Two-Dimensional *De Se* Chance Deference

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1 | Introduction

Principles of chance deference tell you to treat information about the future objective chances as a particularly strong form of evidence. Let t be some future time. Then, so long as circumstances are ordinary and you don't have any information about what happens after t, a principle of chance deference says that, given that the time t objective chance of A is n%, you should be n% sure that 'A' is true.[1,2]

Principles like this run into two kinds of problems. In the first place, they give bad advice about *a priori* knowable contingencies. Consider the following example, from Hawthorne & Lasonen-Aarnio (2009). Tomorrow, we will randomly select 1 name from a list of 100, and the person whose name is selected will win a prize. Before the draw takes place, we introduce a new name for the person whose name is actually selected—we decide to call that person, whoever they may be, 'Lucky'. Before the draw takes place, we won't know what it takes for 'Lucky wins' to be true (beyond the trivial disquotational knowledge that 'Lucky wins' is true iff Lucky wins). If Sundar actually wins, then what it takes for 'Lucky wins' to be true is for Sundar to win. If Evîn actually wins, then

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1. Following philosophical tradition, I reserve the word 'chance' for objective probabilities. Throughout, my focus is on *tychistic* chance (like the chance of making certain observations in collapse interpretations of quantum mechanics), which I distinguish from *deterministic* chance (like the chance of a flipped coin landing heads in a Newtonian universe). See Gallow (2021).

2. Throughout, I'm going to sloppily use regular quotation marks for quasi-quotation.

what it takes for 'Lucky wins' to be true is for Evîn to win. Since we don't know whether Sundar or Evîn actually wins, we don't know what it takes for 'Lucky wins' to be true. Nonetheless, we do know that the truth-conditions of 'Lucky wins', whatever they are, have a 1% chance of being satisfied. *Whoever* Lucky is, they have a 1% chance of winning the prize, same as everyone else. It then looks like a principle of chance deference will tell us to be 1% sure that Lucky wins. But we should be nearly 100% sure that Lucky wins. It is, after all, *a priori* knowable that, if anybody wins, then Lucky does.[3]

In the second place, principles of chance deference appear to give bad advice when you have lost track of the time. For instance, you may have evidence about *today*'s chances without having evidence about, for instance, *Monday*'s chances or *Tuesday*'s chances. And you may not know for sure whether today is Monday or Tuesday. In cases like this, when we apply the standard principles of chance deference to the Monday chances, they will tell you that your credence in 'A' should diverge from what you know for sure to be *today's* chance of A.

Here, I'll introduce and explore a new principle of chance deference. My proposal differs from more familiar principles of chance deference in two ways. In the first place: I will not tell you to defer to chance by aligning your credence in 'Lucky wins' with the objective chance of Lucking winning. Instead, I will tell you to align your credence in 'Lucky wins' with the objective chance that 'Lucky wins' is true. In the second place: whereas familiar principles of chance deference contain an 'opt-out' clause which allows your credence to depart from the chances if you have evidence which is about the future, I will propose an 'opt-out' clause which allows your credence to depart from the chances if you have evidence, 'E', such that the objective chances might not be certain that 'E' is true.

I'll close by applying this principle of chance deference to Adam Elga's *Sleeping Beauty* puzzle (Elga, 2000). Lewis (2001) took his principle of chance deference to militate against Elga's 'thirder' solution to that puzzle. However, the principle of chance deference I will propose here is perfectly consistent with the 'thirder' solution and inconsistent with Lewis's own 'halfer' solution.

3. Similar cases are discussed in Schulz (2011), Nolan (2016), and Salmón (2019).

2 | Lewis's Principle of Chance Deference

Lewis (1980) thought that you should defer to the chances by adhering to the following principle.[4]

Lewis's Principle of Chance Deference For any thought 'A', any number $n\%$, and any time t, your credence in 'A', given that the time t chance of 'A' is $n\%$, should be $n\%$,

$$C(A \mid \mathcal{C}h_t(A) = n\%) = n\%$$

(so long as you lack any time t inadmissible evidence)

Let me offer a a few comments on this principle. On notation: '$C(A \mid E)$' is your rational conditional credence function. You hand it a pair of thoughts, 'A' and 'E', and it hands you back a number between 0% and 100% which indicates how confident you should be in 'A', on the indicative supposition that 'E' is true.[5] "$\mathcal{C}h_t$" is the definite description "the time t objective chance function". Thus, '$\mathcal{C}h_t(A) = n\%$' says that the time t objective chance of A is $n\%$.[6]

Two comments on terminology. Firstly, Lewis generally calls information 'time t inadmissible' whenever the information is *about* times after t. Lewis (1980, p. 272) tells us that he has "no definition of admissibility to offer, but must be content to suggest sufficient (or almost sufficient) conditions for admissibility". He suggests that two kinds of information are generally admissible: historical information about times before t, and hypothetical information about how the objective chances depend upon historical information like this.

4. This isn't Lewis's *Principal Principle*, though it follows from the Principal Principle given the updating rule of conditionalisation.

5. Throughout, whenever I write a schematic formula specifying what your conditional credences should be, I only mean to endorse substitution instances for which the 'conditioning' thought 'E' is epistemically possible. If 'E' is epistemically possible but is given a credence of zero, then the conditional credence $C(A \mid E)$ will only be defined relative to the additional parameter of a partition. See Easwaran (2019). Lewis thought that no epistemically possible thought should be given a credence of zero, so he was not concerned with relativising conditional credences to partitions. (This required him to use infinitesimal credences—for more, see Williamson (2007), Easwaran (2014), and Hájek (ms).) If we part ways with Lewis and allow that an epistemically possible thought may be given a credence of zero, then the natural partition to use in understanding Lewis's principle is $\{\mathcal{C}h_t(A) = n\% \mid n\% \in [0, 1]\}$.

6. Humeans about objective chance will have to revise Lewis's principle for reasons unrelated to the problem cases I'm focused on here—see the discussion in Thau (1994), Lewis (1994), Hall (1994), Ismael (2008), and Briggs (2009). Humeans should interpret "$\mathcal{C}h_t$" as the definite description "the objective chance function, conditioned on the proposition that it is the objective chance function". So understood, the principle will be equivalent to the so-called '*New* Principle'.

Why 'as a rule'? Why 'almost sufficient'? Why isn't this condition just sufficient, full stop? Because Lewis was worried about time travellers, crystal balls, oracles, and the like.[7] So long as there's no funny business like that, we should take E to be admissible when, and only when, it is about the chances or times before t.

