Richard Dietz   *Editor*

Vagueness and Rationality in Language Use and Cognition

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Preface

The idea for this editorial project goes back to 2014 when I was invited to give a lecture series on vagueness at Seoul National University, where I met Chungmin Lee, the editor-in-chief of the *Language, Cognition, and Mind* (LCAM) series with Springer. One of the results of our discussions was Chungmin's suggestion to contribute a volume on vagueness to the then just newly launched LCAM series. I put the idea aside at first, for lack of time. A couple of years later, I came back to the idea. By that time, it had become obvious to me that the fast-growing literature on vagueness and rationality deserves more attention. If there is something like a received view about vagueness as a theoretical issue, it seems to boil down to something that may be characterised in terms of formal logic only. Undoubtedly, this logical approach to vagueness has proven very productive in the last decades. But there is reason for doubt that there is no more of theoretical interest to vagueness than a logical puzzle. For one, the orthodox model of rational decision, expected utility theory, does not supply sufficient means of accommodating vagueness in utility and in credence adequately. There is a growing sense in decision theory that there is no straightforward fix to this limitation in a way that would do justice to empirical data. Insofar as decision theory is meant to provide a predictive model of real-world behaviour, it seems fair to say that this problem is not a minor one. For another, insofar as predictive models of behaviour are guided by the methodological presumption of rationality, the question arises how to square vagueness in preferences or beliefs with constraints on rational behaviour. In particular, the question of how vague language use may be explained as a kind of rational behaviour has received increasingly attention in the social sciences. It is my hope that this volume will make this cluster of related questions more visible on the map.

Tokyo, Japan   Richard Dietz

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Introduction

Richard Dietz

Abstract This brief introduction offers a survey of the contributed papers to this volume.

Vagueness in language and cognition has traditionally been interpreted in semantic or epistemic terms. Specifically, on the standard picture of vagueness, it is suggested that considerations of agency or rationality, broadly conceived, can be left out of the equation. Likewise, theories of rationality in choice behaviour traditionally abstract from the potential vagueness of notions that are fundamental to the theory of rational decision-making, such as credence or preference. It is in this regard fair to say that theories of vagueness and theories of rationality tend to be premised on the idea that they have nothing to contribute to one another. Recently, new literature has emerged, suggesting that this received idea is inadequate. For one, theories of vagueness in language or cognition have been used for models of rational vagueness-related credence (Edgington 1997; Dietz 2010; Williams 2012; Douven and Decock 2017; Smith 2014) and decision theory (Williams 2014).[1] For another, it has been argued that considerations of rationality should essentially factor into a more comprehensive account of vagueness. Proposals in this vain are diverse, ranging from philosophical theories on the supposed connection between vagueness and interest relativity (Fara 2000) or indeterminate projects (MacFarlane 2016), adaptations of choice theory for the semantics of vague languages (revealed preference: van Rooij 2011; social choice: Grinsell 2012), Bayesian models of pragmatic reasoning (Lassiter and Goodman 2017), or applications of evolutionary game theory to the theory of vagueness (for an overview, see Franke and Correia 2017).

This volume presents new conceptual and experimental studies that explore interconnections between vagueness in language and cognition and the theory of rational behaviour. The first three papers, by Mahtani, Smith, and Andreou, turn on the ques-

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[1] The literature on imprecise credence (Bradley 2014) and imprecise preference (Hsieh 2016) is vast, but rather disconnected from the philosophical and linguistic literature on vagueness.

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tion of how vagueness affects rational choice and related fundamental notions. The other cluster of papers, by Green and van Deemter, Correia and Franke, Douven, Grinsell, and Kochari and van Rooij, bring models of rationality to bear to the theory of vagueness in language and cognition.

1. *Vagueness in Rational Choice*: Mahtani and Smith present different positions on the controversy whether rational credence may be imprecise. While Mahtani essentially agrees with previous philosophical arguments for imprecise cre-dence, she disagrees with the common way of modelling imprecise probabilities by means of sets of admissible probability functions. Mahtani argues that a supervaluation-ist approach to imprecise probabilities offers a more adequate means of modelling comparisons in probability between agents, or between times for a fixed single agent.

Smith distinguishes between two conceptions of credence, a dispositional conception (the disposition to act on a given proposition) and an epistemic conception (the degree to which belief in a proposition is justified by given evidence). He grants that similar to basic fuzzy theories of vagueness, any theory of epistemic credence that commits to precise probability assignments is open to the objection that this precision is artefactual. However, he argues that Bayesian models of credence in the dispositional conception, which commit likewise to precise assignments, are defensible against this kind of objection.

