EPISTEMIC CLOSURE, COGNITIVE BRACKETING, AND NON-MONOTONIC LOGIC

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Abstract

Lottery propositions are well-known to epistemologists. Their peculiarity is that we don't think we are in a position to know them, despite their high probability. Hawthorne in *Knowledge and Lotteries* (2004) formulated the following puzzle: (a) we do not think we are in a position to know lottery propositions; (b) we can deduce lottery propositions from other propositions which we think we are in a position to know; (c) so, if knowledge claims are closed under deduction, as many philosophers think they are, we should be in a position to know lottery propositions. In this paper I show that without denying that knowledge claims are closed under deduction, the tension between (a) and (c) can be resolved by using non-monotonic logic and by appealing to what I call "cognitive bracketing."

1 Asymmetry and closure

Even if a propositions is highly probable, we do not always think we are in a position to know it. Here is a well-known example. Jack holds a ticket, which is part of a fair lottery that consists of a million tickets and one winning ticket. The proposition '*Jack's ticket is a loser*' is highly probable, but we typically do not think we are in a position to know it, at least without further information about the lottery drawing. Following standard terminology, I shall call *lottery propositions* those which we do not think we are in a position to know, despite their high probability.[1] On the other hand, we take ourselves to know propositions—call them *ordinary propositions*—whose probability is roughly the same as that of lottery propositions, or even lower. For instance, on the assumption

[1] As (Vogel, 1990) noted, the phenomenon generalizes to situations beyond lottery scenarios. Imagine John parked his car in a relatively crime-free neighborhood and went to eat in a nearby restaurant; unless we knew John returned to his car and found it still parked, we would be disinclined to take ourselves to know the proposition '*John's car has not been stolen*,' despite its high probability. Further, consider this scenario: Mike is young and in good health; the proposition '*Mike will not suffer a sudden heart attack*' is highly probable, but again we would be disinclined to take ourselves to know it, unless we had more precise information about Mike.

that Jack is of modest means, we would easily take ourselves to know the proposition '*Jack will not be able to afford a luxury vacation*,' despite the small chance that he might inherit a fortune or win the lottery.[2]

But now a question suggests itself. Why do we exhibit an *asymmetry* in our knowledge attributions across ordinary and lottery propositions, despite the fact that they are both highly (and roughly equally) probable? Philosophers have advanced various accounts,[3] but regardless of the account one endorses, a further difficulty arises. As John Hawthorne pointed out, the asymmetry in our knowledge attributions across ordinary and lottery propositions is in tension with the plausible principle of epistemic closure, which can be formulated as follows:

> If S takes herself to know proposition p and competently infers q from p, then S should take herself to know q as well.

Observe that a lottery proposition can be inferred from an ordinary one, e.g. '*Jack's ticket is a loser*' follows from '*Jack will not be able to afford a luxury vacation*' because if Jack does win the lottery, he would presumably gain a considerable amount of money and be able to afford a luxury vacation. Now, from the premise that we take ourselves to know an ordinary proposition, the principle of closure guarantees that we should take ourselves to know a lottery proposition as well; but this is in conflict with asymmetry. I shall call such conflict between asymmetry and epistemic closure *Hawthorne's problem*.[4]

The pattern that we found in Hawthorne's problem is not unique to lottery and ordinary propositions. Already Nozick and Dretske puzzled over similar matters.[5] They noted that although we take ourselves to know ordinary propositions such as '*Mark has hands*' (provided Mark is showing

[2]Here is a couple of other examples. If John parked his car in a safe neighborhood, we would be willing to take ourselves to know the proposition '*John's car is parked around the corner*,' although we can never be fully certain; and the same holds for the proposition '*Mike will be in New York this evening*,' on the assumption that e.g. Mike was flying to New York in the afternoon.