Lewis's Criterion of Admissibility So long as there's no funny business with time travel or prognostication, 'E' is time t admissible iff 'E' is about the chances or times before t.[8]

Second comment on terminology: I stipulatively reserve 'thought' for whatever the arguments of your credence function happen to be. In his *A Subjectivist's Guide to Objective Chance*, Lewis assumes that the arguments of your credence function are truth-conditions. (By 'A''s *truth-conditions*, I mean the set of metaphysically possible worlds which your thought 'A' accurately describes—holding fixed the meaning it has for you, here and now.) However, he treats this as a simplifying assumption which would be lifted in a more general treatment (Lewis, 1980, p. 268). In general, Lewis takes the arguments of your credence function to be properties, or sets of *centred* possible worlds (see Lewis, 1979). So, for Lewis, thoughts are properties. But you may disagree with Lewis. You might think that thoughts are something like Fregean senses, or guises, or pairs of truth-conditions and guises, or sentences in a language of thought, or algorithms for computing truth-values, or something else altogether.[9] I will try as far as possible to remain neutral on these kinds of questions here. One substantive assumption I will make is that it is not rational to be uncertain about *a priori* matters like whether the actual winner wins or whether you are here now, and that it can be rational for you to be uncertain about who you are, where you are, and what time it is. You may disagree. You may think that rationality allows you to be uncertain about whether you are here now, and that it forbids uncertainty about whether today is Monday. Instead, what rationality

7. "If the past contains seers with foreknowledge of what chance will bring, or time travelers who have witnessed the outcome of coin tosses to come, then patches of the past are enough tainted with futurity so that historical information about them may well seem inadmissible. That is why I qualified my claim that historical information is admissible, saying only that it is so "as a rule" (Lewis, 1980, p. 274). See also the discussion in Meacham (2010).

8. Lewis used the account of aboutness which he offered in his 1988. On this account, E is *about* times before t (and so, as a rule, admissible) if, for any two worlds which have precisely the same history up until t, either E is true at both or false at both.

9. See Frege (1892), Fodor (1975), Salmon (1986), Castañeda (1989), Moschvakis (1994), Chalmers (2011), Braun (2016), and Fitts (2014), among others.

requires is that you be certain that the English sentence 'I am here now' is true; and what rationality permits is uncertainty about whether the sentence 'today is Monday' is true.[10] If this is your view, I believe that there's a translation of much (though not all) of what I'll say below into terms you could accept. Unfortunately, I won't have the space to provide that translation here, so I'll have to leave it as an exercise for the interested reader.

I'll argue in §§2.1–2.2 that Lewis's principle faces two kinds of problems. In the first place, it faces problems with *a priori* knowable contingencies. (This problem has been noted and discussed by Hawthorne & Lasonen-Aarnio (2009), Schulz (2011), Nolan (2016), and Salmón (2019), among others.) In the second place, it faces problems in cases where you've lost track of the time. (To my knowledge, this second problem has not been recognised before.)

2.1 | *A Priori Knowable Contingencies*

To illustrate the first problem, suppose that we are going to flip a coin at time t, and, at some point before t, I introduce the name "Uppy" by saying "Let's call whichever side of the coin actually lands up 'Uppy'". Let 'U' be the thought that the coin lands on Uppy. Then, Lewis's principle tells us that your credence in 'U', given that the objective chance of U is 50%, should be 50%.

$$C(U \mid Ch_t(U) = 50\%) = 50\%$$

But you know for sure that the objective chance of U is 50%. For you know for sure that Uppy is either heads or tails. If Uppy is heads, then the chance of the coin landing on Uppy is the chance of the coin landing on heads, which is 50%. And if Uppy is tails, then the chance of the coin landing on Uppy is the chance of the coin landing on tails, which is 50%. So, either way, the chance of the coin landing on Uppy is 50%.[11] If C is a probability—and I'll suppose throughout that it is—and you know something for sure, then you may ignore it when it appears on the right-hand side of a conditional credence. That is: if $C(E) = 100\%$, then $C(A \mid E) = C(A)$. So Lewis's principle says that your credence in 'U' should be 50%,

$$C(U) = 50\%$$

10. Cf. Stalnaker (1978).

11. In fact, the chance that a flipped coin lands heads is best understood as a *deterministic* chance, not a *tychistic* chance (which is my focus here). I'll stick to coin flips in the interests of readability, but if we want to be ideally careful, we should think of the coin as a quantum system in the state $\sqrt{1/2} \cdot |\text{heads}\rangle + \sqrt{1/2} \cdot |\text{tails}\rangle$, and we should think of 'flipping' the coin as measuring whether it is in the state $|\text{heads}\rangle$ or $|\text{tails}\rangle$.

This looks like bad advice. After all, it is *a priori* knowable that the coin lands on Uppy (so long as it lands on anything at all). So it looks like your credence in 'U' should be close to 100%, and not down around 50%.

One reaction to the case is to think that the naming ceremony in which "Uppy" was introduced has provided you with some inadmissible information. Let me make three points about this reaction. Firstly, if the dubbing ceremony provides you with inadmissible evidence, then inadmissible evidence is much easier to come by than Lewis indicates in *A Subjectivist's Guide to Objective Chance*. As I mentioned above, so long as they are sitting around before the time t, Lewis thought that ordinary humans left to their own devices would only have time t admissible evidence. It is only with time travel or prognostication that ordinary humans could come to possess inadmissible information.[12] But ordinary humans left to their own devices are perfectly capable of introducing names like "Uppy". Secondly, we can generate this problem for Lewis's principle without any dubbing ceremony or the introduction of any *name* at all. All we need is the rigidified definite description 'the side of the coin which actually lands up'. You should be certain, or nearly certain, that the side of the coin which actually lands up lands up, but you are also certain, or nearly certain, that the chance of this happening is 50%. So it seems that any solution which appeals to the kind of knowledge gained in dubbing ceremonies isn't going to solve the problem in general. Thirdly, and I think most importantly, if *a priori* knowable contingencies like 'the coin lands on the side it actually lands on' are going to count as inadmissible evidence, then it begins to look like Lewis's principle will never impose any constraints on your credences. For any chancy process which takes place at some future time t, you can know *a priori* that the chancy process will have its actual outcome. If this is enough to give you time t inadmissible evidence, then it looks like you will always have time t inadmissible evidence, and so Lewis's principle will never require you to align your credences with the time t chances. That's not to deny that these *a priori* knowable contingencies are inadmissible, given Lewis's criterion—indeed, I think that they are (more on this in §4.2 below). It's just to say that the appeal to inadmissibility only solves our problem insofar as it trivialises Lewis's

12. Admittedly, Lewis had adopted a much more liberal conception of inadmissibility by 2001, when he said that learning what time it is can provide you with inadmissible information about the future, "namely, that [you] are not now in it" (Lewis, 2001, p. 175). I won't have anything to say about this view of admissibility beyond the following observation: if all it takes to have time t inadmissible information is to know that it is now before t, then we would have inadmissible evidence about the outcome of a coin flip whenever we know that the coin flip will take place in the future. So, if we understand 'inadmissibility' in this incredibly liberal sense, Lewis's principle won't constrain our credences in even this paradigm case.

principle of chance deference.

