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Vagueness and Ambivalence

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Abstract What is the proper attitude toward what is expressed by a vague sentence in the face of borderline evidence? Some call this attitude "ambivalence" and distinguish it from uncertainty. It has been argued that Classical Epistemicism conjoined with classical probability theory fails to characterize this attitude, and that we must therefore abandon classical logic or classical probabilities in the presence of vagueness. In this paper, I give a characterization of ambivalence assuming a supervaluationist semantics for vague terms that does not revise either. The theory, which I call the theory of Superprobabilities, identifies the proper attitude toward a vague sentence, in the presence of exact borderline evidence, as the set of classical probabilities of the evidence on each member of the set of all precisifications of a vague sentence. I defend the use of sets of probabilities against objections by generalizing the theory of Superprobabilities to a decision theory called Superrationality. I then compare the merits of the theory of Superprobabilities to Classical Epistemicism and nonclassical probabilities theories with respect to the problem of ambivalence.

Keywords Vagueness · Supervaluationism · Mushy credences · Imprecise probabilities · Conjunction problem

1 Introduction

Consider the vague predicate "is salty". What is our typical belief about the stew being salty when it tastes borderline salty? What should it be? One answer to both questions is *ambivalence* and *not uncertainty*. The answer to the first, descriptive question rests on phenomenological grounds. The feel of our attitude toward the proposition that the stew is salty is one of being pulled in two directions. This is not the same as the feeling of not being pulled in either direction. I am uncertain as to whether the stew is salty when I have seen a bit of salt added but have not tasted the stew. But this attitude of uncertainty does not feel like the one I have when I have tasted the stew as perceptively as possible,

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and it is clearly a borderline case of salty. This latter seems to be a genuine attitude, not the lack of an attitude. If you march me through a continuum of cases as you add one grain of salt at a time to the stew, I would start by being fully confident that it was not salty, and I would end up fully confident that it was salty. In the middle, it would be difficult to claim that I have no views at all about the saltiness of the stew. I have views expressible in other terms, like "it is borderline salty" or "it is not clearly salty, but also not clearly not salty". Yet, the fact that I can express attitudes in other terms does not answer the question of what I think about these terms, "is the stew salty?" The answer, according to these phenomenological considerations, is ambivalence, a distinct attitude from uncertainty.

According to the *Conjunction problem* for *Classical Epistemicism*, ambivalence, and not merely uncertainty, is also the proper attitude to have toward the claim that the stew is salty. (This problem is first offered in the work of Schiffer (Schiffer 2003), and addressed extensively by MacFarlane (MacFarlane 2010)). According to Classical Epistemicism, for every pot of stew, either the stew is salty or the stew is not salty. A stew with absolutely no percentage of salt is not salty. A stew that is three percent salt is salty. Therefore, by classical logic, there is an n such that a pot of stew containing n % salt is not salty, but the same pot containing the same stew with n % + one grain of salt is salty. Indeed, for all vague terms, there is a sharp-cutoff in a continuum of cases where the term applies to all cases at or above (below) the cutoff, and the negation of the term applies to all cases below (above) the cutoff. While this conclusion strikes people as implausible, the explanation for this seeming implausibility according to the Epistemicist is that no human is in a position to know the value of n, and no one can conceive of what it would take to know the value of n. This necessary ignorance follows from certain truths about the limits of human knowledge. Where humans find themselves necessarily ignorant, like whether and where there is a sharp-cutoff for applications of the term "salty", they conclude that it is implausible that there is such a thing . But since humans would be ignorant even if there were a sharp-cutoff, the implausibility is no evidence against the existence of a sharp-cutoff. The Epistemicist argues that in favor of the existence of the cut-off is (1) all of the successes of first-order logic, (2) an argument that every other view will require some kind of unknowable sharp-cutoff, in which case positing only one cut-off between truth and falsity is simplest and most coherent, and (3) the insufferable problems faced by all views denying a single sharp cut-off. [1]

For the Conjunction Problem, note that Classical Epistemicism requires that the rational attitude to take toward the stew being salty, when it tastes borderline salty, is one of uncertainty, like the uncertainty we have if we lacked complete information about the stew. When the stew tastes borderline salty, we do not know whether it is salty, for it might just as likely be above or below the cutoff for saltiness given this evidence. Thus we should be 50 % certain that the stew is salty. By parity of reasoning, we should also be 50 % certain that the stew is spicy when it tastes borderline spicy. The same will be true if the stew also tastes borderline sour. Let us assume that being salty, spicy, and sour are independent.[2] We now have the following

[1] Classical Epistemicism is defended in (Williamson 1994), (Sorensen 1988), and (Sorensen 2001)

[2] A false assumption, but no matter. Change the predicates to your favorite three that pick out independent properties.

evidence; the stew tastes borderline salty, and borderline spicy, and borderline sour. What should be our attitude toward the proposition that the stew is salty, and spicy, and sour? On the presumption that the rational attitude to take are degrees of certainty, and the presumption that degrees of certainty ought to cohere with the laws of probability, the answer is that we should be 12.5 % sure that the stew is all three. That is, we should be pretty sure that the stew is not salty and spicy and sour. This conclusion would be natural if there were in fact sharp cut-off points for salty, spicy, and sour, as in Classical Epistemicism. If the cut-off points for each of these predicates were unknown, what would be the probability that we have a stew which is above all three cutoffs? Surely it would be far less than the probability that we are above one cutoff in particular. Yet, this result seems intuitively wrong. Its intuitive wrongness can be turned into an argument for the advocate of the Conjunction Problem in the following way; let *unappetizing* be defined as the property a stew has when it is salty and spicy and sour. The property of being unappetizing surely is derivative from other properties, but our experiences of it can be basic. People can experience something as being unappetizing prior to being able to understand and articulate why. Imagine that you taste the stew, and it tastes to you borderline unappetizing. According to Schiffer, parity of reasoning should make you 50 % certain that the stew is unappetizing. But now we have a contradiction, for we cannot be both 12.5 % and 50 % certain that the stew is unappetizing. Therefore, it is not the case that the attitude to take toward the stew being salty is one of uncertainty, akin to the uncertainty we have if we had no information about the stew. Instead, we should be ambivalent, a distinct attitude from uncertainty.