Vague preferences may give rise to regret regarding past opportunities that have been missed through making a choice, while at the same time there is a continued endorsement for the choice that was eventually made. A significant amount of the literature on this phenomenon focuses on the multidimensionality of preference relations as an explanation for preferential vagueness. Andreou's paper brings the acyclicity of preference relations to the fore as another possible explainer for preferential vagueness and related regret with a continued endorsement.

2. *Rationality in Vague Language Use and Cognition*: Is vagueness merely a defect in agents' ways of representing reality, in language or cognition? Or is it in some way useful for agents to represent reality in vague ways rather than in precise ways? In their experimental study on vague referential noun phrases, Green and van Deemter put the hypothesis that vagueness *is* of instrumental value to a test. The authors explain that their results are rather negative, and that observable advantages in vague language use can be explained away by other features of linguistic expressions.

In contrast to Green and van Deemter's experimental study, the conceptual studies by Correira and Franke, Douven, and Grinsell offer arguments for the idea that there is a rationale for representing reality in vague ways rather than in precise ways. Correia and Franke provide a novel argument of this kind from evolutionary game theory. In previous arguments of this type, it has been suggested that on certain provisos, best communication strategies for speakers and hearers in signalling games should be vague. The authors suggest that language communities with vague strategies, in the long run, prevail over communities with precise strategies.

Douven's account of vagueness in cognition is set out in a conceptual spaces framework, where concepts are represented as extended areas in a multidimensional space, with the dimensions being types of features relevant to categorisation. The argument is premised, first, on constraints on best solutions for categorisation prob-

lems and, second, on an empirical assumption about the features of proto- typical instances of concepts. According to this account, concepts are bound to be vague, provided that they satisfy certain elementary constraints on rational cate- gorisation and they go along with typicality judgements that are in some sense fuzzy.

Paradoxes of vagueness involve so-called sorites series, where adjacent items are indistinguishable in relevant respects (to the application of a term in question), with indistinguishability being an intransitive relation. Grinsell's basic idea is that vague terms are multidimensional, and that categorisations along relevant dimensions are choice functions, the aggregation of which can be modelled in terms of social choice theory. On this account, the sorites-susceptibility of certain terms may be explained as being due to the acyclicity of social preferences, which are due to conservative constraints on rational social choice and structural features of the relevant domain of items to be categorised.

Another way of modelling the semantics of vague terms in terms of choice functions is defended by Kochari and van Rooij. According to them, the relevant indistinguishability relation in sorites paradoxes can be understood as a relation of being different to a relevant magnitude that is lower than a given threshold. The authors furthermore present experimental results on gradable adjectives that shed new light on the relationship between vague implicit comparatives (x is red while y is not red) and associated explicit comparatives (x is redder than y).

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Part I
Vagueness in Rational Choice

Vagueness and Imprecise Credence

Anna Mahtani

Abstract In this paper I investigate an alternative to imprecise probabilism. Imprecise probabilism is a popular revision of orthodox Bayesianism: while the orthodox Bayesian claims that a rational agent's belief-state can be represented by a single credence function, the imprecise probabilist claims instead that a rational agent's belief-state can be represented by a set of such functions. The alternative that I put forward in this paper is to claim that the expression 'credence' is vague, and then apply the theory of supervaluationism to sentences containing this expression. This gives us a viable alternative to imprecise probabilism, and I end by comparing the two accounts. I show that supervaluationism has a simpler way of handling sentences relating the belief-states of two different people, or of the same person at two different times; that both accounts may have the resources to develop plausible decision theories; and finally that the supervaluationist can accommodate higher-order vagueness in a way that is not available to the imprecise probabilist.

1 Introduction

On the orthodox Bayesian account, every rational agent has a precise credence (or degree of belief) in every proposition that she entertains. Many have objected that this claim is implausible. A rational agent does have a precise credence in *some* propositions: for example, if I am about to toss a coin that you know to be fair, then your credence that (HEADS) it will land heads is presumably exactly 0.5. But now consider the proposition (SARDINES) that my neighbour has at least one tin of sardines in her kitchen cupboard. What is your credence in SARDINES? There are reasons to think that you don't have any precise credence in this proposition.