A more careful response shows up in the work of Schulz (2011), Schwarz (2014), and Spencer (2020, fn 20). They each emend Lewis's principle by altering its parenthetical 'opt-out' proviso. They say that your credence in 'A', given that the time t chance of A is n%, should be n%—so long as you don't have any time t inadmissible evidence *and so long as the thought 'A' is apt for deference at t*. According to Schulz, 'A' is *apt for deference* at the time t iff, at t, it is not a matter of chance what 'A' means. (That is to say: it is not a matter of chance which set of possible worlds 'A' accurately describes.) Before the coin is flipped, whether 'Uppy' refers to heads or tails is a matter of chance. So, before the coin is flipped, it is a matter of chance whether 'the coin lands on Uppy' means that the coin lands on Uppy. So 'the coin lands on Uppy' is not apt for deference, and this emendation of Lewis's principle won't tell you to be 50% sure that the coin lands on Uppy.

This proposal solves our first problem. But it does not address the second.

2.2 | *Losing Track of the Time*

To illustrate the second problem, suppose that you don't know whether it's Monday or Tuesday, but you think it's equally likely to be either. And while you don't know what day it is, you know for sure that *today*'s chance of Secretariat winning the race ('W') is 75% and that *yesterday*'s chance of Secretariat winning the race was 25%. Suppose, for instance, that you've been carefully following the racing news, and you know that, yesterday, Mudskipper, who was strongly favoured to win, suffered an accident and won't be racing, boosting Secretariat's chances from 25% to 75%. Then, if we set 'A' to 'W', t to Monday (mon), and n% to 25% and 75%, respectively, Lewis's principle tells us that

$$\begin{aligned} & C(W \mid Ch_{mon}(W) = 25\%) = 25\% \\ \text{and} \qquad & C(W \mid Ch_{mon}(W) = 75\%) = 75\% \end{aligned}$$

You know for sure that $Ch_{mon}(W) = 25\%$ iff it is Tuesday ('*Tuesday*'), and you know for sure that $Ch_{mon}(W) = 75\%$ iff it is Monday ('*Monday*'). If $C(E) > 0$ and you know for sure that $E \leftrightarrow F$, then $C(A \mid E) = C(A \mid F)$. So the equalities above imply:

$$\begin{aligned} & C(W \mid \textit{Tuesday}) = 25\% \\ \text{and} \qquad & C(W \mid \textit{Monday}) = 75\% \end{aligned}$$

Since you are 50% sure that it is Monday and 50% sure that it is Tuesday, this implies (*via* the law of total probability) that

$$\begin{aligned} C(W) &= C(W \mid Monday) \cdot C(Monday) + C(W \mid Tuesday) \cdot C(Tuesday) \\ &= 75\% \cdot 50\% + 25\% \cdot 50\% \\ &= 50\% \end{aligned}$$

But this looks like bad advice. After all, you know for sure that *today*'s chance of Secretariat winning is 75%. Given that, it seems that you should be 75% sure that Secretariat wins, and not merely 50% sure. (By the way, if we apply it to the *Tuesday* chances, Lewis's principle will tell us, correctly, that your credence in 'W' should be 75%. Therefore, so long as you don't have any Monday-inadmissible evidence, Lewis's principle doesn't only give *bad* advice; it gives *contradictory* advice.)

A thought like 'Secretariat wins' should count as apt for deference on either Monday or Tuesday. There don't seem to be any cheap tricks with naming. And on Monday, it is not a matter of chance whether 'Secretariat wins' means that Secretariat wins.

Lewis's principle will only imply that your credence that Secretariat wins should be 50% *if* we assume that you don't have any Monday-inadmissible evidence. And you might suspect that, in this case, you *do* have some Monday-inadmissible information. After all, for all you're in a position to know for sure, today is Tuesday. And if it is Tuesday, then your evidence that *today's* chance of W is 75% is about times after Monday. By Lewis's criterion, it is Monday-inadmissible.

It's true that, *if* today is Tuesday, then your evidence that today's chance of W is 75% will be about times after Monday, and so will count as Monday-inadmissible, according to Lewis's criterion. But nothing about the case requires us to suppose that today is Tuesday. Suppose that, unbeknowst to you, today is in fact Monday. If that's the case, then your evidence that today's chance of W is 75% will not be about times after Monday, and so will not count as Monday-inadmissible, given Lewis's criterion.

The issue is that Lewis's formal theory of aboutness isn't built for *de se* thoughts—it assumes that your thoughts are truth-conditions, or sets of metaphysically possible worlds. So, in applying the theory, I've looked at the truth-conditions of 'today's chance of 'W' is 75%'. If today is Monday, those truth-conditions don't distinguish between worlds which only disagree about matters after Monday. So, if it's Monday, then your evidence is not about times after

Monday, and so it is admissible on Lewis's criterion. The upshot is that, when we are dealing with *de se* thoughts, our criterion of admissibility will have to be generalised. And we should want that generalisation to tell us that, in this case, you have Monday-inadmissible evidence. Perhaps we should say that evidence is time t inadmissible iff, *for all you're in a position to know for sure*, it is about times after t?[13] This is an interesting proposal. I'll have more to say about it in §4.2 below.

3 | Two-Dimensional *De Se* Chance Deference

In this section, I will introduce two revisions to Lewis's principle of chance deference to solve our two problems. The first revision, in §3.1, will say that, rather than aligning your credence in 'A' with the objective chance of A, you should instead align your credence in 'A' with the objective chance that 'A' expresses a truth for you, here and now. The second revision, in §3.2, will say that the total evidence 'E' is admissible for the time t iff you know for sure that the time t chance function is certain that 'E' expresses a truth for you, here and now.