[3]We can identify three strategies. First, some philosophers argued that the asymmetry is rooted in the fact that our evidence is not causally or explanatorily connected with a lottery proposition, whereas it is connected with an ordinary proposition; see (Achinstein, 1978) and (Nelkin, 2000). Second, others invoked modal notions such as "safety" and "tracking," and argued that the belief in a lottery proposition is not safe nor tracking, whereas it is safe or tracking when it comes to an ordinary proposition; see (Pritchard, 2005), (Williamson, 2000), (DeRose, 1996), and (Roush, 2006). Finally, others argued that we are not in a position to rule out the scenario in which a lottery proposition is false, but we are in such a position while considering an ordinary proposition; see (Dretske, 1971), (Vogel, 1999) and (Lewis, 1996).

[4]See Hawthorne (2004).

[5]See Nozick (1983), Dretske (1970), and Dretske (1971).

us his hands) or '*this is a red lamp*' (provided we see a red lamp in front of us), we do not take ourselves to know propositions such as '*Mark is not a brain-in-a-vat*' or '*this is not a blue lamp which looks red because of a rare optical illusion*.' Call such propositions *heavyweight propositions*. Here, too, we exhibit an asymmetry in our knowledge attributions across ordinary and heavyweight propositions. But now notice that '*Mark has hands*' entails '*Mark is not a brain-in-a-vat*,' for brains-in-a-vat do not have hands. Also, '*this is a red lamp*' entails '*this is not a blue lamp which looks red because of a rare optical illusion*,' for red lamps are not blue. Thus, by the principle of epistemic closure, we should take ourselves to know '*Mark is not a brain-in-a-vat*' and '*this is not a blue lamp which looks red because of a rare optical illusion*.' The problem is that we don't; we cannot know heavyweight propositions unless we were in a position to disprove skepticism. I shall call this new tension between asymmetry and epistemic closure the *Nozick-Dretske's problem*.

By inspecting the structure of the Hawthorne's and the Nozick-Dretske's problem, it would appear that a resolution requires one of the following: (I) denying epistemic closure; (II) denying asymmetry; (III) denying that an ordinary proposition entails a heavyweight or a lottery proposition. The puzzle here is that each item we could deny is quite plausible in itself. In this paper, I shall offer a compromise between the demands of asymmetry and those of epistemic closure by using non-monotonic logic and by appealing to what I call "cognitive bracketing." I shall endorse a weaker closure principle which still allows for knowledge claims to grow by reasoning and inference, *at least in some cases*.[6]

The plan for the paper is as follows. I begin with a brief examination of the literature and the available options in section 2. Next, in sections 3 and 4 I examine the question of asymmetry and closure from the point of view of our assertions and conversational practises. In section 5 I make the transition from assertions to knowledge attributions by introducing the notion of a cognitive model. In sections 6 and 7 I offer an account of our asymmetry in knowledge attributions. Finally, in the remaining sections I formulate a weaker principle of closure, based on non-monotonic logic, which should resolve the tension with asymmetry.

[6]To my knowledge, Lawlor (2005) offerred one of the few arguments for a weaker closure principle.

2 OPTIONS

In this section I chart the available options for tackling the Hawthorne's and the Nozick-Dretzske's problem. As said earlier, the three most obvious options are: denying closure; denying asymmetry; or denying the entailment relation between ordinary and heavyweight or lottery propositions. A fourth option is to endorse some form of contextualism.

Closure. Nozick, Dretske and others invoked the purported tension between asymmetry and epistemic closure as an argument for abandoning closure. They preferred to maintain asymmetry rather than closure, and accordingly, they offered characterizations of knowledge which can justify asymmetry but which make epistemic closure fail.[7] In so doing, they thought that abandoning epistemic closure would not be too harmful for epistemology, yet many epistemologists after them disagreed, lamenting that epistemic closure is an extremely intuitive principle. Now, I think it is important to spell out what is intuitive about closure. Let me distinguish between closure *as a principle* and closure *as an ideal*. What is intuitive is not the principle or its formulations; there are many possible formulations of closure, each one slightly different from the other.[8] What is intuitive is the ideal—what closure allows us to do, i.e. it allows for knowledge to grow by means of reasoning, inference, and deduction. This is the ideal we should fulfill, because if new knowledge cannot rest on reasoning and inference, most of our scientific knowledge would be impossible. Unfortunately, the discussion about closure is often about the principle, not about the ideal; this is a mistake. The principle of closure is suspect, as the Hawthorne's and the Nozick-Dretske's problem indicate. Nozick and Dretske, I hold, were right in denying closure (as a principle), yet many contemporary epistemologists are also right in defending closure (as an ideal). To accomodate both, in this paper I propose a weaker version of the principle, one that can still satisfy the ideal of closure.