One reason is that nobody knows what your credence is in SARDINES—not even you. If you are asked what your credence is, then it is likely that no particular number will spring to mind. If pushed, you may be able to produce a number, but

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the number that you produce will be arbitrary. You might say, for example, '0.352', but you could just as easily have said '0.353'. You do not *know* what your credence is in this claim. And it seems odd that you might have a precise credence—and so be in some particular mental state—without knowing what it is.[1]

Another reason is this: it is not clear why your credence in SARDINES is some particular value (0.352, say), rather than some other nearby value (such as 0.353). What is it about you that makes it the case that your credence in this proposition is exactly 0.352?[2]

Here we might think that both of these problems can be easily dealt with, for on the orthodox Bayesian view, there is a tight relationship between an agent's credence function and her dispositional betting behaviour. Here is Bruno De Finetti on the subject:

> One can…give a direct, quantitative, numerical definition of the degree of probability attributed by a given individual to a given event…. It is a question simply of making mathematically precise the trivial and obvious idea that the degree of probability attributed by an individual to a given event is revealed by the conditions under which he would be disposed to bet on that event.
>
> Let us suppose that an individual is obliged to evaluate the rate p at which he would be ready to exchange the possession of an arbitrary sum S (positive or negative) dependent on the occurrence of a given event E, for the possession of the sum pS; we will say by definition that this number p is the measure of the degree of probability attributed by the individual considered to the event E (De Finetti 1964, pp. 101–2).

To illustrate De Finetti's method here, we can apply it to elicit your credence in HEADS. We suppose that you are forced to bet with a bookie over HEADS, and the way the bet works is that you give the bookie some sum pS, and in exchange you will get the sum S if and only if HEADS is true. Before the bet is settled, you get to name the rate p (your 'betting quotient'), and then the bookie gets to fix the sum S. The bookie can fix this sum as either negative or positive, and the idea is that this forces you to produce as the rate p your true credence in HEADS. To see why this is, suppose first that you give some high figure such as 0.8 for rate p. Then the bookie will set the sum S as a positive value—let's say as £10. Then you give the bookie £8 (for this is 0.8(£10)), and the bookie will give you £10 back if and only if HEADS is true. Thus you are left committed to a bet which is—by your own lights—a bad deal for you. Now suppose instead that you give some low figure such as 0.2 for rate p. Then the bookie will set the sum S as a negative value—let's say—£10. Then the bookie will give you £2 (for this is equivalent to your giving the bookie 0.2(–£10)), and you will have to give the bookie £10 if and only if HEADS is true. Again, you are left committed to a bet which is a bad deal for you. The only way to ensure a neutral deal is to set p equal to your own credence in HEADS—i.e. 0.5.

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[1]At any rate, this idea seems odd at first, though an externalist about knowledge may be easily reconciled to it. Thanks to an anonymous referee for pointing this out.

[2]There may also be other reasons to doubt that you do or should have a precise credence in SARDINES. For example, James Joyce would argue that your evidence does not justify any particular credence (Joyce 2010).

Can we similarly use this method to elicit your credence in SARDINES? Presumably if we elicited your betting quotient as De Finetti recommends then you would manage to produce some rate p, but the number that you produce would be arbitrary. You would have no good reason to choose the number 0.352, say, over 0.353. Forced to pick a particular number, you might decide on a whim, or choose at random. We can see this clearly by thinking about the betting quotients that you would produce across close possible worlds, where you have the same evidence and rationality as in the actual world. If your betting quotient is elicited in several of these worlds, then the answers you give across these worlds will vary. For you are just deciding randomly or on a whim, and the results of these random or whimsical processes will vary across close possible worlds. We can contrast this with the case where we elicit your betting quotient for HEADS: presumably in each close possible world where you have the same evidence and rationality as you have in the actual world, you will produce the very same number (0.5) when your betting quotient for HEADS is elicited. In this way your betting behaviour across close possible worlds is *stable* where HEADS is concerned, but *unstable* where SARDINES is concerned. I have argued elsewhere (Mahtani 2016) that this sort of instability in betting behaviour is typical of the sorts of cases that motivate theorists to resist the orthodox Bayesian's claim that a rational agent has a precise credence in every proposition that she can entertain.

