

Introduction

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1 Vagueness

One could define vagueness as the existence of *borderline cases* and characterise the philosophical debate on vagueness as being about the nature of these. The prevalent theories of vagueness can be divided into three categories, paralleling three logical interpretations of borderline cases: (i) a borderline case is a case of a truth-value gap; it is neither true nor false; (ii) a borderline case is a case of a truth-value glut; it is both true and false; and (iii) a borderline case is a case where the truth-value is non-classical. The third of these is proposed in the fuzzy logic approach to vagueness. Three-valued approaches have only $\frac{1}{2}$ as a value in addition to the standard values 1 and 0. These approaches can be interpreted either as allowing for gaps or gluts, depending on how the notion of satisfaction or truth is defined. If a sentence is taken to be true only if its value is 1, it allows for gaps, but if it is taken to be true already if its value is at least $\frac{1}{2}$ it allows for gluts. The most popular theories advertising gluts and gaps, however, are supervaluationism and subvaluationism, both of which make use of the notion of precisifications, that is, ways of making things precise. Truth-value gaps in supervaluationism are due to the way truth simpliciter, or supertruth, is defined: A proposition is supertrue (superfalse) if it is true (false) at all precisifications. This means that a proposition can be neither true nor false in case there exist two precisifications, one of which make it true and one of which makes it false. Conversely, in subvaluation theory, the same scenario would lead to a truth-value glut. That is, the proposition would be both true and false. This is because subvaluationism defines truth simpliciter as being true at some precisification.

The vagueness debate is a lively one since there are quite a few additional aspects to vagueness that need to be accounted for. One is higher order vagueness: the fact that the very boundary between definite cases of a predicate *T* and borderline cases is itself vague. Traditionally, however, probably the most crucial burden of any theory of vagueness is to account for the Sorites Paradox: Why is it that we accept (1), but not the apparent consequence that thereby everyone should count as tall?

- (1) If person *x* is tall, then someone ever so slightly shorter than *x* is tall too.

In section 2 of this introduction we will present an overview of the philosophical theoretical debate on vagueness, focusing in particular on this paradox.

The topic of vagueness, however, far extends the essentially logical issue of how to treat borderlineness and the sorites. In linguistics, the tight connection between vagueness and the grammatical notion of gradability has sparked a lively

line of research into the relation between the meaning of degree expressions and vagueness. The linguistics of vagueness is the topic of section 3 of this introduction. It is becoming apparent that for a true understanding of vagueness, however, one needs to look beyond just linguistics and philosophy proper. The psychology behind the sorites, and the use of vague terms in general, was until recently pretty much unexplored territory. Section 4 provides the backdrop for new directions the study of vagueness is taking.

2 Logic and Philosophy: The Sorites

The inductive premise of the sorites paradox (henceforth referred to as P), represents a crucial ingredient of vagueness, namely *tolerance*. Vagueness entails indifference with respect to small changes in the degree to which some quality holds. It is precisely this aspect of vagueness that is centre stage in the theoretical debate.

Formally, let us write $x \sim_T y$ for x and y are *neglectably different* with respect to the degree of T -ness. The general scheme for the Sorites Paradox is then the following, where given the possibility of a series $x_0 \sim_T \dots \sim_T x_n$ from one extreme of T -ness to another, it would appear that C follows from P .

$$(P) \quad \forall x \forall y [(x \sim_T y \wedge T(x)) \rightarrow T(y)]$$

$$(C) \quad \forall x [T(x)]$$

There are two main theoretical options to account for the paradox. The first stance is to deny P , in which case the paradox simply disappears, but a more difficult problem surfaces of why it *seems* to us that P . The alternative is to tackle P head-on, by trying to understand how it follows semantically and, crucially, how it does not entail C .