Asymmetry. I now turn to the second option: denying asymmetry. Some philosophers endorse

[7] Nozick (1983) proposed to characterize knowledge in terms of the modal notion of "tracking." Dretske (1970) and Dretske (1971) held that knowledge that p consists in having conclusive reason for p or in having ruled out all relevant alternatives in which p is false.

[8] One is the formulation in terms of knowledge attributions which I used in the previous section; another is the following: *If S knows that p and competently infers q from p, while maintaining knowledge of p throughout, then S knows q as well.* The specification 'while maintains knowledge of p throughout' excludes cases in which S forgets about p.

probabilism, the view that probability and degrees of belief should take a more central role in epistemology, and also, that knowledge should be replaced by a probabilistic measure of the evidential strength for or against a proposition. A consequence of this view is that if our evidence for a lottery proposition and our evidence for an ordinary proposition are (probabilistically) equally strong, we are unjustified in exhibiting any form of epistemic asymmetry. This is an attractive view because, so to speak, it promises to straighten up epistemology with the mathematical language of probability. Yet, probabilism is also quite revisionary of our epistemic practises, and while it could be normatively adequate, it is unilluminating at the descriptive level. The picture I propose in this paper is different from probabilism, although I will comment on how it relates to probabilism towards the end.[9]

Entailment. The third option consists in denying that there is an entailment relation between ordinary and lottery/heavyweight propositions. I find this hard to accept in the case of ordinary and heavyweight propositions, for '*this is a red lamp*' entails '*this is not a blue lamp (which appears red because of a rare optical illusion)*.' Granted, the entailment is not logical, but so long as we master the words 'red' and 'blue,' the entailment is unobjectionable. More plausible is to think that a lottery proposition need not follow from an ordinary one. For instance, if Jack will not be able to afford a luxury vacation, it need not follow that his lottery ticket is a loser, for even if he were to win the lottery and collect the money, he might suddenly lose it and thus be unable to afford the vacation. All we can say, it would seem, is that if Jack wins, it is highly likely that he will be able to afford the vacation.[10] This is a far point, but all it shows is that we can only draw conclusions which are tentatively, not definitely true. This point, as we shall see, fits well with the use of non-monotonic logic as a basis to formulate a weaker closure principle.

Contextualism. The final option is to endorse contextualism, the view that our knowledge attributions vary depending on context and epistemic standards (which are influenced by what is at

[9]Probabilism aside, if one wishes to deny asymmetry, there are two additional sub-options: becoming a skeptic or a dogmatic. Skepticism follows if we maintain epistemic closure and we posit that we do not know heavyweight propositions. Then, by closure, it follows that do not know ordinary propositions either—this is skepticism. Alternatively, if we posit that we know ordinary propositions, by closure, it follows that we know heavyweight propositions as well. This is a form of dogmatism because it rules out the possibility of deception and error. Although skepticism and dogmatism are interesting theoretical options, I shall set them aside and take it for granted that they are unappealing options.

[10]Roush (2006) makes this point.

stake, the topic of the conversation, the speakers' interests, etc.). Contextualists hold that ordinary propositions are associated with a lower epistemic standard than the standard for lottery and heavyweight propositions; this explains asymmetry. Further, contextualists hold that epistemic closure is valid within a given context, not across different contexts. This preserves epistemic closure but it does not contradict asymmetry. For, given that the epistemic standard for a heavyweight or lottery proposition is higher than that for an ordinary proposition, an inference from the latter to the former kind of proposition would cut across different contexts. Consequently, epistemic closure, though still valid within a given context, would not apply across ordinary and lottery/heavyweight propositions.