Although the Conjunction problem is formulated as a problem for Epistemicism, it is in fact a more general problem of characterizing the correct doxastic attitudes in the presence of vagueness. Underlying the Conjunction problem is the idea that our credence toward the conjunction of two vague conjuncts should not be significantly lower than our credence toward each conjunct. Identifying ambivalence with uncertainty under the Epistemicist view seems to violate this intuition. So what alternative views of ambivalence correctly characterize this structural feature? Opponents of Classical Epistemicism answer this question differently. For Schiffer (ibid. 198–207), it is a distinct sui generis attitude, called Vagueness-Related Partial Belief, governed not by the laws of probability, but according to the Lukasciewicz truth-tables for continuum-valued logic. Instead of understanding the tables in terms of degrees of truth, Schiffer understands them in terms of the condition for the rationality of this sui generis attitude. For MacFarlane (ibid. §2.2), ambivalence is the attitude of taking a proposition as being true to a certain degree. Both views must take into account cases where we can be both rationally uncertain *and* ambivalent, like when we know a spoonful of stew comes from one of two pots, one of which is definitely not salty, and the other of which is borderline salty, but we do not know which pot has been sampled. What should be our attitude toward the proposition that the spoonful of stew is salty? MacFarlane shows that Schiffer's view suffers from being mathematically incoherent in these cases (MacFarlane 2006). In its place, MacFarlane offers a view requiring continuum-valued logic. MacFarlane's view thus rises and falls on all of the same strengths and weaknesses of that particular analysis of vagueness. Others, for instance (Field 2000), reject the classical laws of probability for a version of probability theory that takes into account a belief that the proposition is indeterminate. On

Field's view, the probability that the stew is salty, when it is clearly a borderline case, is zero, as is the probability that the stew is not salty. When it is not so clearly a borderline case, we might have a probability that the stew is salty, and the probability that the stew is not salty, add up to less than one. But Field also rejects the data that there is something counterintuitive about finding it highly unlikely that the stew is salty, spicy, and sour when it tastes a borderline case of each ((Field 2011) §3). So while Field's view captures the idea that there is a distinct attitude toward borderline claims, he does not feel the need to explain the Conjunction problem.[3]

In this paper, I present an account of ambivalence that, like the Epistemicist, identifies it with uncertainty. However, unlike Epistemicism, the account presumes a Supervaluationist semantics for vague terms. The view I offer responds to the Conjunction Problem without positing a distinct sui generis attitude, nor a many-valued logic, nor revises the theory of doxastic confidence as a theory of classical probability. There may be independent reasons for taking one of these alternative routes, but I would like to illustrate why these alternatives are not required as a solution to the Conjunction problem. I begin by presenting a theory of how to acquire probabilities on vague sentences where such sentences are given a certain kind of Supervaluationist semantics. According to the theory of *Superprobabilities*, given some evidence E, the rational attitude toward what is expressed by the sentence "The stew is salty" will be some set of precise probabilities on E of every admissible precisification of "the stew is salty". The rational attitude toward what is expressed by "The stew is salty and spicy and sour" will be some set of the precise probabilities on E of every precisified proposition in the set of all admissible precisifications of "the stew is salty and spicy and sour." The theory of Superprobabilities deals with the Conjunction Problem by (1) making use of the idea of imprecise probabilities, and (2) giving up the probabilistic analog of truth-functionality for sentences, namely, *probabilistic-functionality*: It is false that for all sentences S, R, where S and R are independent, that pr(S & R) is a function of pr(S) and pr(R). However, probability-functionality for propositions is preserved: for all propositions p, q where p and q are independent, pr(p & q) is the standard probability function of pr(p) and pr(q). After a brief defense of the use of imprecise probabilities, I then compare the theory of Superprobabilities with a Classical Epistemicist attempt to deal with the Conjunction problem, and conclude that the considerations are not conclusive in favor of either view.

2 Review of Supervaluationism

Assume a theory of propositions where a proposition must be precise. Perhaps propositions are nonfuzzy sets of possible worlds. Perhaps propositions are made up of objects, properties, and relations, and these things are not vague. There are ways of making the assumption consistent with one's favorite theory of propositions, but let us take the characterization of propositions as made up of nonvague objects, properties, and relations for illustrative purposes. If propositions must be precise, then vague sentences like "the stew is salty" do not express a proposition. This is because the vague term "salty" does not pick out a precise property, but admits of a range of

[3] §5 below contains more discussion of Field's view in relation to the Conjunction problem.

possible precise properties. Ignoring higher-order vagueness for the moment, suppose that 0–2 % salt content is clearly not salty, and over 3 % salt is clearly salty. Between two and three percent salt are the borderline cases of saltiness. The (precise) property of containing greater than 2.12 % salt is one possible property admissible as the referent of "salty". Another possible referent is the property of containing greater than 2.334 % salt. Thus, the sentence "the stew is salty" has a range of propositions it can be classically precisified to express, namely, every proposition of the form 'the stew has greater than *n* % salt' for all *n* between two and three. For any sentence "S", let the set of propositions the sentence can be precisifed into expressing be *I(S)*. A sentence is supertrue just in case every member of I(S) is true. A sentence is superfalse just in case every member of I(S) is false. A sentence is neither supertrue nor superfalse when there is at least one member of I(S) that is true, and one that is false. A sentence "S" is precise when I(S) has exactly one member, and vague when I(S) has more than one member. This, in a nutshell, is Supervaluationism.[4]

My task in this paper is not to advocate, or defend, a Supervaluationist semantics for vague terms. It is to present a solution to the Conjunction problem assuming a Supervaluationist semantics for vague terms. I see a solution to (or dissolution of) the Conjunction problem as one element in a complete semantic, epistemological, and metaphysical theory of vagueness. As such, the Supervaluationist version of the solution ought to be investigated. The aim of this paper is to make such an investigation. In the process, many of the existing demerits (and merits) of a Supervaluationist semantics will be set aside.

3 Superprobabilities

On the assumption that our fine-grained attitudes toward propositions must cohere with the laws of probability, what should be our attitude toward the stew being salty when all of our evidence points to the stew being a borderline case of saltiness? On the Supervaluationist semantics just given, we cannot give an answer to this question, as there is no single proposition that is expressed by the vague sentence. We might have different probabilities for each candidate precisification of "the stew is salty". Nonetheless, in some circumstances, it seems that we can discern a single precise probability for the truth of a vague sentence "the stew is salty". For instance, if you receive decisive evidence that there is absolutely no salt whatsoever in the stew, then your credence that the sentence "the stew is salty" is true should be zero. Parity of reasoning will give you a probability of one to "the stew is salty" when one's evidence is that the salt level is clearly very high, like 4 %. It is clear why this is so. No matter what proposition one chooses as the precisification of "the stew is salty", the evidence renders that proposition to the same degree probable. Generalizing, then, we can initially define the *superprobability* of a sentence "S" on evidence E is *n* if and only if the probability of each proposition in I(S) on E is *n*. *n* need not be zeroes and ones, as in our examples. If there were ten pots of stew in the

[4] Supervaluationism is a semantics of vague terms originally given by (Dummett 1975) (Kamp 1975), (Fine 1975), (Lewis 1982) and defended admirably in (Keefe 2000) though these views can differ in details from each other, and from the simplified summary here.

other room, one of which contained 4 % salt, and nine of which contained 1 % salt, and you were presented with a spoonful of stew sampled from the other room, the superprobability of "this spoonful of stew is salty" would be one-tenth.

