that her ideal worlds are ones in which it is *false*. Put another way, to regret p is to wish that $-p$:

(101) $[\![\text{regret}]\!] = \lambda p \lambda e.\ \forall e' \in \textsc{pt}(e)[\text{WISH}(-p)(e')]$

Of course, this means that in the scenario for *wish* discussed above, (102a) and (102b) come out as true for the same reason that (99a) and (99b) did.

(102) a. Ron regrets that he didn't {learn Russian/visit Quebec/eat peanuts}.

b. Ron regrets that he didn't learn Russian more than he regrets that he didn't visit Quebec.

6 Conclusion

In this paper, I argued based on evidence from English and Chinese that intensity is a monotonic measure of mental states like hatred, love, respect, desire, and regret. I then provided a basic natural language metaphysics of intensity that allowed for this monotonicity, leading to a unified semantics of verbal measurement constructions. Finally, I illustrated a means of integrating ordering and quantification over worlds into the part-whole structure of attitude states, so that attitude comparatives could also enjoy the benefits of such a unified semantic theory. In concluding, I will note two areas that warrant further investigation in the short-term, outside of those questions that have already arisen over the course of this paper.

First, one might reasonably ask whether altitudes deserve an independent existence in the natural language ontology, as assumed here, or whether a metaphysics can be established that generates the same results as the proposal in this paper without the stipulation of a distinct dimension reserved exclusively for psychological intensity. In the form adopted in this paper, mental states extend partly into their own little world, existing in a dimension that other kinds of objects seem not to occupy. The spatiotemporal dimensions are not nearly as restricted in this regard, containing a variety of entities and eventualities that cannot clearly be lumped under a single natural kind. Running events, states of happiness, and pieces of paper all have some relationship to time and space, so it is *prima facie* odd that there should be a dimension that only contains mental states. It would therefore be ideal to either independently justify the existence of such a separate dimension within the natural language metaphysics, or integrate psychological intensity into the metaphysics in a way that diminishes or eliminates its unique status.[35]

Second, I have had nothing to say in this paper about desires that are, or are believed by the experiencer to be, mutually incompatible. But mutually incompatible desires arise all the time. I can want to spend my summer relaxing on the beach,

[35] Francez & Koontz-Garboden (2017) provide an ontology for the domains of nouns like *courage* and *hunger* that is similar to my proposed ontology of mental states, but that makes no use of altitudes. Instead, they propose that these domains simply come with a "size" ordering that respects part-whole relations, much like monotonic measure functions. So far as I can tell, this simpler ontology would work fine for mental state verbs like *hate*. However, it is unclear how a constraint like DOG could then be defined, except by using some alternative means to essentially reconstruct a notion of altitudes. I leave further exploration of this matter for future work.

while also wanting to spend my summer catching up on research. On a certain level, the possibility for incompatible desires to arise is quite easy for a neo-Davidsonian theory like the one in this paper to account for. Since desire states are existentially quantified over in desire ascriptions, I can simply have two distinct desire states: one in which I spend my summer at the beach in all ideal worlds, and another in which I work all summer in all ideal worlds. If this is the case, then of course there is a state of me wanting to be at the beach, and there is a state of me wanting to work, so I want both. But such an account brings with it a host of questions, including basic ones about the ontological origins of and relationship between distinct desire states with the same experiencer, as well as the nature of the resolution of conflicting desires in the establishment of one's overall, "all things considered" desires. Furthermore, each of these questions must be paired with the methodologically prior question of whether the given issue is linguistically relevant at all: which folk-psychological beliefs about conflicting desires are reflected in the semantics of natural languages, and which are simply extralinguistic facts about how humans conceive of others' minds, as well as their own? Such questions are empirical in nature, and require further teasing apart of the linguistic tools at speakers' disposal in discussing desire and other mental states.

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