Examples of accounts within the first tradition, where P is argued not to hold, include fuzzy logic approaches, which contend that our tendency to accept P is because it is *almost* true (i.e. it has a truth-value close to 1). Fuzzy logic gives rise to some unwelcome properties (see for instance the critiques in [9,14,40]). In particular, it predicts truth-values for complex propositions that are in many cases not entirely intuitive. A further often cited criticism is that the degrees of truth in fuzzy logic are unsuitable as a basis for a semantics of the comparative. It appears that fuzzy approaches would naturally interpret *John is taller than Bill* as *John is tall* having a higher truth-value than *Bill is tall*. However, this entails that all comparison takes place on the same scale, namely that of degrees of truth. This is problematic since comparative forms are restricted to certain dimensions. For instance, *The temperature is higher than John is tall* is uninterpretable. Fuzzy logic, however, suggests that this sentence should express the statement that it is more true that the temperature is high than it is true that John is tall.

A much more popular alternative is supervaluation theory. The core proposal in supervaluationist accounts is that vagueness is the result of many possible

ways in which things could be precise. A proposition is supertrue, if it is true irrespective of how we resolve our semantic indecision. The selling point of supervaluation theory is that it preserves all classical validities. Thus, or so it is claimed, logically speaking there is no difference between classical logic and supervaluation theory. But the non-standard way of accounting for these validities still comes with its logical prize. To see why, consider the following. Proponents of supervaluation theory hold that although there is a cutoff-point – i.e. the formula $\exists x \exists y [T(x) \wedge x \sim_T y \wedge \neg T(y)]$ is supertrue –, still, no one of its instantiations itself is supertrue. This is a remarkable logical feature: in classical logic it holds that $\varphi \vee \psi \models \varphi, \psi$ (meaning that at least one of φ and ψ must be true in each model that verifies $\varphi \vee \psi$). In supervaluation theory this doesn't hold anymore; $\exists x [T(x)] \not\models_{\text{supv}} T(x_1), \dots, T(x_n)$. The relation between supervaluation theories of vagueness and classical logic is the topic of the contribution by Cobreros in this volume. His starting point is the observation that supervaluationist logic no longer has a classical notion of logical consequence once a “definite” operator is taken into account. Cobreros shows, however, that there exist deduction systems that come very close to being classical, thus showing new light on the alleged non-classicality (and its consequences) of supervaluationism.

Beyond the classicality debate surrounding supervaluationism, a problem of a more conceptual nature has been noted. Supervaluation theory makes use of complete refinements, and supervaluation theory assumes that we can always make sharp cutoff-points: vagueness exists only because in daily life we are too lazy to make them. But this assumption seems to be wrong: vagueness exists, according to Dummet [7], because we cannot make such sharp cutoff-points even if we wanted to.

An early variation on supervaluationism originates in [24]. According to Lewis, vagueness arises as a consequence of there being many possible precise language that can be used in communication. The contribution of Lassiter takes this idea as a starting point. He explores a theory of vagueness which locates vagueness not in semantics, but rather in the probabilistic representation of linguistic knowledge. In Lassiter's approach this uncertainty is probabilistically represented. That is, the context contains a probability distribution over the set of possible languages, where these possible languages differ in the threshold for what counts as *tall*, *smart*, *a heap* etc.

An alternative to supervaluationism especially popular in the 1980s among linguists (and later by philosophers as well) was the so-called ‘contextualist’ approach. This approach was initiated by Kamp [15]. To solve the Sorites paradox, he (i) makes use of a sophisticated mechanism of *context change* and (ii) adopts a non-truth conditional analysis of conditional sentences, and proposes a weak, but non-standard notion of entailment. The idea of context change is that once it is explicitly accepted within the discourse that x has property P , for any vague predicate, the initial contextually given valuation function V changes into (possibly) new valuation function V' such that indistinguishable, or at least sufficiently similar individuals to x must be counted as having property P as well according

to new valuation function (and context) V' . In other words, what Kamp proposes is that each of the inductive premises is true in case its antecedent is verified, because of context change.

In this volume, Forbes critically discusses contextualist accounts of the Sorites, most particularly that of Soames [37]. Contextualists typically tackle the individual steps in the inductive premise by assuming they involve a context-shift. He argues that certain versions of the Sorites are left unexplained by such accounts.