Thus defining an agent's credence in terms of her betting quotient has not helped. Intuitively, there is no particular number that is your credence in SARDINES, and similarly there doesn't seem to be any particular number that is your betting quotient for SARDINES—for there is no single number that is *the* number that you would produce were we to elicit your quotient as De Finetti recommends. How then should we respond? In the next section I consider (and set aside) a nihilist position, according to which you have no betting quotient, and no credence in SARDINES. Then in Sect. 3 I set out an alternative theory: that the expression 'credence' is vague.

2 Nihilism

I start by considering a nihilist position—in order to set this position aside. On this nihilist view, you do not have a credence in SARDINES. We might argue for this as follows[3]:

1. Your credence in SARDINES is the number that you would produce were your betting quotient to be elicited.

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[3]This argument rests on the assumption that your credence in SARDINES is identical to your betting quotient in SARDINES, which of course is open to challenge. But it is not clear how the claim that your credence is not identical to your betting quotient can help us here: there are strong intuitive reasons to doubt that you have any particular credence in SARDINES, and the claim that your credence is identical to your betting quotient introduced in the hope that this would fix your credence in SARDINES.

2. Thus your credence in SARDINES is the number that you produce in the closet possible worlds in which your betting quotient is elicited.
3. But there are a range of equally close worlds in which your betting quotient is elicited, and the number that you produce varies across these worlds.
4. Thus there is no such thing as *the* number that you produce in the closest possible worlds in which your betting quotient is elicited.
5. Thus there is no such thing as your credence in SARDINES.

We could generalize this argument to show that you have no credence in many of the propositions that you entertain. Thus if you have a credence function at all, it does not map each proposition that you entertain onto a number between 0 and 1. Rather, at best it maps *some* of the propositions that you can entertain (such as HEADS) onto numbers between 0 and 1: your credence function does not map propositions like SARDINES to anything whatsoever. Is this a plausible position? And how can we resist the argument for it given above?

I want to start by showing that we can produce an argument paralleling that above to the conclusion that you have no resting heart rate. This seems like a surprising conclusion. Intuitively you *do* have a resting heart rate, even if you are not currently resting. Perhaps you are reading this paper while working out on a treadmill, and so your heart rate is currently elevated, but if so it would still make sense for a trainer to ask what your resting heart rate is—perhaps to check that your current training session is pitched at the right level. Thus intuitively you do have a resting heart rate, even when you are not resting. And this is because your resting heart rate is a dispositional property: it is the rate at which your heart *would* beat *were* you at rest. The problem is that there are a variety of ways to rest, and you could just as easily rest in one way as another. For example, you could rest by lying down in a cool room; or you could rest by sitting up in a warm room. Plausibly there are a range of equally close counterfactual cases where you are resting, and your heart rate will vary across these cases because your heart rate is sensitive to all sorts of factors. There are some guidelines that specify more precisely what is meant by 'resting' (Palatini 2009), but because these inevitably fall short of exact precision, your heart rate may vary even across close counterfactual cases where the guidelines are met. Thus we can construct the following argument:

1. Your resting heart rate is the rate at which your heart would beat were you at rest.
2. Thus your resting heart rate is the rate at which your heart beats in the closest possible worlds in which you are at rest.
3. But there are a range of equally close worlds at which you are at rest, and the rate at which your heart beats varies across these worlds.
4. Thus there is no such thing as *the* rate at which your heart beats in the closest possible worlds in which you are at rest.
5. Thus there is no such thing as your resting heart rate.

We could also argue along similar lines that you have no height. This is counterin-tuitive, for surely you do have a height—something in the region of 5′10′, say. This is your height even if you are sitting down, and thus currently measure considerably

less than $5'10'$ across every dimension. If you are sitting down in the doctor's office, and she asks for your height, you do not need to check how you are currently oriented to be able to answer. For your height is a dispositional property. It is the distance that there *would* be between the top of your head and the soles of your feet *were* you to stand in a particular way: straight, but not on tiptoe. So your height depends on what this distance is in the closest worlds where you are standing in the relevant way. But the problem is that there will be a range of equally close worlds where you are standing in the relevant way: ones where you stretch your neck out slightly more; ones where you are imperceptibly slouching, and so on. The distance between the top of your head and the soles of your feet will vary across these possible worlds. Measurements of a person's height vary a surprisingly large amount: the measurement depends on many factors, including precisely how you are standing, and whether traction is applied as you are measured (Buckler 1978). Thus there is no such thing as *the* distance that there would be between the top of your head and the soles of your feet *were* you to stand up straight. Thus (following the argument pattern above) we can show that you have no height.[4]