3.1 | Defer to Chance About Whether Your Thoughts are True

Chance deference principles like Lewis's are instances of a broader class of principles of expert deference. And, in general, principles of expert deference face difficulties because your thoughts can differ in important ways from the expert's thoughts. (Recall, I use 'thought' stipulatively for whatever the arguments of your credence function are. Likewise, the expert's thoughts are whatever the arguments of *their* probability function are.) For instance, let the relevant expert be Beyoncé's doctor. A naïve principle of doctor deference would tell Beyoncé: given that your doctor's credence in 'A' is $n\%$, your credence in 'A' should be $n\%$, too. But set 'A' equal to the *de se* thought 'I am sick'. Then, this principle will tell Beyoncé: given that your doctor is confident in 'I am sick', you should be confident in 'I am sick', too. But this is bad advice. When Beyoncé's doctor entertains the thought 'I am sick', they entertain a thought which is true iff *they* are sick. When Beyoncé entertains that thought, she entertains a thought which is true iff *she* is sick. Since there's no connection between Beyoncé's health and her doctor's health, she should not see her doctor's high credence in 'I am sick' as imposing any rational constraint on her own credence

13. This proposal appears in Wilson 2014, §6.

in 'I am sick'.[14]

In my view, our first problem arises because—just as Beyoncé's thought 'I am sick' differs in important ways from her doctor's thought 'I am sick'—your thoughts differ in important ways from the objects of chance. Objective, tychistic chances are something like brute propensities of the universe to evolve over time in different ways. So chance is a function defined on the space of metaphysically possible worlds. Chance draws no hyper-intensional distinctions. When we say that the objective chance of A is $n\%$, we mean that the universe has an $n\%$ propensity to evolve over time in such a way that it satisfies 'A''s truth-conditions. So, if 'A''s truth-conditions are the same as 'B''s truth-conditions, then the chance of A must equal the chance of B.

On the other hand, your thoughts do draw hyper-intensional distinctions. They cut finer than sets of metaphysically possible worlds. In some good sense, your credence that Mark Twain is Samuel Clemens can differ from your credence that Samuel Clemens is Samuel Clemens, even though, necessarily, Mark Twain is Samuel Clemens iff Samuel Clemens if Samuel Clemens. Therefore, there must be at least two of your thoughts with the very same truth-conditions.

Before deferring to the objective chances, you must find a way of associating your thoughts with the objects of chance. A standard way of doing this is to associate any thought 'A' with its truth-conditions—denote those truth-conditions with '$\langle A \rangle$'. $\langle A \rangle$ is the set of possible worlds, w, such that w is accurately described by 'A'—holding fixed the meaning 'A' actually has for you, here and now. But you could instead associate 'A' with the set of metaphysically possible worlds in which 'A' expresses a truth—call this set '$[A]$'. $[A]$ is the set of possible worlds, w, such that, at w, the thought 'A' expresses a truth for you, here and now—not given the meaning it actually has for you, here and now, but instead given the meaning it would have for you, here and now, at w.

We can illustrate the difference with the thought 'the coin lands on Uppy', 'U'. Either the coin will actually land heads, or it will actually land tails. If the coin actually lands heads, then 'U' will mean that the coin lands heads—so

14. We may think that the doctor's thought 'I am sick' is not the same as Beyoncé's thought 'I am sick'. However, we should not think that the doctor's thought 'Beyoncé is sick' is the same as Beyoncé's thought 'I am sick'—for, presumably, if it were, the doctor's thought 'Beyoncé is sick' would be the same as Beyoncé's thought 'Beyoncé is sick'. By the transitivity of sameness, Beyoncé's thought 'I am sick' would be the same as her thought 'Beyoncé is sick'. But if Beyoncé suffers from amnesia, her credence in these thoughts can differ, wherefore they must be different. So, whether the doctor's thought 'I am sick' is the same as Beyoncé's thought 'I am sick', the upshot is the same: in order for Beyoncé to defer to her doctor, she must find some way of associating her thoughts with the thoughts of her doctor.

it will be true if the coin lands heads, and false if the coin lands tails. And if the coin actually lands tails, then 'U' will mean that the coin lands tails—so it will be true if the coin lands tails, and false if the coin lands heads. This is summarised in the 'two-dimensional' array below.[15]

$\langle U \rangle$	**heads**	**tails**
heads	✓	✗
tails	✗	✓

In this array, the rows correspond to epistemic (centred) possibilities—ways the world might actually be (for you, here and now). And the columns correspond to metaphysical (uncentred) possibilities—ways the world could have been. In each row, an entry under a column is marked with a '✓' if the possibilities in that column are included in the set $\langle U \rangle$. The entry is marked with an '✗' if they are not included. In each row, to see whether a column possibility is included in $\langle U \rangle$, suppose that you're actually in that row, and then ask yourself: does 'U' accurately describe that column possibility? So, for instance, in the upper right-hand corner of the array, suppose that the coin actually lands heads, and ask yourself: does 'the coin lands on Uppy' accurately describe a possibility in which the coin lands on tails? The answer is 'no'. Because the coin actually landed on heads, Uppy is heads. So, if the coin had landed on tails, the coin would not have landed on Uppy. So the upper right-hand entry of the array tells us that, if the coin actually lands heads, then possibilities in which the coin lands tails are not included in $\langle U \rangle$.

On the other hand, 'U' will end up expressing a truth for you, here and now, no matter how the coin actually lands. If the coin were to land on heads, then 'Uppy' would mean heads, in which case 'the coin lands on Uppy' would express the truth that the coin lands on heads. And, if the coin were to land on tails, then 'Uppy' would mean tails, in which case 'the coin lands on Uppy' would express the truth that the coin lands on tails. So, no matter how the coin were to land, 'the coin lands on Uppy' would express a truth. This is summarised in the array below.

$[U]$	**heads**	**tails**
heads	✓	✓
tails	✓	✓

15. Cf. Stalnaker (1978), Davies & Humberstone (1980), Kaplan (1989), Chalmers (2004), and Chalmers (2006*a*,*b*). To be clear: this is what Chalmers calls an *epistemic* two-dimensional array.

In each row, to see whether a column possibility is included in $[U]$, suppose that you're actually in that row, and then ask yourself: would 'U' express a truth for me, here and now, in that possibility? Because it would, no matter which row or column we're considering, $[U]$ contains both heads and tails possibilities, no matter whether the coin actually lands heads or tails.

In general, whether a possible world belongs in $\langle A \rangle$ depends upon what things are actually like. So, to check whether a possible world w belongs in $\langle A \rangle$, you first make an indicative supposition about what things are actually like—not just which possible world is actual, but also who you are in that world, and where you are located in time and space. Then, you ask yourself whether 'A' accurately describes the possible world w, given the meaning that it actually has for you, here and now. If it does, then, if things are actually that way, w belongs in $\langle A \rangle$.