While most contextualists (e.g. Pinkal, Raffman, Graff) follow Kamp making use of context change, they normally seek to improve on (ii) above by making the resulting logic more classical.¹ In this volume, Egré's contribution follows the lead of Raffman [31] of comparing the role of context in Sorites series to comparable phenomena in perception. Egré explores an account of the sorites in which borderline cases are ambiguous. He sketches the paradox as a combination of two plausible constraints: on the one hand the conservation of categorisation between adjacent items and on the other hand the existence of a category switch somewhere in a sorites series. He argues that these constraints are compatible if the switch occurs among items that are ambiguous between the two contrasted categorisations. Egré compares category switches to percept switches such as those in Fisher-type series [10]. He also discusses the consequences of an ambiguity approach to the principle of tolerance.

3 Vagueness and Linguistics

Although vagueness occurs in a variety of categories, such as nouns (*heap*), prepositions (*near*) and verbs (*enjoy*), in linguistics, it is naturally associated with adjectives like *tall*. This is because the linguistic study of vagueness is deeply connected to notion of *gradability*: the possibility to use modifiers to express the degree to which a predicate, typically an adjective, holds. Although the exact relation between gradability and vagueness is an interesting issue in itself (see below), there are several obvious reasons to connect the two phenomena. First of all, the inductive premise of a sorites paradox is based on a comparison with respect to *degree*, witness the comparative form of *short* in the inductive premise *if John is tall, then someone who is ever so slightly shorter is tall as well*. Second, degree modifiers interact with vagueness. That is, some introduce vagueness, while yet other degree modifiers remove it. For instance, the bare use of *straight* in (2-a) is hardly vague at all, but modification with *almost* introduces (more) vagueness. Conversely, the positive form of *tall* in (3-a) is vague, while its comparative form (modification by the comparative morpheme *-er*) is not.

- (2) a. The rod is straight.
b. The rod is almost straight.
- (3) a. John is tall.
b. John is taller than Bill.

¹ For a somewhat different contextual solution, see [11,29,32].

A final example of the connection between gradability and vagueness is a minimal variation on (3):

- (4) a. Compared to Bill, John is tall.
 b. John is taller than Bill.

These two sentences do not have an equivalent meaning. The crucial case is when John is taller than Bill to a degree that is just barely observable. In that case, (4-b) is true, but (4-a) is not. In other words, tolerance is an aspect of what Kennedy [20] calls *implicit comparison*, comparison using the positive form of an adjective. It is not an aspect of *explicit comparison* (the morphosyntactic comparative form). Kennedy proposes that the difference between (4-a) and (4-b) is compositional. The comparative morpheme *-er* imposes a strict comparison of degrees. In the case of (4) this amounts to comparing John's height to Bill's height. The positive form in (4-a) is the result of combining an adjective with the (silent) modifier *POS*. Kennedy proposes that the type of comparison encoded by *POS* is different from the one encoded by *-er*. It expresses that a degree *significantly exceeds* a contextual standard of comparison. One possible implementation of this involves Fara's notion of interest-relativity ([8]), which explains the non-crisp judgement for (4-a) as follows: if, given my interests, John's height exceeds the standard of comparison in a way that is significant, then it could not be that the slightly different height of Bill does not. Independent of the specific implementation, crucial is the understanding that the positive form encodes a fundamentally different mode of comparison from the morphosyntactic comparative form. This was stressed too by van Rooij [33], who presents an alternative approach to Kennedy's within a framework based on Klein's comparison class-based delineation approach. Van Rooij stresses that explicit comparison involves a weak order, while implicit comparison involves a semi order. The difference is best explained in measure-theoretic terms. Let $f(x)$ be some measure of x (say, height), and e be some fixed value which acts as a margin of error, then the following is a definition of a semi order $\succ_T$.

- (5) $x \succ_T y$ iff $f(x) > f(y) + e$

If e is 0, then $\succ_T$ is a weak order. Clearly, the difference between a weak and a semi order is closely related to Kennedy's proposal for the difference between the positive and the comparative: weak orders represent a strict mode of comparison, while semi orders represent comparison based on significant differences in measurement. To account for the contrast, van Rooij proposes that (4) involves two different kinds of uses of comparison classes. While (4-b) involves existential quantification over comparison classes, (4-a) is based on comparing just John and Bill. Crucially, not all comparison classes are admissible. A comparison class is only pragmatically appropriate if the gap between individuals that have the relevant property and those that do not is significant. In other words, for the case in which John and Bill hardly differ in height, $\{\text{John, Bill}\}$

is not an admissible comparison class, hence the unacceptability of (5-a) in such a context.