If we accept the conclusions of these arguments, we arrive at a sort of nihilism: you have no height, no resting heart rate, and no credence in many of the propositions that you can entertain. Is this a plausible position? Well, it seems more plausible than Peter Unger's radical position on vagueness (Unger 1979). Unger has argued that there aren't any tall objects, nor bald objects, nor indeed any 'ordinary things': this is his response to the sorites paradox—a paradox that I discuss in the next section. Unger's position is very counterintuitive, because he denies many claims that we take to be uncontroversially true—such as the claim that a person who is $6'5''$ is tall. If we deny that you have a heart rate, a height, or a credence in SARDINES, do we similarly deny claims that are uncontroversially true? It is much less obvious. For though at first blush it seems obvious that you have a resting heart rate, say, this intuition is not very robust. Once we start to think about what your resting heart rate is *exactly*, it becomes clear that there is no n such that it is uncontroversial that your resting heart rate is n: thus the intuition that you have a resting heart rate is itself controversial, in contrast to a truly uncontroversial claim, such as the claim that a person who is $6'5''$ is tall.

Should we then accept that you have no resting heart rate, and no height, and so on? This would leave us with some puzzles. What is happening when the doctor asks for your resting heart rate, and you utter some number, and she takes that number into account in her assessment? If you had no resting heart rate, how could we explain

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[4]With the concept of 'height' there is an added complication. We know that your height is the distance between the top of your head and the soles of your feet in some close possible world(s) in which you are standing in the right sort of way—but we do not know how to choose between the various close possible worlds that seem to meet this criterion. This is the problem described above, which has an obvious analogue for the concepts of 'resting heart rate' and 'betting quotient'. But for the concept of 'height' there is a further problem: we do not even know in any given possible world what the distance is from the top of your head to the soles of your feet. This is because we don't know where your head or feet end—which molecules of dead skin to include—for the boundaries to your body are vague.

this exchange?[5] We cannot hope to explain it as make-believe—as we might explain some dialogues involving fictional predicates—for the doctor takes your contribution seriously and uses it to guide her diagnosis. Furthermore, even though there may be no uncontroversial truths of the form *your resting heart rate is* n, there seem to be other uncontroversial truths in the vicinity. For example, it may be uncontroversially true that your resting heart rate is higher than 20 bpm, and less than 200 bpm. How can we explain the uncontroversial truth of these claims if you have no resting heart rate?

My suggestion is that we claim that you *do* have a resting heart rate, but that it is a vague matter what this resting heart rate is. The same can be said for your height, and for your credence in SARDINES. In the next section, I consider what it means to say that these predicates are vague—given that they do not fit the usual mould.

3 Vagueness

Philosophers usually introduce the phenomenon of vagueness with archetypal one-place predicates, such as '… is bald', '… is tall', '… is a small number', and so on. Vague predicates are taken to have certain features: they typically have both borderline cases and clear cases, appear to lack sharp boundaries, and are susceptible to sorites paradoxes (Keefe 2000, p. 6).

Can predicates with different forms be vague as well? Rosanna Keefe argues that they can, and that '[a] theory of vagueness should have the resources to accommodate all the different types of vague expression' (Keefe 2000, p. 14). I claim that predicates such as '… at … has a resting heart rate of…' are vague expressions—even though they do not seem to have the features typical of vague expressions. Below I work through these features in turn:

(1)   *Vague terms typically have both borderline cases and clear cases*

We can use the archetypally vague predicate '… is bald' to illustrate this feature. A person with 0 hairs on his head is clearly bald; a person with 500,000 hairs on his head is clearly not bald; and a person with 5739 hairs on his head may be a borderline case. Thus this predicate has an extension with some objects clearly falling within it, some objects clearly falling outside it, and some borderline cases.

Now let us turn to our predicate '… at … has a resting heart rate (in bpm) of…' and see whether this predicate also exhibits this feature. This is a three-place predicate: if anything belongs within its extension, it will be ordered triples consisting of an animal, a time, and a number. It is easy enough to find clear cases of ordered triples that do not fall within the extension of this predicate: for example, the ordered triple

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[5]We might try saying that your resting heart rate at any time is just whatever it was most recently measured as—but this is not plausible, because it makes sense to think that your resting heart rate has increased or decreased since it was last measured. And of course we might reasonably form a conjecture about a person's resting heart rate even if we knew that person had never had this measurement taken.