Acquiring a superprobability when we have evidence of clear saltiness is easy, but what about cases of borderline evidence? That is, suppose that a piece of evidence E makes one member of I(S) *n* degrees probable, and another member *m* degrees probable, where $m \neq n$. What should be our probability that "S" is true? A concrete case will help illustrate. Imagine a simple, two-way precisifiable predicate "on campus", where a person is clearly on campus if she is in region A, clearly not on campus if she is in region C, and a vague case of "on campus" if she is in region B. "On campus" can therefore be precisified as being in region A, or being in region A+B. Now imagine, for the sake of simplicity, that region A+B is 50 acres, region C is 50 acres, and region A is three-quarters the area of region B. See the Fig. 1 below for an illustration.

Our friend Rachel has come to town, and we know for certain that she is in region A+B+C, but we have no evidence whatsoever where she is exactly within that region. In this circumstance, we will say that our evidence of Rachel's location is *inexact*.[5] Our state of evidence should therefore make us 1/2 certain that Rachel is in C, 3/8 certain that she is in A, and 1/8 certain that she is in B. Now how certain should we be that Rachel is on campus?

The evidence we have makes different precisifications of "Rachel is on campus" probable to different degrees. On the precisification that "Rachel is on campus" expresses the proposition that Rachel is in region A, we should be 3/8 certain, and on the precisification that "Rachel is on campus" expresses the proposition that Rachel is region A+B, we should be 1/2 certain. This raises the question; what degree of certainty ought we to have on the truth of "Rachel is on campus" given that the degree our evidence justifies depends on the precisification? Here is at least one intuitive constraint: whatever it is, it cannot be below the minimum, or above the maximum, probability of the evidence on each member of I(S). In this case, it cannot be below 3/8 and above 1/2.[6] But within such a constraint, two strategies for proceeding suggest themselves. One is to somehow generate a precise degree of certainty as a function of the different probabilities of each members of I(S). I call this the *Aggregation strategy.* The Aggregation strategy could have you in some way average the two to get a degree of certainty, say 7/16. The average can be linear or weighted, or some other method of generating a precise number, subject to the intuitive constraint. The Aggregation strategy allows for a general definition of superprobability as follows: *n* is the superprobability of a sentence "S" on evidence E just in case *n* is the result of aggregating every probability of E on each member of I(S). As long as the Aggregation function abides by the intuitive constraint, then this

[5] Here I am following Williamson's usage of "exactness" and "inexactness" from (Williamson, ibid).

[6] This constraint is not compatible with Field's view, on the assumption that we are fairly to absolutely certain that Rachel is not a clear case of being on campus. Field's view results in a very low probability (possibly 0) that Rachel is on campus. Interestingly, (Dietz 2008) proves that Field's non-additive probability calculus follows from a supervaluationist semantics for vague terms when joined with a construal of degrees of belief as (precise) unconditional bets on the truth of propositions expressed by vague sentences, where a bet is lost when we end up with a borderline case. Given Dietz' work, the Supervaluationist must therefore reject this characterization of degrees of belief in vague contexts or otherwise accept Field's calculus. This particular constraint alone seems to me to put a lot of pressure on Dietz' characterization of degrees of belief. The reason for this will be given in § 6 below.

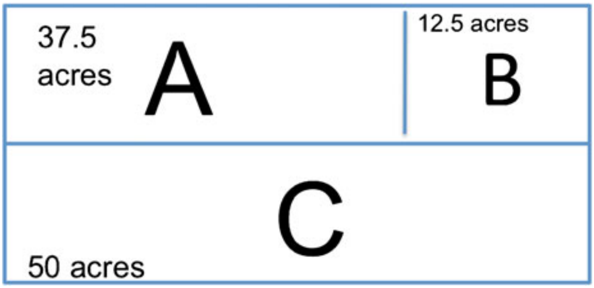

Fig. 1 Rachel's location

definition allows for the special case where there is an *n* such that E on every member in I(S) is *n*, which is our initial definition of a superprobability.

Another strategy I call the *Mushy Credence* strategy. If Rachel is at least 3/8 probable to be on campus, and at most 1/2 probable to be on campus, then we can simply be between 3/8 and 1/2 certain that Rachel is on campus, not some other precise probability. According to the Mushy Credence strategy, our confidence that Rachel is on campus is the interval [min I(S), max I(S)], where min I(S) is the lowest probability of the evidence on a member of I(S), and max I(S) is the highest probability of the evidence on a member of I(S). The Mushy Credence strategy skirts the difficult issue of choosing between competing aggregation functions and identifies intervals as the best model for our doxastic attitude on vague sentences. The Mushy Credence Strategy allows for a general definition of superprobability as follows: [*n, m*] is the superprobability of a sentence "S" on evidence E just in case *n* is the minimum of E on I(S), and *m* is the maximum of E on I(S). This definition allows for the special case where $n=m$, which is our initial definition of a superprobability.

3.1 Updating Superprobabilities

To illustrate the theory at work, let us take a couple of simple examples of evidence you can acquire about Rachel's location. Suppose that you now gain decisive evidence that Rachel is not in C. Your total evidence is still inexact, but now you can narrow down Rachel's location to region A+B. What should be your new probability that Rachel is on campus? Below is the result of updating each individual proposition in I(S) and acquiring a new probability according to both the Aggregation and Mushy Credence strategy, where simple linear averaging is used as the aggregation function.

Evidence	Pr(Rachel is in A)	Pr(Rachel is in B)	Pr(Rachel is on Campus)
Rachel is not in C	3/4	1/4	Aggregation 7/8
			Mushy [3/4, 1]

What about the case where we come to know the exact coordinates of Rachel's location, and it is in region B? This is now a case of exact evidence. This plays the role of the kind of evidence Schiffer discusses in raising the Conjunction problem. It seems that there can be no more information we can acquire as to Rachel's location, and it is within the region that counts as a borderline case of being on campus. What should our probability be that Rachel is on campus, on the views we are discussing?

Evidence	Pr(Rachel is in A)	Pr(Rachel is in B)	Pr(Rachel is on Campus)
Rachel is in B	0	1	Aggregation 1/2
			Mushy [0, 1]

The Aggregation view of 1/2 is numerically the same as Schiffer's intuition in his original formulation of the Conjunction problem, and is the same as the Classical Epistemicist view. The Mushy-Credence view of [0,1] makes the attitude distinct from the numerically precise attitudes of probabilities associated with uncertainty. Which view should we choose as the better strategy to solve the Conjunction problem?