And, in general, whether a possible world belongs in $[A]$ depends upon what things are actually like. So, to check whether a possible world w belongs in $[A]$, you first make an indicative supposition about what things are actually like—not just which possible world is actual, but also who you are in that world, and where you are located in time and space. Then, you ask yourself whether 'A' would express a truth for you, here and now, in w. That is, you ask whether 'A' would accurately describe w, not given the meaning it actually has for you, here and now, but instead given the meaning it would have for you, here and now, in w.

Because the set of possible worlds in $\langle U \rangle$ is not the set of possible worlds in $[U]$, the chance of the former is not the chance of the latter. Because the chance of heads and the chance of tails are both 50%, you know for sure that the chance of $\langle U \rangle$ is 50%—or, as I'll write it from here on out, you know for sure that $Ch_t\langle U \rangle = 50\%$. On the other hand, because you know that your thought 'U' will express a truth no matter whether the coin lands heads or tails, you know for sure that the chance of $[U]$ is 100%—or, as I'll write it from here on out, you know for sure that $Ch_t[U] = 100\%$.

In this case, you know for sure that $Ch_t\langle U \rangle = 50\%$ and that $Ch_t[U] = 100\%$. But in general, uncertainty about what things are actually like, or where you are located in space and time, can translate into uncertainty about which possibilities are included in $\langle A \rangle$ and $[A]$. And so, in general, you can be uncertain about the values of $Ch_t[A]$ and $Ch_t\langle A \rangle$, even if you can precisely characterise the objective chance distribution over possible worlds.

In general, when you think that the time t objective chance of $\langle A \rangle$ is $n\%$, you think that, at t, the world has an $n\%$ propensity to evolve over time into a world which is accurately described by 'A', given the meaning it has for you, here and now, in the actual world. And, in general, when you think that the time t objective chance of $[A]$ is $n\%$, you think that, at t, the world has an $n\%$ propensity to evolve over time into a world in which 'A' expresses a truth for you, here and now. As the case of 'U' demonstrates, these two thoughts are not equivalent. Corresponding to these two thoughts are two principles of chance deference. On the one hand, we could insist that, for any thought 'A', any time t, and any number $n\%$,

$$(1) \qquad C(A \mid \mathcal{C}h_t\langle A \rangle = n\%) = n\%$$

Because $\mathcal{C}h\langle A \rangle$ is what we usually mean by 'the objective chance of A', this is how chance deference principles are usually understood. On the other hand, we could insist that, for any thought 'A', any time t, and any number $n\%$,

$$(2) \qquad C(A \mid \mathcal{C}h_t[A] = n\%) = n\%$$

To be clear, $\mathcal{C}h_t\langle - \rangle = \mathcal{C}h_t(\langle - \rangle)$, and $\mathcal{C}h_t[-] = \mathcal{C}h_t([-])$. Though the function $\mathcal{C}h_t$ over possible worlds is the same in both of these functions, the nested functions, from your thoughts to sets of worlds, are different. Though there is just one chance function over possible worlds, $\mathcal{C}h_t\langle - \rangle$ and $\mathcal{C}h_t[-]$ are two different functions *of your thoughts*. Hand $\mathcal{C}h\langle - \rangle$ the thought 'U', and it will give you one probability; hand $\mathcal{C}h_t[-]$ the thought 'U', and it will give you another. These two different functions of your thoughts correspond to two different ways of associating your thoughts with the objects of chance. With $\mathcal{C}h_t\langle A \rangle$, we hand the objective chance function the set of worlds accurately described by 'A', given the meaning it actually has for you, here and now. With $\mathcal{C}h_t[A]$, we hand the objective chance function the set of worlds in which 'A' expresses a truth for you, here and now.

Return to Beyoncé and her doctor. A natural suggestion is that Beyoncé should set her credence in 'I am sick' equal to her doctor's credence in 'Beyoncé is sick'. This works well if Beyoncé knows she is Beyoncé, but suppose she is unsure whether she is Beyoncé or Kelly. In that case, Beyoncé's should satisfy the following two constraints: given that she is Beyoncé and the doctor is $n\%$ sure that Beyoncé is sick, she should be $n\%$ sure of 'I am sick'. And, given that she is Kelly and the doctor is $n\%$ sure that Kelly is sick, she should be $n\%$ sure of 'I am sick'.

In general, let us call a thought a 'location' if it clears up all uncertainty about who you are and where and when you are in space and time, and it doesn't convey any stronger information about what the world is like. And, given any thought 'A', and any location, 'λ', let 'A_λ' (the *de dicto* λ-surrogate of 'A') be a thought which expresses a truth for anyone, anywhere and anywhen, iff there is someone, somewhere and somewhen, for whom both 'A' and 'λ' express truths.[16] For instance, if 'S' is the *de se* thought 'I am sick' and 'β' is Beyoncé's location (a thought like 'I am Beyoncé and now is t and here is x' which expresses a truth for Beyoncé, here and now), then, even if 'S' is a *de se* thought about which Beyoncé and her doctor can faultlessly disagree, 'S_β' will be a *de dicto* thought which is true iff Beyoncé is sick, here and now. Then, the natural suggestion is that Beyoncé should defer to her doctor by satisfying constraints like

$$C(S \mid \beta \wedge \mathcal{D}(S_\beta) = n\%) = n\%$$

(where 'C' is Beyoncé's credence function and '$\mathcal{D}$' is the definite description 'the doctor's credence function'.)

In general, for an arbitrary expert, $\mathcal{E}$, so long as you're sure that you don't have any information the expert lacks, and so long as you're sure the expert knows who you are, where you are, and what time it is, you should defer to them as follows: for any thought 'A', and any potential location 'λ', given that the expert's probability for the *de dicto* λ-surrogate of 'A', 'A_λ' is $n\%$, you should be $n\%$ sure of 'A'.

$$C(A \mid \lambda \wedge \mathcal{E}(A_\lambda) = n\%) = n\%$$

In a slogan: you should defer to the expert about whether your thoughts are true, given the locations at which you might be entertaining them.

Turning to the expert of chance, notice that '$\mathcal{C}h_t[A] = n\%$' is *a priori* equivalent to a disjunction of conjunctions of the form '$(\lambda \wedge \mathcal{C}h_t\langle A_\lambda\rangle = n\%)$', where the disjunction is taken over each potential location λ,

$$\mathcal{C}h[A] = n\% \leftrightarrow \bigvee_{\lambda} (\lambda \wedge \mathcal{C}h_t\langle A_\lambda \rangle = n\%)$$

That is: you know *a priori* that the chance of 'A' expressing a truth for you, here and now, is n% iff either you are at the location λ_1 and the chance of 'A' expressing a truth for the person at λ_1 is $n\%$, or you are at the location λ_2 and the chance of 'A' expressing a truth for the person at λ_2 is $n\%$, or ....[17] If you

16. The notion of a *de dicto* locational surrogate therefore provides us with what Titelbaum, 2008 calls a 'context insensitive' claim, which we can use as a surrogate for a 'context sensitive' claim like 'I am sick'.