Some form of contextualism must be true, in the sense that e.g. the epistemic standards in science must be different from those we use in our everyday life. But suppose now we focus on what we might call "an everyday context," because, after all, ordinary and lottery propositions are not a matter of science, but of everyday life, and so are heavyweight propositions, although they are a bit more exotic. Does it make sense to have multiple contexts even within a fixed everyday context? The problem with this is that contexts would multiply indiscriminately, and knowledge attributions would come and go too easily. Yet, despite its possible degeneration, contextualism is still an appealing view. I find it appealing because of its cognitive underpinnings: as finite cognizers, we cannot consider all variables and aspects at the same time; we can only consider some aspects at a time. We are only able to assess propositions relative to a context. Accordingly, in this paper I will be mostly concerned with contextualism as rooted in the resource-bounded nature of human rationality.

3 Conversational bracketing

I have assumed that we think we are in a position to know ordinary propositions of various kinds, but not lottery propositions. This might not be entirely correct, given that our knowledge attributions about ordinary propositions might be more variable than the asymmetry thesis indicates. To appreciate this variability, I think, is pivotal to resolve the tension between asymmetry and epistemic closure. In this section I explore the phenomenon of variability by looking closely at our

assertions, while leaving the treatment of knowledge attributions for later. To begin with, consider the following conversations:

- Jack, we're going to a luxury resort this weekend. Wanna come?

- I'd like to, but I am short of money. I won't be able to afford it.

- Paul, do you have hands?

- Of course, I do! Look [*showing his hands*]!

On a natural reading, Jack asserted that he does not have enough money for a luxury vacation, and Paul that he has hands. Undoubtedly, we do seem to assert ordinary propositions. But now consider a possible sequel to the above conversations:

- Jack, you bought a lottery ticket. What if you win?

- Well, in that case, I'll be able to afford the vacation and come with you.

- Paul, what if you are a brain-a-vat?

- Well, if it's all an illusion, I have no hands, and neither do you!

Jack initially said that he couldn't afford an expensive vacation, yet he later added that he could if he were to win the lottery. In the second bit of conversation, Jack conceded that he might win the lottery and therefore be able to afford the vacation; this concession, though, is in tension with his previous categorical statement that he could not afford it. Similarly, Paul initially flat-out asserted that he—of course!—has hands, but he later conceded that he might not, provided one entertains the far-fecthed hypothesis that we are under a systematic illusion.

Although we often flat-out assert ordinary propositions, we are also ready to concede that they might be false. It is as though we are willing to assert ordinary propositions and yet also willing to withdraw our assent to them. Our pattern of assertions is not so clear-cut and it exhibits some degree of variability. One way to make sense of this variability is to say that, after making flat-out categorical assertions, Jack and Paul retracted them and replaced them with more fitting statements. But I don't think this is what is going on in the above conversations. When Jack's interlocutor raised a doubt, Jack was not surprised, nor did he feel he was being contradicted. His

interlocutor did not tell him anything he did not know already. Although Jack flat-out asserted that he could not afford an expensive vacation, he was well aware that winning the lottery would change his life, but he simply decided not to mention this possibility. Further, although Paul was a bit surprised by his interlocutor, he did not feel contradicted. He readily conceded that if one wishes to doubt even the obvious, there is always room for far-fetched possibilities to occur.

A better way to make sense of the conversations above is to think of flat-out categorical assertions as containing a *hidden qualifier*.[11] Jack's first answer can be rewritten as: *I am of modest means, so I will not be able to afford an expensive vacation unless something unexpected happens (e.g. I win the lottery, I inherit a considerable amount of money)*. Similarly, Paul's first answer can be rewritten as: *I see I have hands and nobody ever told me otherwise, so presumably I must have hands, unless something unexpected obtains (e.g. we are systematically deceived)*. If this is what Jack and Paul *actually* asserted, it becomes clear why the remarks of their interlocutors did not contradict them. Such remarks only made explicit certain tacit conversational assumptions.