The two theories of Kennedy and van Rooij are representative of the two main contenders among linguistic semantic approaches to degree phenomena: the degree approach, which maintains that the semantics of gradable predicates necessitates the use of some notion of degrees, versus what is often called the delineation approach, where gradable predicates lack degree arguments. There is considerable variation among degree approaches. For instance, Kennedy [17] takes an adjective to be a measure function, a mapping from entities to degrees. A popular alternative is to treat adjectives as relations between entities and degrees [36,38,13]. Opposing the degree approaches are proposals inspired by supervaluationist or contextualist theories of vagueness. Most prominent is the comparison class approach of Klein [22], and recent reincarnations of that theory (for instance, [6,33]). According to these approaches, a predicate like *tall* is always evaluated with respect to a comparison class. So, $\text{tall}_c(x)$ is true if x is tall with respect to class c . To a large extent, these theories are equivalent to a (certain kind of) degree semantics for gradable predicates. For instance, a glance at the semantics of comparatives shows that degrees and comparison classes are not entirely dissimilar. The following two forms represent the interpretation of *John is taller than Bill* in the two frameworks.

- | | | |
|-----|--|-----------------------|
| (6) | $\exists d[\text{tall}(j, d) \ \& \ \neg \text{tall}(b, d)]$ | degree semantics |
| (7) | $\exists c[\text{tall}_c(j) \ \& \ \neg \text{tall}_c(b)]$ | delineation semantics |

What is different, however, is the interpretation of the positive form. Kleinian analyses offer a direct interpretation of the positive form: *John is tall* is true iff John is tall in the relevant comparison class. In degree approaches, however, the positive needs to be interpreted indirectly, since the semantics of the adjective yields not the interpretation of the positive, but rather a degree relation or function. In degree approaches, *John is tall* is therefore interpreted by first quantifying the degree argument of the adjective. An example of this is Kennedy's approach discussed above, where the positive is the result of applying a silent modifier *POS* expressing that the relevant degree significantly exceeds a contextual standard c :

- (8) $[\text{John is } [POS \text{ tall}]] \text{ is true}$
 $\Leftrightarrow$
 $\exists d[\text{tall}(x, d) \ \& \ d \text{ significantly exceeds } c]$

Part of the debate is based on which approach is somehow more natural. Klein [22] argued that the comparison class proposal is more in line with the principle of compositionality than its degree counterpart is, for it predicts that the comparative form is derived from the positive form, as is the case in (almost) all natural languages. Von Stechow [38] and others have argued, however, that

this argument is not entirely conclusive, and hold that comparison is cognitively primary.²

Comparison classes are not just relevant to the approach of Klein [22] and its offspring. A comparison class can be made explicit using *for* phrases, as in *John is tall for a basketball player*. When it is not made explicit, it is often assumed to be part of the interpretation of the positive form. It is not trivial, however, what contribution a comparison class makes to the standard of comparison of a positive form. Kennedy [19] points out that theories along the lines of Cresswell [4], where the standard of comparison is the average measure of the individuals in the comparison class, is untenable. If such analyses were on the right track, then examples like (9) would be expected to be contradictory:

- (9) John is taller than the average height of a basketball player, but he is still not tall for a basketball player.

Solt, this volume, addresses this issue further and argues that a crucial ingredient of the semantics of the positive depends on the distribution of measures of the individuals in the comparison class. In her analysis the comparison class is an argument of the positive operator. She furthermore builds on von Stechow [39] in assuming that positive forms make use of a neutral region on the relevant scale (as opposed to the single value on the scale represented by the standard of comparison). This so-called standard range, Solt argues, depends on the distribution of the individuals in the comparison class (with respect to the relevant quality dimension). She furthermore discusses other semantic aspects of *for* phrase comparison classes, such as their alleged presuppositionality. (If John is tall for a basketball player, then he has to be a basketball player. Cf. [19]).