17. To be clear: I am saying that you are *at* λ iff 'λ' expresses a truth for you.

defer to the objective chances in the way I propose you should defer to experts in general, you will satisfy

$$C(A \mid \lambda \wedge \mathcal{C}h_t\langle A_\lambda \rangle = n\%) = n\%$$

for each potential location λ. Because each potential location excludes the others, if you satisfy the principle of conglomerability,[18] it then follows that you will satisfy

$$C(A \mid \mathcal{C}h_t[A] = n\%) = n\%$$

So the general principle of expert deference, applied to the time t objective chances, implies that—at least so long as you don't have any inadmissible evidence—you should defer to the time t chances by aligning your credence in 'A' with $\mathcal{C}h_t[A]$, rather than $\mathcal{C}h_t\langle A \rangle$.[19]

This solves the problem with *a priori* knowable contingencies. The solution is that—at least so long as your total evidence is admissible—you should align your credence in A' with the objective chance that 'A' expresses a truth, and not with the objective chance of A. Because you know for sure that the chance of 'the coin lands on Uppy' expressing a truth is 100%, this proposal implies that you should be 100% sure that the coin lands on Uppy.

3.2 | *Admissibility*

In my view, the solution to our second puzzle is to revise our understanding of what kind of evidence severs the usual normative connection between chance and credence. Lewis (1980) taught us that, as a rule, you needn't defer to the

18. Conglomerability says that, for any thoughts 'A' and 'E' and any collection of thoughts $\{F_i\}$ which are mutually exclusive and such that 'E' is *a priori* equivalent to $\bigvee_i F_i$,

$$\inf_i C(A \mid F_i) \leqslant C(A \mid E) \leqslant \sup_i C(A \mid F_i)$$

When the number of possibilities is at most countably infinite, this principle follows from the assumption that your credences are a countably additive probability. I endorse conglomerability as a constraint on rational credence in general.

19. Nolan (2016) and Salmón (2019) have responded to problems like the one from §2.1 by suggesting that objective chances are opaque. I disagree, but I'm not sure the disagreement is substantive. I think that, when we say that the objective chance of A is n%, we mean that there is an n% chance that the truth-conditions of 'A' will be satisfied—that is, I think we mean that $\mathcal{C}h_t\langle A \rangle = n\%$. This is why it sounds false to say that Lucky has a better chance of winning the lottery than I do, or that the coin is biased towards the side it actually lands on. So I think that, when we talk about the objective chances, we are generally talking about the transparent function $\mathcal{C}h_t\langle - \rangle$. But you may disagree because you think that chance is defined by its role as a guide to credence; and $\mathcal{C}h_t[-]$ is the function which guides credence, not $\mathcal{C}h_t\langle - \rangle$. So $\mathcal{C}h_t[-]$ is the objective chance function, and it is opaque.

time t chances if you know something *about* times after t. In contrast, I will suggest that the lesson of our second puzzle is that the evidence 'E' severs the usual connection between rational credence and the time t chances whenever, for all you know for sure, the time t chance function is less than certain of $[E]$.

Admissibility 'E' is time t admissible iff you are certain that the time t chance of $[E]$ is 100%.[20]

$$C(\mathcal{C}h_t[E] = 100\%) = 100\%$$

Equivalently: 'E' is time t *in*admissible iff, for all you know for sure, the time t chance of 'E' expressing a truth for you, here and now, is less than 100%, $C(\mathcal{C}h_t[E] < 100\%) > 0\%$. Or, in slogan form: '$E$' is time t *in*admissible iff, for all you know for sure, it is news to the time t objective chances that 'E' is true.

Given this criterion of admissibility, you have Monday-inadmissible evidence in the case from §2.2. For you have the evidence that *today*'s chance of Secretariat winning the race is 75%, $\mathcal{C}h_{today}[W] = 75\%$. If today is Tuesday, then $[\mathcal{C}h_{today}[W] = 75\%]$ is the set of worlds in which the *Tuesday* chance of $[W]$ is 75%. And, if today is Tuesday, then you're sure that the *Monday* chance of $[W]$ is 25%, which means that the Monday chance that the Tuesday chance of $[W]$ is 75% must be less than 100%.[21] So, if it is Tuesday, then you have some evidence that is news to the Monday chance function. Since, for all you know for sure, today is Tuesday, for all you know for sure, you have some evidence that is news to the Monday chance function. So you have some Monday-inadmissible evidence.

Notice that, on this criterion, simply losing track of what time it is can make evidence that was previously admissible become inadmissible. Suppose you start off certain that it is Monday. Then, the evidence that today's chance of $[W]$ is 75% will count as Monday-admissible. For, if you are certain that it is Monday, then you are certain that the evidence that today's chance of $[W]$ is 75% just is the evidence that the *Monday* chance of $[W]$ is 75%. Since you're certain that this is not news to the Monday chance function,[22] it is Monday-

20. Any name or definite description which you know for sure to denote a unique time is an acceptable substituend for 't'. So, for instance, in the right circumstances, '5:55 Tuesday morning' or 'five minutes from now' could be substituted for 't'. The same goes for the 't' which appears in the principle **Chance Deference** below.

21. This follows if we assume that the objective chance function satisfies van Fraassen (1984, 1995)'s principle of *Reflection*: for all (rigidly denoted) times t and t^* such that t comes before t^*, any set of worlds X and any number n, $\mathcal{C}h_t(X \mid \mathcal{C}h_{t^*}(X) = n\%) = n\%$. For then, if $\mathcal{C}h_{mon}$ were certain that the Tuesday chance of $[W]$ is 75%, $\mathcal{C}h_{mon}$ would itself be 75% sure that $[W]$.

22. If you're a Humean and this worries you, recall the discussion from footnote 6.

admissible. But then suppose you forget which day it is, and begin assigning some positive credence to today being Tuesday. At this point, the evidence that $Ch_{today}[W] = 75\%$ becomes inadmissible; because now, for all you know for sure, this evidence is news to the Monday chances. So according to **Admissibility**, losing track of the time can—all by itself—give you inadmissible information.

In the problem case from §2.2, losing track of the time does mean that you shouldn't set your credence in 'W' equal to your best estimate of the Monday chances. But it shouldn't mean that your credence in 'W' can swing completely free of your views about the Monday chances. In general, when you think you might have evidence that the time t objective chances lack, you shouldn't defer directly to the time t chances. Instead, you should defer to the time t chances, *conditioned on any evidence you have that they might lack.* So, in general, you should defer to the chances in the way described by **Chance Deference**.