4 Superprobabilities and the Conjunction Problem

Let the predicate "wearing a hat" be vague and two-ways precisifiable. It can either refer to the property of wearing a hat on the top of your head, or wearing a hat anywhere on your body (including the top of your head). Rachel is in town, and definitely in A+B+C, and you know she brought her hat, although half of the time she keeps it in her luggage. Of the half of the time it is somewhere on her body, three-quarters of the time it is on the top of her head, and a quarter of the time it is on her shoulder. You don't have any evidence as to whether the hat is anywhere on her body. What is the probability that Rachel is wearing a hat on campus? This is the issue of the probability of the conjunction of vague sentences. Starting off with the evidence at hand, the sentence "Rachel is wearing a hat on campus" is now 2×2 ways precisifiable. It can express one of the following four propositions {Rachel is wearing a hat on top of her head in region A, Rachel is wearing a hat on top of her head in region A+B, Rachel is wearing a hat anywhere on her body in region A, Rachel is wearing a hat anywhere on her body in region A+B}. The following matrix gives the probabilities of the evidence on each of these four propositions, as a function of the probabilities of the conjuncts given the evidence:

	In region A, 3/8	In region A+B, 1/2
Hat on head, 3/8	9/64	3/16
Hat on body part, 1/2	3/16	1/4

We are now in a position to compare the probabilities of each conjunct and each conjunction with a certain kind of evidence that should be rather uncontroversial. When the evidence is rather inexact, where we have both ambivalence *and* uncertainty, we get the following results on the probabilities of the conjunction:

Mushy Rule	Aggregation
[9/64, 1/4]	Average = .19
	Weighted = .29

For the Aggregation strategy, the first number is the linear average, the second is the result of giving twice as much weight to 3/16 as the others. This now leads us to the controversial case of the Conjunction problem. Essential to the problem is the case when we have exact evidence that places Rachel within the borderline of each of two independent properties. The anti-Epistemicist intuition is supposed to be that our doxastic attitude ought to be the same (or close to the same) with respect to the conjunction as it is with respect to each conjunct. The relevant case, in our toy example, is when we have decisive evidence of Rachel's exact location in region B, and decisive evidence that Rachel has a hat on her shoulder. The following table indicates the respective probabilities on each of these propositions given this evidence.

Classical Epistemicism		Mushy Supervaluationism		Aggregation Supervaluationism	
Conjunct	Conjunction	Conjunct	Conjunction	Conjunct	Conjunction
1/2	1/4	[0, 1]	[0, 1]	1/2	.19, .29

The Aggregation strategy still requires us to be much less certain in a vague conjunction than in each vague conjunct, but it does better than Classical Epistemicism if we go with a certain kind of weighted average manner of aggregation. This, however, depends highly on some nonarbitrary assignment of weights, and the strategy cannot account for the strong Schifferian intuition that credence in a vague conjunction ought to be the same as credence in each conjunct. The Supervaluationist, then, ought to adopt the Mushy Credence strategy, which yields precisely the same attitude in the conjunction as the conjunct, namely, the same interval probability. As already noted, the Mushy Credence strategy has the added benefit that, as a model of uncertainty, it can capture the phenomenological differences between ambivalence and uncertainty. On the Aggregation strategy, there really is no difference, except one of strength, between credences in vague sentences in which one is uncertain, and ones in which one is ambivalent. On the Mushy Credence strategy, that difference is captured by an imprecise probability rather than a precise one. The theory of Superprobabilities is also not a revision of classical probability theory. Our probabilities on propositions are fully classical and can even be fully precise. Only at the level of what is expressed by sentences (which is not fully propositional) does there appear to be a departure from classical probabilities. As an initial attempt at a Supervaluationist solution to the Conjunction problem, I propose the theory of Superprobabilities together with the Mushy Credence strategy.

5 Superprobabilities and Constraints on Rational Action

The idea of an imprecise probability has been around for quite some time in the literature on fine-grained belief (for instance, (Walley 1991), (van Fraassen 1995), (Joyce 2005)), and it has recently had its share of detractors. Before proceeding to investigate the comparative merits of the theory of superprobabilities with Classical Epistemicism, I would like to take a moment to respond to one of the central objections to imprecise, or interval-valued probabilities recently made in the literature. Unfortunately, I cannot respond to all of these recent objections (see (Joyce

2010) for extensive responses), so I choose one that I believe the application of imprecise probabilities to vagueness is particularly effective at addressing.

One of the complaints, voiced prominently by Adam Elga (Elga 2010) and Cian Dorr (Dorr 2010), is that there does not appear to be a way for advocates of fine-grained probabilities to make sense of certain constraints on rational actions required of a theory of uncertainty. The central case presented in Elga's paper is one where someone is presented with two bets occurring over time that appear to be jointly rationally irrefusable, but each of which a theory of imprecise probabilities renders rationally refusable. Suppose that you have some credence in P, you are offered a bet, Bet A, where you are out \$10 if P is false, but gain \$15 if P is true. You care about nothing other than money, and your value of money is perfectly linear. Then, before any change in your epistemic position with respect to P, or any change in the value of your money, you are offered a bet, bet B, where you gain \$15 if P is false, and lose \$10 if P is true. It seems clear that you are rationally required to accept at least one of those bets regardless of your credences. However, argues Elga, some interval-valued credences will make it permissible for you to rationally reject both bets. For instance, if your credence was between 0.1 and 0.8, then it is rationally permissible for you to reject bet A, and rationally permissible for you to reject bet B. This is assuming that, because it is consistent with your beliefs that the probability of P is above .6, it is permissible for you to reject bet A. Because it is consistent with your beliefs that the probability of P is below 0.6, it is permissible for you to reject bet B. Finally, the argument goes, since it is permissible to reject A, and permissible to reject B, then it is permissible to reject the total book of bets A and B. Since this is incompatible with the rational requirement to accept at least one of the bets, argues Elga, it is false that rationality permits imprecise probabilities (Elga ibid., page 4).

The solution to this problem on the theory of superprobabilities is a natural generalization of the theory, the theory of *Superrationality.* A single bet, book of bets, or series of bets, that a sentence S is true is superfair just in case it is fair on all precisifications of S. They are superrationally required just in case on every precisification of S, they are rationally required. We most certainly bet using language that is vague. I can certainly accept or reject bets that Rachel is on campus. But how do I collect on these bets? If "S" is only true relative to some precisification, then the rationality of my betting behavior will be relative to precisifications. It can be rationally permissible to accept a bet relative to one precisification, but not another. A bet is superrationally required just in case on every precisification, my probability on that precisification, given my total evidence, makes that bet rationally required. *Superpermissibility* we will define as permissible given my probabilities on at least one precisification. We can identify rational requirement with being superrationally required, and rational permissibility with being superpermissible. Given these definitions, we can satisfy all of Elga's assumptions in his argument while denying that it is permissible to reject the series of bets A and B, because on every precisification of any vague sentence, it will be required that we not reject both bets A and B. That is, whatever our probabilities on members of the class of precisifications, we will be rationally required to accept at least one of bet A and bet B. This is true even though it is not superrationally required to accept bet A, and not superrationally required to accept bet B, and thus permissible to reject A, and permissible to reject B. This result, odd as it may sound, is familiar territory for the Supervaluationist. According to

Supervaluationism, “either the stew is salty or not salty” can be true, while neither “the stew is salty” nor “the stew is not salty” is true. This is not a new bullet required of the Supervaluationist to bite.