So far, we have pointed out the relevance of the linguistic study of gradability to vagueness mostly by discussing the role of comparatives and positive forms in the Sorites and in regulating vagueness. However, a look at a typology of gradable adjectives (and arguably other gradable expressions) yields a more fundamental look at vagueness. Here we enter the question of which concepts give rise to vague natural language expressions, and what exactly is the relation between vagueness and gradability.

Standardly, it is assumed that there are two kinds of gradable expressions: (i) those that are context-dependent or *relative*, like *tall* and (ii) those that are context-independent or *absolute*, like *straight*. That is, while our understanding of (10) depends on what counts as tall in the given context, (11) expresses the same in any context, namely that the rod is not bent.

- (10) John is tall.
 (11) This rod is straight.

² The degree/delineation debate goes beyond this foundational issue of compositionality, however. A number of empirical phenomena have been used to argue either in favour of or against the use of degrees in semantics. Such considerations are well beyond the scope of this introduction, however. See [38,17,25,32,6,5].

The difference between expressions like *tall* and *straight* is often connected to a notion of scale structure ([30,21,34,19]). Following the line of reasoning of Kennedy [19] (in part based on [21]), scale structure influences the (likely) standard of comparison an adjective is evaluated against. Degrees of height are positioned on a principally open-ended scale, which yields no salient reference point as to what counts as tall in any context.³ In contrast, *straight* is associated to a scale of bendiness, which contains a zero point.⁴ This scalar end-point is used as a context-independent standard of comparison: *straight* entails *no* bendedness, *bent* entails *some* bendedness. A similar construal of *tall* would simply be meaningless.

The absolute/relative distinction is particularly relevant to the relation between vagueness and gradability. It shows that not all gradable predicates are vague. This is particularly interesting in the light of the tight relation that certain theories predict between the two notions. In delineation theories, vagueness often entails gradability. That is, the existence of different delineations for a predicate (via, for instance, comparison classes) is exactly what drives comparison. It has been argued ([19]) that this means that such theories will not be able to account for the absolute / relative distinction. This conclusion is countered, however, by van Rooij [33] and McNally (this volume), among others.

An immediate problem for the above absolute analysis of terms like *straight* is that as a result it cannot be truthfully applied to any observable object: there is no object that is absolutely straight according to an ultimate high *standard of precision*. Thus, if we want to explain our use of absolute terms, we still have to make their meaning context-dependent, although this context dependence now involves standards of precision rather than standards of comparison (cf. Lewis, 1979). Standards of precision are also relevant for the interpretation of measure phrases. Intuitively, if you truly (enough) say that John is 2 meters tall, he can actually be taller than Mary, of whom it is truly (enough) said that she is 2.01 meters tall. One way to account for this observation is to assume that the underlying structure of measurement in the former case is *coarser grained* than the measurement structure in the latter case. The *point* denoted by ‘2 meters’ on the coarse scale corresponds with a *set of points* on the finer-grained scale, and might include, for instance, 2.02 meters. But why do we associate the different expressions with the different measurement structures? Krifka [23] argues that this can be derived by Horn’s division of pragmatic labor: ‘2.02 meters’ is a more complex expression than ‘2 meters’ and its use thereby signals that a more complex, i.e. fine-grained, measurement structure is involved. In this volume, Bastiaanse provides a game theoretical account of round number interpretation, elaborating on Krifka’s account. He also suggest applying a similar model to other vague expressions.

³ Though you might wonder why according to Kennedy and associates *tall*’s antonym does not have such a salient reference point.

⁴ This difference in scale structure arguably also explains why some modifiers better pair with some adjectives than others: one can say ‘This bar is absolutely straight’ without the modifier having an epistemic reading, while this doesn’t seem to be possible with ‘John is absolutely tall’ (cf. [35]).

Kennedy has argued that the interpretation of absolute adjectives depends on pragmatics. Kennedy's interpretative economy principle states that the contribution of the conventional meanings of elements in a sentence should be maximised. Since scale structure is part of the conventional meaning of an adjective, this should be used as a basis for the standard of comparison, which would be an end-point for closed scale adjectives (rendering them absolute). McNally's contribution to this book challenges Kennedy's approach by identifying empirical problems for interpretative economy. She argues that the absolute / relative distinction should be compared to the distinct classification strategies of classification by rule (absolute) and classification by similarity (relative) [12].