Chance Deference If 'E' is your time t inadmissible evidence, then for any thought 'A', any number $n\%$, and any time t, your credence in 'A', given that the time t chance of $[A]$, conditional on $[E]$, is $n\%$, should be $n\%$.

$$C(A \mid Ch_t[A \mid E] = n\%) = n\%$$

(Just as I'm using '$Ch_t[A]$' as an abbreviation of '$Ch_t([A])$', I am using '$Ch_t[A \mid E]$' as an abbreviation of '$Ch_t([A] \mid [E])$'.) If you have no inadmissible evidence, then we needn't condition the chances on anything at all, and the principle should be understood to say that your credence in 'A', given that the time t chance of $[A]$ is $n\%$, should be $n\%$.

In the problem case from §2.2, this norm, applied to the Monday chances, tells you to be 75% sure that Secretariat wins, 'W'. For, once you've lost track of the time, your total inadmissible evidence is that *today*, the chance of $[W]$ is 75%, $Ch_{today}[W] = 75\%$. And you foresee only one possible value for $Ch_{mon}[W \mid Ch_{today}[W] = 75\%]$. If today is Monday, then '$Ch_{today}[W] = 75\%$' says that the *Monday* chance of Secretariat winning is 75%. Since the Monday chance function knows its own values, you'll be sure that the Monday chance of $[Ch_{today}[W] = 75\%]$ is 100%, so that $Ch_{mon}[W \mid Ch_{today}[W] = 75\%] = 75\%$. On the other hand, if today is Tuesday, then '$Ch_{today}[W] = 75\%$ says that the *Tuesday* chance of Secretariat winning is 75%. This *is* news to the Monday chances. However, once you give this news to the Monday chances, they will be 75% sure that

Secretariat wins.[23] So you know for sure that, no matter what day it is today, $Ch_{mon}[W \mid Ch_{today}[W] = 75\%] = 75\%$. So **Chance Deference** will require you to be 75% sure that Secretariat wins.

4 | Further Discussion

4.1 | Sleeping Beauty

The principle of chance deference I've developed here has a surprising consequence for the *Sleeping Beauty* puzzle (Elga, 2000). In this puzzle, we imagine that on Sunday evening, you are informed of the following: you will be put to sleep with a powerful sedative and awoken on Monday morning in a laboratory. On Monday evening, you will be put back to sleep, and a fair coin will be flipped. If the coin lands heads, then you will be kept asleep throughout Tuesday, and you will awake in your house on Wednesday morning. If, on the other hand, the coin lands tails, then your memories of Monday will be erased, and you will be awoken in the laboratory again on Tuesday before being delivered back home on Wednesday. Also, just by the way: you're beautiful.

When you awake in the laboratory on Monday morning, you will know for sure that, if it is Tuesday, then the coin flip on Monday landed tails. However, you won't know for sure whether it is Monday or Tuesday. For all you'll know for sure, it is Tuesday and your memories of being awoken on Monday have been erased. The central debate over *Sleeping Beauty* concerns how confident you should be that the coin landed heads, '*Heads*', upon waking on Monday morning. So-called *thirders* say that your credence in '*Heads*' should be one third. They advocate the credence distribution shown in figure 1a.[24] So-called *halfers* are unhappy with this distribution, in part because it means that your credence in '*Heads*' departs from the known Monday *chance* of *Heads*. They say instead that your credence in '*Heads*' should be one half.[25] They advocate the credence distribution shown in figure 1b.[26]

Let '*Awake*' be the thought 'I am awake today'. You have this evidence on Monday morning—for this is the evidence which allows you to rule out that

23. This follows from van Fraassen (1984, 1995)'s principle of *Reflection*, applied to the objective chances. See footnote 21.

24. See, for instance, Elga (2000, 2004), Dorr (2002), Arntzenius (2003), Hitchcock (2004), Horgan (2004), and Weintraub (2004).

25. See, for instance, Lewis (2001), Halpern (2004), Bostrom (2007), and Meacham (2008).

26. Of course, the *thirder* and *halfer* positions are not exhaustive. For one alternative, see the 'imprecise' suggestion discussed in Monton, 2002 and defended in Singer, 2014.

	Monday	*Tuesday*
Heads	1/3	
Tails	1/3	1/3

(a)

	Monday	*Tuesday*
Heads	1/2	
Tails	1/4	1/4

(b)

FIGURE 1: The thirder's favoured distribution is shown in figure 1a, whereas the halfer's favoured distribution is shown in figure 1b.

today is Tuesday and the coin landed heads.[27] Moreover, if today is Tuesday, then the Monday chances are not certain of [*Awake*]. Recall, [*Awake*] is the set of possibilities in which '*Awake*' expresses a truth for you, here and now. If today is Tuesday, then '*Awake*' expresses a truth for you, today, iff you are awake on Tuesday. And the Monday chances are not certain that you will be awake on Tuesday. So '*Awake*' is inadmissible evidence.

If today is Monday, then [*Awake*] is the set of worlds in which you are awake on Monday. And the Monday chances are already certain that you are awake on Monday, so $Ch_{mon}[Heads \mid Awake] = Ch_{mon}[Heads] = 50\%$. On the other hand, if today is Tuesday, then [*Awake*] is the set of worlds in which you are awake on Tuesday. And the Monday chances know for sure that you will be awake on Tuesday iff the coin lands tails. So, if today is Tuesday, then $Ch_{mon}[Heads \mid Awake] = 0\%$. And you know for sure that today is either Monday or Tuesday. So, on Monday morning, you know both of the following biconditionals for sure

$$\begin{aligned} Monday &\leftrightarrow Ch_{mon}[Heads \mid Awake] = 50\% \\ Tuesday &\leftrightarrow Ch_{mon}[Heads \mid Awake] = 0\% \end{aligned}$$

If you know the biconditional $A \leftrightarrow B$ for sure, then 'A' and 'B' are interchangeable in your credence function. So, if you satisfy **Chance Deference** from §3.2, then

$$\begin{aligned} & C(Heads \mid Monday) = C(Heads \mid Ch_{mon}[Heads \mid Awake] = 50\%) = 50\% \\ \text{and} \quad & C(Heads \mid Tuesday) = C(Heads \mid Ch_{mon}[Heads \mid Awake] = 0\%) = 0\% \end{aligned}$$

27. Horgan (2004) and Weintraub (2004) both observe that you learn '*Awake*' upon waking, and both suggest that this evidence breaks the usual connection between chance and credence.