Does it matter that the bets in Elga’s case occur over time (or diachronically) and not synchronically? One way of understanding a norm for diachronic rationality is that, if you can foresee ahead of time a betting situation that occurs across two different future times, and that the total evidence you will have across those times are such that some series of betting situations ensures a guaranteed gain, then those series of future bets are rationally required. This way of formulating a norm of diachronic rationality poses no problem for the theory of Superrationality. Whenever you are fully disclosed, now, to be offered a succession of bets, first A, and then B, and all of the correct conditions hold (as Elga formulates them), you are superrationally required to do α just in case, on every precisification of the sentences on which you are betting, your total foreseeable evidence at the time of each bet for each precisification makes α rationally required. The sequence of bets, rejecting bet A and then subsequently rejecting bet B, is foreseeably superimpermissible in these circumstances.[7] Therefore one is in advance, superrationally required to accept bet B if in the future one first rejects bet A.

Now this particular solution to the problem does not fully respond to the Elga problem, as the problem is not formulated in terms of bets on vague sentences, but on (precise) propositions. I do not take a stand on whether interval-valued probabilities on propositions are ever warranted as our actual attitudes, or as a theoretical model of our actual attitudes on proposition (in fact, as we will see in the final section, I ultimately reject them for vague sentences). However, I do believe that the same solution to the problem is available for such theorists. According to the standard mushy-credence theorists, an interval probability [*n, m*] in P is the set of all classically precise probability functions that give a value of *n, m* and all values between *n* and *m*, to P. This set is called the Representor (van Fraassen, ibid. White, ibid.) Such a theorist, in the face of Elga’s objection, can still claim that it is not permissible to reject the series of bets A and B. One can define rational impermissibility as the property of being impermissible according to every function in the Representor. One can define rational permissibility as the property of being permissible according to at least one function of the Representor. These definitions yield an exactly similar solution to the problem; it is permissible to reject A because there are some functions in the Representor that permit rejecting A, and it is permissible to reject B, because there are some functions in the Representor that permit rejecting B. But there is no function in the Representor that permits rejecting the series consisting of both A and B. Indeed, for any book of bets that one wants to evaluate for its rational permissibility, if every classically precise probability function makes that book impermissible, synchronically or diachronically, then it will be rationally impermissible on this view, and thus we have no problem. Once again, we still have the standard Supervaluationist problem; how can it be rationally required of us to accept either bet A

[7] There is some evidence that Elga accepts this way of formulating the norms of diachronic rationality, as he is explicit in stating that the setup of the bets are fully disclosed in advance, and that you see all of the sequencing and payoffs in advance (Elga ibid., page 4). On this understanding of diachronic rationality, the norms of diachronic rationality are a complex way of formulating your rational requirements now with respect to what you foresee to be future payoffs, credences, and available actions across future times ((Skyrms 1993)).

or bet B, but not be rationally prohibited from rejecting both bets? This is no more and no less problematic than what we already know about Supervaluationism.

6 Superprobabilities versus Zero probabilities

The Supervaluationist approach from the previous sections assigns some positive credence to a vague sentence in the face of borderline evidence. The motivation is intuitive (though this motivation is admittedly far from an argument, nor do I present it as such). If Rachel is a borderline case of being on campus given our inexact evidence, it seems that we should not be less than 3/8 certain that she is on campus, since on any precisification it is at least 3/8. Can this intuitive motivation be defended?

It is possible for an alternative Supervaluationist view that assigns a probability of zero to all borderline cases. Combining Hartry Field's view (Field 2000) with Supervaluationism does exactly this. Field's view does not presuppose a Supervaluationist semantics, nor is it presented as an extension of Supervaluationism. Yet, a Supervaluationist might find certain features of his view to be preferable to the theory of Superprobabilities. In fact, Richard Dietz proves that a Supervaluationist semantics together with a certain construal of betting applied to borderline cases allow one to give Dutch book theorems for Field's nonclassical probability calculus for vagueness (Dietz 2008). According to Dietz, the generalization of betting on borderline cases that generate the Dutch Book theorems for Field's calculus is for a bet on P to be a bet that pays if P is (super)true, and not to pay if P is not (super)true. Field's view, described in Supervaluationist vocabulary, makes it so that my probability that S is equal to my probability that "S" is supertrue ([ibid.], pp. 16–17). According to Supervaluationism, supertruth is truth, and naturally we would want my probability that S to be equal to my probability that "S" is true. Thus, if a stew is a borderline case of saltiness, then the sentence "the stew is salty" is not supertrue. Thus, the sentence is not true. If someone tasted a stew and it seemed clearly borderline salty, then that person has a probability 1 that the stew is borderline salty. Thus, she should have probability zero in the supertruth of the sentence "the stew is salty", and thus she should have probability zero in its truth. Therefore, she should have probability zero that the stew is salty, contrary to the theory of Superprobabilities.

In addition to being able to deal with the identification of truth with supertruth, Field's view would assign any conjunction of borderline cases a zero probability, in virtue of assigning each conjunct a zero probability. Thus, we would have the same attitude warranted toward borderline conjunctions as we do borderline conjuncts, and we have a solution to the Conjunction problem. Why is this particular view not better for a Supervaluationist than the theory of Superprobabilities, which solves the Conjunction problem but does not seem to capture the Supervaluationist identification of truth with supertruth?

One reason I can see is that, while a Supervaluationist does identify truth with supertruth, she should not identify the probability of S with the probability of "S" being supertrue, as Field's view requires. This is because it is essential to the Supervaluationist view to deny *Disquotationalism* about truth. That is, a Supervaluationist denies that "S" is true if and only if S, given that truth is supertruth. This is because Disquotationalism together with Supervaluationism entails the principle of bivalence, which is contrary to Supervaluationism.[8] Given this denial, the identification of one's probability of P with the probability of P being supertrue is problematic. It is problematic for the same reason that identifying belief that P with belief that P is supertrue is problematic. Denying Disquotationalism means the denial of the principle that for all S, if S, then "S" is supertrue, where the variable "S" ranges over sentences in the object language.[9] Therefore, there is an S, say σ, in which σ and it is not the case that "*a*" is supertrue. As Supervaluationists, if we knew that it is not the case that "σ" is supertrue, then we would want our degrees of belief in σ to come apart from our degrees of belief in "σ" is supertrue, since σ. Butsince "σ" is supertrue gets probability zero in these cases, then one wants some nonzero probability in σ. Field's view precludes degrees of belief of this kind, a preclusion that would make sense under Disquotationalism, but does not make sense under its denial.[10]

Moreover, the account of rationality as superrationality has repercussions for views identifying the proper attitude toward borderline cases to be degrees of belief close to zero. If the natural generalization of supervaluationism for rational betting is the theory of Superrationality, then giving a precise probability for a borderline case that is zero or close to zero can lead to rational bets that are superimpermissible. Looking back to the example of Rachel, suppose it is almost clear that Rachel is aborderline case of being on campus. On the Field–Dietz view, we should have some degree of belief close to zero that Rachel is on campus, call it α. On one precisification, the evidence makes it 3/8 probable that she is on campus, and on the other, it is half probable, so let $\alpha < 3/8$. A bet paying $1 if Rachel is on campus, and $0 if Rachel is not on campus will be sanctioned as at least a fair buy at the cost of $3/8 regardless of the precisification (it will be an advantageous deal on the precisification that makes it 1/2 probable). Thus, buying a bet at $3/8 will be superfair, and so fair. But if the rational degree of belief that Rachel is on campus is also α, then selling the same bet for $α will be fair. Sothe book consisting of a bet bought at $3/8 and one sold at $α would both be sanctioned as fair, but would also be superrationally impermissible, since it would guarantee a loss of 3/8-α for all precisifications no matter what.