More generally, when a subject asserts an ordinary proposition ρ, we should take him to assert the more complex proposition 'ρ *unless the unexpected occurs*.'[12] This means that, as we flat-out assert an ordinary proposition, we bracket from the conversation any explicit reference to what might unexpectedly occur. For instance, we take for granted that our economic condition won't suddenly improve in the immediate future, and thus we say that we will not be able to afford a luxury vacation. Also, we take it for granted that the world we live in—a world with trees, people, hands, etc.—is the way it appears to us through our senses, although we are ready to concede that we might be systematically deceived. All in all, we bracket a number of things from our conversations because to specify every detail or every possible exception would be conversationally unfeasible. We would not be able to communicate any longer because we would be flooded by an excess of information, which is equivalent to no information at all.

[11] The idea that any assertion should be read as containing a hidden qualifier has been defended, among others, by the Jain philosophers; see (Ganeri, 2001).

[12] Stenning and van Lambalgen (2008) make a similar point.

4 CONVERSATIONAL CLOSURE

As the previous section suggests, we can distinguish a *covert* and an *overt* flow of informational content. For instance, when we assert that we will not be able to afford a luxury vacation, we can represent the informational content conveyed by such statement at time t, as follows:

t	
overt content	I will not be able to afford a luxury vacation
evidence	low income
covert content	no luck in lottery; no inheritance; etc.

The above table depicts a conversational context at some point in time. The overt flat-out assertion '*I will not be able to afford a luxury vacation*' is supported by the evidence '*low income*' and it is also accompanied by a covert conversational content, which represents what is taken for granted, bracketed, tacitly assumed in the conversation.[13]

As a conversation progresses, it is plausible to assume that the covert flow of information does not suddenly change unless someone challenges it or brings it to the foreground. But now suppose that after asserting (at time t) that he will not be able to afford a luxury vacation, Jack added (at a later time t') that the lottery ticket he bought must *therefore* be a loser. The ground for the second assertion is that it follows from the first one. Yet, the second assertion will suscitate perplexities in most interlocutors, despite the fact that it can be inferred from the first. To understand the interlocutors' surprise, it is instructive to look at the flow of covert and overt informational content, as follows:

[13] On the neglected role of assumptions in epistemology, see Sherman and Harman (2011).

$t < t'$	
overt content	my ticket is a loser
evidence	//
covert content	no luck in lottery; no inheritance; etc.

Absent any new evidence, the table shows that in asserting that his ticket is a loser, Jack would be actually asserting that his ticket is a loser *on the tacit assumption that* he will have no luck in the lottery. This is a tautology, and the interlocutors' surprise might be explained by the fact that we typically do not expect to be given trivial pieces of information.[14] More precisely, if I assert that my ticket is a loser, my interlocutors would want to know on what basis I am in a position to make such a claim; they would want to know what evidence I have. If my evidence is that I have some inside information about the lottery drawing, they are likely to stop being surprised at my utterance. But if I say that it is because I am unable to afford a luxury vacation, their surprise will persist, the reason being that in doing so I am asserting a mere tautology.

Now consider a close cognate of epistemic closure:

> *Conversational closure.* If S is in a position to assert $p_1, p_2, \ldots$ and competently infers q from $p_1, p_2, \ldots$, then S should be in a position to assert q as well.

The previous discussion suggests that the principle of conversational closure cannot be always true of us. We are not always in a position to assert what we can competently infer from previous, acceptable assertions. The reason is that many of our assertions rest on tacit, background assumptions, which our inferences might unexpectedly bring to the foreground. For instance, when I conclude that my ticket is a loser from the assertion that I will not be able to afford a luxury vacation, I am simply unrevealing a tacit assumption underlying the conversation. So, unless I

[14] See (Stalnaker, 1978).

have suitable evidence for my new statement, I cannot assert it because this would amount to the un-evidenced assertion of a tacit assumption.