The distinction between vague and crisp terms is especially enigmatic when one turns to non-adjectival predicates. For instance, a noun like *chair* allows for borderline cases, but is not gradable (cf. [14]).⁵ Your typical four-legged wooden dinner table chair is not *more a chair* than some oddly shaped plastic 1-legged designer chair, even though the former is definitely more prototypical of the chair concept than the latter. The upshot seems to be that despite their obvious kinship, vagueness and gradability are distinct notions. This should maybe not be that surprising given the essentially grammatical nature of gradability. Gradability is the possibility of being degree modified and is thus, in contrast to vagueness, subject to a wealth of grammatical constraints. Only recently have linguists begun to unravel the full empirical scope of gradability.⁶ Gradability is naturally associated with adjectives, since this category is involved in the bulk of degree phenomena. However, at least since Bolinger [2], it is known that gradability is not limited to adjectives. For instance, some (but far from all) nouns are gradable. The examples in (12) express that John is an idiot to a relatively high degree [26,28]. On the other hand, there is no option to interpret the adjectives in (13) as degree modifiers.

- (12) a. John is a huge idiot.
- b. John is an unbelievable idiot.
- (13) a. That is a huge chair.
- b. That is an unbelievable chair.

4 New Directions

The use of experimentally gathered data has proven very useful in linguistics and philosophy in recent years, for instance in investigating the nature of pragmatic components of meaning such as implicatures or presuppositions. It is obvious that the study of vagueness could benefit from experimental research too. So

⁵ The influential [16] makes the more general point that issue of the relation between gradability, vagueness and prototype similarity is a highly complex one, where many questions remain open.

⁶ See, for instance, [27] for a study that includes several non-adjectival degree phenomena. There is moreover a recent interest in cross-linguistic differences in degree phenomena [1,18].

far, however, very few have ventured in this direction. The notable exceptions show that there is some promising ground to be made. One particular issue that lends itself to experimentation is the question what borderline cases look like; are they gaps, gluts or something else? Bonini et al. [3] split a large group of subjects in two, asking one half when a certain property holds, and the other half when it is false to say that a certain property holds. The difference between the two groups sheds light on the nature of borderline cases. Bonini et al. concluded from their data that a gap-like theory should be preferred and they proceeded to argue for a specific form of epistemicism on the basis of their results. In the contribution to this volume by Alxatib and Pelletier we find a closely related example of experimental work on vagueness. On the basis of new experiments, they argue against the conclusions drawn in [3]. Alxatib and Pelletier instead use their experimental results to argue for a novel approach which combines sub- and supervaluationism.

A related study is Ripley's contribution. Ripley investigates sentences that express the logical form $Tx \wedge \neg Tx$ or $\neg(Tx \vee \neg Tx)$ where T is a vague predicate. Since such sentences are contradictions in classical logic, Ripley calls them "Borderline Contradictions". Such borderline contradictions have played an important role in the discussion of vagueness in language by Kamp [14] and Fine [9]. Ripley's shows that a majority of subjects find such sentences quite acceptable and discusses the consequences of this finding.

Klein's contribution to this volume exemplifies a different kind of experimentation altogether. He uses computational simulation experiments to explore the communicative functions of vagueness. Based on Parikh's idea that, given sufficient overlap in how agents interpret a vague term, vagueness is useful, Klein measures the success of communicating with a vague expression by simulating a task of two agents. He focuses on the vagueness inherent in temporal expressions like *morning* and computes how successful two agents are in actually meeting up on the basis of agreeing to meet at a vaguely indicated time.

The increasing use of experimental methods and of insights from experimental psychology illustrates that despite the fact that vagueness has long since been an important topic in philosophy, logic and linguistics, the function of vagueness in natural language communication is very much an exciting and timely research area. As the diversity of contributions in this volume shows, the renewed interest into vagueness has a distinct cross-disciplinary character and has spawned many new research questions.

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