The Supervaluationist would have to reject the theory of Superrationality in order to prefer the Field–Dietz view. But the theory is a very natural generalization of Supervaluationism, since thinking that sentences express propositions only relative to precisifications would very naturally lead to the view that bets on such sentences being true would be rational relative to precisifications. It would be difficult for a

[8] The argument is due to Williamson (ibid., pp. 162). If supertruth were disquotational, then "S" is supertrue if and only if S. "Either S or not S" is supertrue, so by Disquotationalism, S or not S. If S, then "S" is supertrue, and if not S, then "not S" is supertrue by Disquotationalism. So either "S" is supertrue or "Not S" is supertrue, so either "S" is supertrue or "S" is superfalse. So either "S" is supertrue or "S" is superfalse. Therefore, every sentence is either true or false, and there are no borderline cases, contrary to Supervaluationism. Therefore, supertruth is not disquotational.

[9] No Supervaluationist denies that if "S" is supertrue, then S.

[10] The argument here presumes that, in the situation described, rationality should not preclude a positive degree of belief in σ when σ.

Supervaluationist to reject Superrationality without placing pressure on her principles for accepting Supervaluationism.

For these reasons, I believe the Supervaluationist should not prefer Field's nonclassical probabilities to the theory of Superprobabilities, for the denial of Disquotationalism and the denial of Superrationality do not seem to fit well with Supervaluationism. This is not to say, however, that Field's view is not superior to the theory of Superprobabilties as an account of the appropriate attitudes toward vague sentences and their conjunctions, assessed independently of Supervaluationism, or that Dietz' generalization of betting on borderline cases must be wrong. Perhaps the oddity of separating one's probability that S with one's probability that "S is true is enough to abandon Supervaluationism in favor of Field's view. Perhaps Disquotationalism is enough, as Williamson argues. These are some of the standard objections to Supervaluationism, which are set aside in this paper. I do not claim that the theory of Superprobabilities is to be preferred over Field's view, only that Supervaluationist considerations do not tell in favor of Field's view over Superprobabilities.[11]

7 Epistemicism and the Conjunction Problem

Finally, let us evaluate the comparative merits of Epistemicism with Supervaluationism in light of the Conjunction problem. Can the Epistemicist solve the Conjunction problem on her own terms? According to a Classical Epistemicist, there is a matter of fact as to whether A and only A is on campus, or whether A+B and only A+B is on campus. Thus, distributing your credences as to whether Rachel is on campus when it is clear that she is in region B will be a straightforward matter of distributing your credences over a proposition in which you are ignorant, namely, whether A and only A is on campus, or whether A+B is on campus. Assuming you have no reason to believe that A and only A is any likelier to be on campus than A+B, you ought to be half sure in each. This means that your probability that Rachel is on campus, assuming that her being in region B is independent of whether B is on campus, will be 0.5, as the probability that Rachel is on campus is the probability that Rachel is in B and B is on campus. Thus, in the presence of evidence that Rachel is wearing a hat on her shoulder in region B, your probability that Rachel is wearing a hat on campus will be 0.25 by the same reasoning, using classical probabilities. But since we intuitively ought to take the same attitude toward a vague conjunction as we do in each vague conjunct, Epistemicism together with non-interval classical probabilities cannot accommodate this.

The Classical Epistemicist can either deny the claim that conjunctions should justify the same attitude as conjuncts in cases of exact borderline evidence, or otherwise use the same interval probabilities as the Superprobabilist in matters of ignorance over facts like whether A and only A is on campus. The latter path does not strike me as particularly promising, at least by Classical Epistemicist lights. Presumably, the reason to treat ignorance of facts like whether B is on campus differently from other kinds of ignorance is due to the fact that these are necessary truths about the nature of being on campus. But, by Epistemicist lights, our lack of knowledge about certain necessary truths concerning

[11] There is a lot more to say about the comparative merits of Field's view with the theory of Superprobabilities which should be reserved for future work.

the nature of properties like being on campus, saltiness, or baldness, is not supposed to follow from anything particularly special about our epistemic access to facts of these kinds. Rather, we are supposed to lack knowledge because it is a general feature of all knowledge. Roughly, within any domain, when our capacities give us true beliefs that can easily be false, we cannot know. We do not know that region B is on campus for the same reason that we do not know the number of blades of grass on Wrigley field. So why should the measure of our ignorance and uncertainty be any different between the two, one imprecise and the other precise? Instead of "on campus", imagine that there are precise boundaries in a local ordinance as to whether region A, or region A+B, is owned by Corporation C. It is now impossible to read that ordinance, as the ink has faded beyond human legibility. From the point of view of our doxastic attitudes, the right attitude in light of the evidence that Rachel is in region B is half certainty that Rachel is on land owned by Corporation C. This is exactly analogous, by Classical Epistemicist lights, as the case in which you assign a credence to Rachel being on campus. There is no difference in kind between the ignorance of ownership by Corporation C, and ignorance of being on campus. Thus, to treat ignorance of one by appeal to imprecise probabilities, and the other by appeal to precise probabilities, is contrary to the spirit of Epistemicism.

Far more promising is a Classical Epistemicist denial of the claim that conjunctions should justify the same attitude as conjuncts in cases of exact borderline evidence. The Epistemicist can charge that advocates of the Conjunction problem have committed the Conjunction fallacy. Cognitive scientists have for many years shown that with respect to judgments concerning the probability of conjunctions, humans can be systematically unreliable (Kahneman and Tversky 1983). When people are asked to make a judgment on the comparative probability of a conjunct like "Linda is a bank teller" and "Linda is a bank teller and active in the feminist movement", against a background of information that Linda was an intelligent, politically active philosophy major in college, people are likelier to judge the conjunction likelier than the conjunct, which is probabilistically incoherent. The most common explanation for this fallacy is that people are employing some kind of cognitive bias, the "representativeness bias." The information in the conjunction renders Linda more representative to us of people who were once active, intelligent, philosophy majors in college. The advocate of the Conjunction problem could similarly be charged with misjudging the likelihood of the conjunction of two vague predicates, judging it to be likelier than the laws of probability require.