Yet, although conversational closure is not generally true of us, it must sometimes be true of us. We do (and should be able to) use reasoning and inferences to extend the stock of statements we are in a position to assert. After all, it is through deductions, inferences, and reasoning that we can have a rational conversation and we can spot inconsistencies and weaknesses in the assertions of our interlocutors. We cannot completely dispose of conversational closure. What we need, then, is a weaker principle, along the following lines:

> *Weaker conversational closure.* If, at time t, S is in a position to assert $p_1, p_2, \ldots$ and competently infers q from $p_1, p_2, \ldots$, then S should be in a position to assert q at a later time t', *unless* q is entailed by the set of tacit conversational assumptions at time t'.

One can check that this principle allows for the stock of assertible statements to grow through reasoning and inference. For instance, if we are in a position (at time t) to assert p_1 and in a position to assert p_2, by the principle of weaker conversational closure, we would be in a position (at a later time t') to assert the conjunction $p_1 \wedge p_2$ and the disjunction $p_1 \vee p_2$.

According to the principle above, tacit assumptions are indexed to time. While, in some cases, assumptions remain constant across time, it might be the case that at time t' new evidence is introduced which touches upon a matter covered by a tacit assumption at time t, in the sense that the new evidence turns out to support or refute an existing tacit assumption.[15] When this occurs, the assumption in question should cease to be an assumption. For instance, suppose at time t I assert that (a) I will not be able to afford a luxury vacation, on the tacit assumption that I won't win the lottery nor inherit a fortune. Next, suppose that at a later time t' I assert that (b) my ticket is a loser because I have received reliable information about the lottery drawing. What happened here is that the assumption that I won't win the lottery, behind assertion (a), is now supported by the evidence for assertion (b). Such assumption cannot count as an assumption any longer, and it should therefore be dropped. Graphically, the "assumption dynamics" between time t and t' can be

[15] A piece of evidence supports (refutes) a propositions e.g. whenever it makes the propositions highly (minimally) probable or much more (less) probable.

represented as follows:

t	
overt content	(a) I will not be able to afford a luxury vacation
evidence	low income
covert content	no luck in lottery; no inheritance; etc.

t'	
overt content	(b) my ticket is a loser
evidence	information about drawing
covert content	~~no luck in lottery~~; no inheritance; etc.

As the diagram shows, at time t' the tacit assumption '*no luck in lottery*' was eliminated because the speaker obtained new evidence about the lottery drawing; the other tacit assumptions, instead, remained the same.

The reader might wonder why the set of assumptions needs to be updated over time. If this were not the case, our speaker at time t' would be disallowed to assert '*my ticket is a loser*' or the disjunction '*I will not be able to afford a luxury vacation OR my ticket is a loser*.' If '*no luck in lottery*' would still be a tacit assumption at time t', the principle of conversional closure would block any such assertions. Thus, the set of conversational tacit assumptions should always be dynamically updated in light of new evidence, so that the set can shrink if new evidence ends up supporting or refuting an existing assumption.

5 FROM ASSERTIONS TO KNOWLEDGE ATTRIBUTIONS

The previous section made a first step towards solving the tension between asymmetry and closure, at least at the conversational level. The question now is how to move from the realm of assertions to that of knowledge attributions.

Some philosophers take the relation between knowledge attributions and assertions to be straightforward. They think that knowledge is (or should be) the norm of assertion.[16] Evidently, this claim is descriptively and normatively false in those conversational contexts in which truth and knowledge are not important, e.g. antagonistic contexts where the primary goal is to prevail on the interlocutor. And even putting aside antagonistic conversations, in many other conversations, it seems, mere belief is enough as a norm of assertion. On many occasions, after all, we make statements just because we honestly believe them, and it seems acceptable to do so, though we might have slim supporting evidence for what we say. Still, in scientific research as well as in our everyday life, we find ourselves in cooperative and rational conversational contexts which require some accountability on the part of the interlocutors. At least in those contexts, I think, knowledge attributions and assertions become closely related, so I subscribe to the following bridge principle:

> *Bridge principle.* In a cooperative rational conversation, a speaker S is in a position to assert p whenever he justifiably takes himself to know p.

Inevitably, different rational conversational contexts will have different epistemic standards. In science, assertions are expected to rest on measurements, data, scientific theories, journal publications, etc. In everyday conversations, assertions are expected to rest on the deliverances of the senses, on the testimony of reliable people we interact with, or on the information provided by instruments and the media. For reasons that will become clear later on, my concern here is limited to everyday, cooperative and rational conversations.