This first constraint is powerful. It is inconsistent with the halfer's favoured distribution, and compatible with the thirder's. For the halfer's credence in '*Heads*', conditional on it being Monday, is 2/3rds; whereas the thirder's credence in '*Heads*', conditional on it being Monday, is 1/2. This is noteworthy because one reason halfers object to the thirder's distribution is that the thirder is not deferring to the known chances. Nonetheless, according to the theory of chance deference we've developed here—for quite independent reasons—it is the thirder, and not the halfer, who shows appropriate deference to the objective chances.

The thirder's credence in '*Heads*' is not *equal* to the known chance of the coin landing on heads. But, if we accept the criterion of admissibility from §3.2, then the thirder has a ready excuse. Their credence in '*Heads*' departs from the known Monday chance of *Heads* because they have the Monday inadmissible evidence that they are awake. This is not evidence *about* times after Monday, so it does not count as inadmissible given Lewis's criterion. It is, after all, Monday, and there are, after all, no time travellers, oracles, crystal balls, nor any other form of divination or prognostication. Nonetheless, it is information which might be news to the Monday chances—for it might be Tuesday, and if it is Tuesday, then you being awake is news to the Monday chances. So it counts as inadmissible evidence given our criterion. And, given that they have this inadmissible evidence, the thirder is correctly showing deference to the objective chances.

The account of inadmissibility offered in §3.1 was introduced to solve the problems from §§2.1 and 2.2. Halfers who think you don't have any inadmissible evidence in *Sleeping Beauty*—or that your credence shouldn't depart from the known chances, in spite of this inadmissible evidence—owe us a principle which allows you both to be 75% sure that Secretariat wins in the case from §2.2 and allows you to be 50% sure that the coin lands heads in *Sleeping Beauty*.

4.2 | Inadmissible A Priori Knowable Contingencies

in §2.1, I considered a response to the problem with *a priori* knowable contingencies which alleged that introducing the name 'Uppy' provides us with inadmissible evidence. If admissibility is understood in terms of aboutness, then I believe the response is exactly right. With this name, we can come to know *a priori* a thought ('the coin will land on Uppy') which is *about* the outcome of the coin flip. Given a criterion of admissibility in terms of aboutness, it then follows that we have inadmissible evidence. The trouble with the response isn't that it's exegetically inaccurate, but rather that it makes inadmissible evidence far too easy to come by. With clever naming tricks, or clever use of terms like 'actually', you can come to have evidence about future times without the need of prognostication or divination. With a Lewisian criterion of admissibility, we would then be free to have credences which departed radically from the chances.

While evidence like 'the coin will land on Uppy' or 'the actual winner will win' are *about* future times, and so count as inadmissible given an aboutness-based criterion of admissibility like Lewis's, it is not news to the objective chances that these thoughts express truths. So they will not count as inadmissible evidence given the proposal from §3.2 above. Of course, it *is* news to the objective chances that the actual winner will win. You know for sure that the objective chance of ⟨the actual winner wins⟩ is less than 100%. So it is important that, in **Admissibility**, we are talking about the chance of $[E]$, and not the chance of $\langle E \rangle$.

This is relevant to the proposal which I briefly considered at the end of §2.2, according to which we should say that evidence is time t inadmissible iff, for all you're in a position to know for sure, it is about times after t. This theory will say, correctly, that 'today's chance of W is 75%' is Monday inadmissible in the problem case from §2.2. But it will also say, incorrectly, that you have the *Tuesday*-inadmissible evidence that the actual winner wins. So it will fail to say that you should defer to the Tuesday chances. More generally, for any chancy process which takes place after t, it will say that you have the time t inadmissible evidence that the process has its actual outcome. For this is evidence you have which is about times after t. Since you have all kinds of contingent *a priori* knowledge about the future like this, it seems that any aboutness-based criterion of admissibility is going to say that you always have *a priori* reason to not defer to the future chances.

My objection to aboutness-based criteria of admissibility is that they make far too much *a priori* evidence inadmissible. It is not that they make *any a priori* evidence inadmissible. For the criterion of admissibility from §3.2 *also* rules some *a priori* evidence inadmissible. Suppose on Tuesday you sit below deck without a window, and you know that, yesterday, the captain flipped a coin to decide whether to take the ship in to port or back out to sea. So, today, you are at port if the coin landed heads, and you are out at sea if the coin landed tails. You don't know whether you're at port or at sea, but you do know for sure that you are here. And this is something that the Monday chances do not know for sure. That is, on Tuesday, [*I am here*] is either the set of worlds in which you are at port on Tuesday (if here is the port) or it is the set of worlds in which you are at sea on Tuesday (if here is the sea). Either way, you know for sure that

$Ch_{mon}[I\ am\ here] = 50\%$. So, by **Admissibility**, you have Monday-inadmissible evidence.

The Monday chances know that, if you are at port on Tuesday, then the coin lands heads. So if you are at port, then $Ch_{mon}[Heads \mid I\ am\ here] = 100\%$. And the Monday chances know that, if you are at sea on Tuesday, then the coin lands tails. So, if you are at sea, then $Ch_{mon}[Heads \mid I\ am\ here] = 0\%$. So **Chance Deference** will only require that

$$C(Heads \mid Port) = C(Heads \mid Ch_{mon}[Heads \mid I\ am\ here] = 100\%) = 100\%$$

$$\text{and} \quad C(Heads \mid Sea) = C(Heads \mid Ch_{mon}[Heads \mid I\ am\ here] = 0\%) = 0\%$$

These constraints are compatible with you having any credence between 0% and 100% that the coin landed heads.

So **Chance Deference** need not bind your credences in past chance processes after you've moved about through time and space—not if the way you did so depends upon the outcome of the chance process. But the principle *does* constrain your credences *before* you move about through time and space. On Monday, so long as you're carefully keeping track of the time, and you know that the coin has not yet been flipped, you will not have *a priori* inadmissible evidence. So **Chance Deference** will require your credence that the coin lands heads to be 50% on Monday. In general, you should be disposed to change your credences over time in a way that maximises expected accuracy. And, in this case, the expected accuracy maximising learning dispositions will remain 50% sure of '*Heads*'. So while **Chance Deference** doesn't require you to be 50% sure of '*Heads*' on Tuesday *on its own*, it does require this in conjunction with a norm of rational belief revision. If, sitting below deck on Tuesday, you are 75% sure of '*Heads*', then you are irrational. Either you didn't properly defer to the chances on Monday, or else you were disposed to change your credences in ways expected to take you further from the truth.

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