The Epistemicist must make this charge with some care. If the advocate of the Conjunction problem is committing a fallacy, it is not the fallacy that a conjunction is judged more probable than one of its conjuncts. There is no such judgment in this case. Instead, it would be the subtler fallacy involved in people systematically judging, due to a cognitive bias, some conjunction of independent properties to be likelier than the product of the probabilities of its conjuncts. And, the mere fact that the advocate of the Conjunction problem has apparently probabilistically incoherent judgments cannot show that a fallacy has been committed, for that is precisely what she takes to be a datum. What needs to be argued is that some cognitive bias like the representativeness bias rather than vagueness serves as the likelier explanation of the likelihood judgments present in the formulation of the Conjunction problem.

In light of these considerations, the Epistemicist can make the following case. The Conjunction fallacy appears most prominently in conjunctions pairing an event made likely relative to some background information with an event made unlikely relative to that information (Wells 1985). Linda seems likelier to be a bank teller and active in the feminist movement than a bank teller because the conjunction contains a conjunct that is likely relative to the background information about Linda. The fallacy all but disappears in conjunctions pairing events that are made unlikely relative to some background information. For instance, if one were to ask which is likelier given Linda's background, that she is a bank teller, or that she is a bank teller and works at McDonalds, there does not appear to be much (fallacious) intuitive pull to the conjunction being likelier. If the advocate of the Conjunction problem really were committing some kind of Conjunction fallacy, we would expect structurally similar intuitions. Applying this to the case of vague predicates in the face of borderline evidence, suppose we have exact evidence that makes Joe a borderline case of bald, and a borderline case of fat. Add to this information that Joe is dating someone who tends to prefer hairy men who aren't very thin and aren't very fat. We would expect the advocate of the Conjunction problem to judge that Joe is bald and fat to be likelier than that Joe is bald. This I do not think tells in the Epistemicist's favor, as I do not find such an intuition, even a fallacious one, available for me. On the other hand, if we instead add that Joe is dating a woman who tends to prefer hairy and thin men, we should end up with an intuition that Joe is bald and fat to be significantly less likely than that Joe is bald. I cannot speak for Schiffer and MacFarlane here, but it does not strike me as crazy that this latter intuition is a correct description of our judgments here. But, the Epistemicist can then claim that the difference between this case and the original case that leads to the Conjunction problem are no different with respect to Joe's being a borderline case of both bald and fat. So the argument goes, the advocate of the Conjunction problem has committed a fallacy in the case where the background makes the vague conjuncts equally likely, as in the original case of the Conjunction problem.

The Epistemicist charge here is promising, but not conclusive. First, there is always denying the intuition. Here it can be done sensibly. After all, the advocate of the problem has already hypothesized that we have exact evidence of Joe's hair count and body composition. Why does this exact evidence not just screen off the evidence about the preferences of Joe's date? If it did, we should end up about as sure that Joe is bald and fat with this information as without this information. If Joe's hair count and body composition doesn't screen off such evidence, then one explanation is that predicates like "is bald" and "is fat" are not completely dependent on exact number of hairs or exact body composition, but are in some sense "response-dependent." If so, in the case given, the preferences of the woman Joe is dating is evidentially relevant because it partly constitutes what it is to be bald. But then, this would undermine the supposition that we have exact evidence that Joe is a borderline case of baldness and fatness, which is a presupposition of the Conjunction problem. Finally, even without denying the intuition, by the lights of Schiffer and MacFarlane, in the case where you add information about the woman Joe is dating, you are adding evidence to the borderline evidence that might warrant a revision of your existing beliefs, which does not undermine the idea that the conjunction in light of only borderline evidence is as likely as each conjunct. The lesson here is that constructing test cases to establish that advocates of the Conjunction problem are committing a fallacy is not a straightforward task.

An independent line of reasoning can help the Epistemicist here that a fallacy is being committed. Consider the conjunction of being salty and being spicy. There are four kinds of exact evidence we can have that a stew is salty and spicy. We can have exact evidence that makes it clear that the stew is salty, and clear that the stew is spicy. For example, you taste the stew and it tastes like a habanero pepper soaked in olive brine. We can have exact evidence that makes it borderline that the stew is salty, and borderline that the stew is spicy, like when you taste it and it tastes like club soda with a spritz of raw ginger. We can also have mixed exact evidence, like the taste of olive brine with a spritz of ginger, or club soda with habanero syrup. We can call these kinds of evidence, CLEAR & CLEAR, BORDERLINE & BORDERLINE, CLEAR & BORDERLINE, and BORDERLINE & CLEAR evidence, respectively. Absent details of specific cases, it is hard to say anything general numerically about how these kinds of evidence support conjunctions, but this much seems at least intuitively correct. All things being equal, your probability that P & Q, where both are vague, given CLEAR & CLEAR evidence in favor, should be higher than your probability that P & Q given BORDERLINE & BORDERLINE evidence, which itself should be lower than your probability that P & Q given CLEAR & BORDERLINE in favor. It also seems that all things being equal, CLEAR & BORDERLINE evidence should justify the same probability as BORDERLINE & CLEAR evidence. These intuitions about evidential support generate the following general structure relating to the kinds of evidence we can have in the truth of something vague:

General Structure
$pr\ (P\ \&Q|$ CLEAR and CLEAR) $>$ $pr\ (P\ \&Q|$ CLEAR and BORDERLINE) $=$ $pr\ (P\ \&Q|$ BORDERLINE and CLEAR) $>$ $pr\ P\ \&Q|$ BORDERLINE and BORDERLINE)

This intuitive structure allows the Classical Epistemicist to deny the strong, Schifferian claim that the probability that a stew is salty and spicy, given exact borderline evidence of each, should be the same as the probability that the stew is salty, given exact borderline evidence of saltiness. Consider the case in which borderline evidence justifies a 0.5 probability that the stew is salty, and one has absolutely clear evidence that the stew is spicy. This would push the probability that the stew is spicy to 1. By the laws of probability, this makes the probability that the stew is spicy and salty to be 0.5. But then, by the General Structure above, the probability that the stew is salty and spicy, given borderline evidence of saltiness, and borderline evidence of spiciness, must be lower than 0.5, contrary to the strong Schifferian intuition. Because the General Structure is intuitively plausible independently of Classical Epistemicism, it can be used to deflate the objection posed by Schiffer.

However deflating, though, advocating the General Structure is not itself sufficient to solve the Conjunction problem. The structure implies that, in the right conditions, the probability that the stew is salty and spicy given borderline evidence of each must be below 0.5. It does not say that it is okay for it to drop to .25. In general, there is still the Schiffer-inspired intuition that it seems wrong to become very sure that a stew is not salty, spicy, and sour just because one has exact borderline evidence of all three. Classical Epistemicism together with classical probabilities still seem to require us to be very sure that a stew is not the conjunction of a group of vague predicates too easily and quickly. This intuition has not been denied with the General Structure.[12] Classical Epistemicism will have a very difficult time abiding by the General Structure and accommodating this much weaker intuition involved in generating the Conjunction problem. It is hard to see how one can save the classical laws of probabilities without having the probability that P & Q, on borderline evidence, be anything other than .25.

Much more can be said about whether an advocate of the Conjunction problem can be successfully charged with committing a fallacy. This seem to me the best direction to take with respect to a defense of Epistemicism against this charge. Since it is not my goal to defend Epistemicism, or any particular view about the semantics of vague terms, I will not pursue this line any further. I nonetheless take it to be worthwhile to investigate the comparative merits of a Supervaluationist attempt at dealing with the Conjunction problem, on the assumption that it is a genuine problem, setting aside the (very real and in my view nonobvious) issue as to whether it is based on a fallacy. If it is, then everyone ought to steer clear of the Conjunction problem as telling in favor or against any views of vagueness.

8 Superprobabilities and the Problem of the General Structure

The Classical Epistemicist attempt at responding to the Conjunction problem explored in the previous section raises a problem with the theory of Superprobabilities. That is, the General Structure is incompatible with the theory of Superprobabilities as currently formulated. This might be okay, since the General Structure is an Epistemicist attempt at solving the Conjunction problem, and the theory of Superprobabilities is a Supervaluationist view. Nonetheless, the General Structure is independently intuitively plausible, and it entails that the judgment we have that Rachel is wearing a hat on campus, given that she is wearing a hat on her shoulder in region B, cannot be equal to the judgment we have that Rachel is wearing a hat on her shoulder, in region A. This, however, is precisely the result of the current formulation of Superprobabilities. For someone who takes the General Structure seriously, it is a strike against the theory of Superprobabilities.[13]

I believe that this issue arises because I have hitched the theory of Superprobabilities to existing theories of imprecise probabilities. This is the theory of an imprecise probability as an interval, where an interval is a Representor. However compelling such a theory is for the modeling of ordinary imprecise credences in propositions, it is both too strong and too weak for an account of credences in vague sentences. It is too strong because it carries unnecessary formal baggage. If we look at the case of the credence in the truth of "Rachel is on campus", given that she is in A+B+C, the credence is either 3/8 or 1/2. It is not the entire interval between 3/8 and 1/2. There should be no probability function placing a credence of 3/7 that "Rachel is on campus" as part of the representation of my credence, for there is no proposition in I(S) that the evidence makes 3/7 probable. Rather than taking the set of all probabilities between 3/8 and 1/2,

[12] In fact, MacFarlane's view (ibid.) has it so that classical probabilities together with the denial of classical logic lead to probabilities that satisfy the General Structure, but also saves the weaker Schiffer-inspired intuition.

[13] It might be an argument in favor of exploring the Aggregation Strategy discussed above.

the set should only be {3/8, 1/2}. In general, the set of probabilities representing my credences should not be the entire interval [min I(S), max I(S)], but simply the set of all probabilities of E on each member of I(S).

On the other hand, the use of interval-valued probabilities also makes us lose some kinds of information we can otherwise use to represent my state of mind with respect to a vague sentence. Consider the case of our credence that “Rachel is wearing a hat on campus”, when our evidence is that she is in region A+B+C with her hat. The first matrix above shows that this is the set of probabilities: {9/64, 3/16, 1/4}. But that is not all that it shows. The probability 3/16 that she is on campus is twice as likely as either 9/64 or 1/4, because twice as many precisifications yield that probability on the given evidence. This is not irrelevant information. Consider the extreme case where a set of precisifications of “S” has 100 members, and the evidence makes 99 of these propositions 100 % likely, while making one 50 % likely. Another set of precisifications of “R” has 100 members with the evidence making half of them 50 % likely and the other half 100 % likely. There seems to be a genuine difference in the attitude we ought to take with respect to what is expressed by these sentences. That information should not be excluded from the way we are modeling our credences.

Instead, I submit that we should model our credences as the set of probabilities generated by the evidence on each member of I(S), followed by a second, higher-order set of probabilities on each member of that set generated by the frequency of appearances of a particular probability among the set of precisifications. In the case of “Rachel is wearing a hat on campus”, we can write it this way, {9/64, 3/16, 1/4}, *pr* (9/64) = 1/4, *pr* (3/16) = 1/2, and *pr* (1/4) = 1/4. I believe that this new way of modeling imprecise credences in vague sentences can help capture the General Structure while simultaneously keeping all of the benefits of the theory of Superprobabilities. According to the Conjunction problem, we ought to have the same attitude in a conjunction as the conjuncts when we have exact borderline evidence of each. The theory of Superprobabilities accomplishes this by having the attitude in “Rachel is wearing a hat on campus”, when we know that Rachel is wearing a hat on her shoulder in region B, be {0, 1}. This is the same as the attitude in each conjunct on the same evidence. It also captures the idea that ambivalence feels differently from uncertainty, which is modeled as a single number.[14]

But in addition, in the case when we know that Rachel is wearing a hat on her shoulder in region A, we have BORDERLINE and CLEAR evidence, whereas when we know that Rachel is wearing a hat on her shoulder in region B, we have BORDERLINE and BORDERLINE evidence. The General Structure requires a lower credence given the latter evidence. This is now captured in the higher-order distribution over our first-order set of probabilities. In the case of BORDERLINE and CLEAR evidence, we have *pr* (0) = 1/2, *pr* (1) = 1/2. In the case of BORDERLINE and BORDERLINE evidence, we have *pr* (0) = 3/4, *pr* (1) = 1/4. Our higher-order probabilities say that it is much likelier now to be zero given BORDERLINE and BORDERLINE evidence than it is

[14] This idea also captures recent views, expressed in (Caie 2012) and (Barnett, D. “Vagueness and Rationality”, unpublished manuscript) claiming that the semantic properties of sentences, like vagueness or indeterminacy, infects our attitudes about that which is expressed by those sentences. In other words, if a sentence is vague, our attitude about its truth should be also. {0, 1} is a vague attitude between belief and disbelief. The theory of Superprobabilities coheres with these independent arguments for this conclusion, though I do not take a stand on the merits of these arguments.

with BORDERLINE and CLEAR evidence. We have therefore captured the way in which ambivalence can respect the General Structure; it is respected as second-order uncertainty.

9 Conclusion

The Supervaluationist can solve the Conjunction problem, originally raised by Schiffer, with a generalization of supervaluationism to probabilities and decision theory. However, this paper has not been an argument for these generalizations. I have not given an argument for, or defense of, Supervaluationism, and such generalizations rest entirely on Supervaluationism. Nonetheless, I have argued the theory of Superprobabilities and Superrationality has within its means the ability to give Supervaluationists a well-motivated and coherent means to deal with the Conjunction problem, and to address the issue of assigning credences to vague sentences generally. I have also highlighted the ways in which seeing probabilities within a Supervaluationist framework allows one to bypass certain problems that arise elsewhere for the theory of imprecise credences. A lot must be taken on board, however, for the entire package of Supervaluationism, Superprobabilities, and Superrationality to be accepted. The Classical Epistemicist, on the other hand, has a defensible, though inconclusive case that the Conjunction problem rests on a mistake, and that therefore it should not be taken as raising special problems for Epistemicism.

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