What does it mean to justifiably take oneself to know a proposition p? My suggestion rests on the notion of a *simplified cognitive model*. In order to get by in the world, take decisions, plan, and interact with others, we adopt simplified cognitive models of our physical and social surroundings.

[16] Among others, Williamson (1996), Hawthorne (2004), and DeRose (1996) are sympathetic to the claim that knowledge is the norm of assertion.

We construct different models depending on the task at hand or on what is at stake, and we also gather supporting evidence through our senses, the testimonies of others, etc. We can justifiably take ourselves to know a proposition p of interest, provided p is true relative to our cognitive model of choice, and provided we take such model to be adequate for the task at hand and to be supported by the evidence.

What do these simplified models of reality look like? Firstly, our cognitive models are simplifications or surrogates of reality, because they bracket many aspects of it, such as unexpected events, small chance events, etc. For instance, as I walk down a street, I am aware of a number of things (other individuals, cars, obstacles, pickpockets, etc.), but I tend to bracket some other matters (insects on the pavement, birds flying around, the shapes of the clouds, etc.). As I walk, I take some aspects to be relevant for my action, and others to be irrelevant. I call this *cognitive bracketing*, similar to the phenomenon of "conversational bracketing" talked about before.[17]

Connected to cognitive bracketing are three additional features of our cognitive models which bear mentioning. First, they are *commonsensical* models. We might be brains-in-a-vat and being systematically deceived, but this is not how we see things in our everyday life. Second, our cognitive models are *causal*. Philosophers have debated whether or not causality is an objective feature of reality and the issue is far from being settled. Yet, we must concur that in our ordinary view of the world causality rules: it is a powerful cognitive construction for us to make predictions, take decisions, rely on certain courses of events. Third, our cognitive models are *inertial*, in the sense that in them things remain the same over time unless changed. As we walk down the road, we do not worry that the soil underneath our feet might disappear or that suddenly a tree might block our way. Things stay the same unless changed, or at least this principle governs our simplified understanding of reality. We might call our models of reality *commonsensical inertial causal models*.[18]

As I shall explain, an appeal to these cognitive models can allow us to make sense of our

[17] A number of psychologists and philosophers have argued that this is what our senses do; they simplify and select among an incredible number of inputs and bits of information out there. Similarly, our brain processes only a limited number of pieces of information, because our cognitive abilities are limited.

[18] Much of the literature in Artificial Intelligence is about attempting to spell out these models more precisely. See (Stenning and van Lambalgen, 2008).

epistemic asymmetry, and in the next section I will offer an account of our epistemic asymmetry across ordinary and lottery propositions.

6 Inertial and chancy processes

When we ponder whether we can afford a luxury vacation, our model will primarily take into account our stable salary which, for the sake of argument, we know to be insufficient to pay for a luxury vacation; the model will also take into account the inertial process in which our salary is not going to increase in the immediate future. We take it for granted that if we currently have a salary, it will not suddenly increase, unless something unexpected happens. Thus, on this model, it follows that we will not be able to afford a luxury vacation.

More precisely, we rely on the outcomes of inertial processes, although these processes may fail to deliver those outcomes. We rely on them as a result of cognitive bracketing and we take for granted that a number of unexpected events will not occur and will not disrupt the unfolding of the inertial processes in question. Inertial processes are those in which, given a state of the system at a certain time, the system will persist in roughly the same configuration until an external input modifies it. The outcome of inertial processes can therefore be predicted. Suppose I am hired in a company and guaranteed a fixed salary; my monthly income will remain constant until I am promoted or discharged. The state of affairs consisting in Jack being unable to afford a luxury vacation is the result of an inertial, non-chancy process; that is why, I suggest, we take ourselves to know an ordinary proposition such as '*Jack will not be able to afford an expensive vacation*.'[19]

Besides inertial processes, there are processes which we may call "chancy." A process is chancy if, when repeated more than once, will give rise to different outcomes, although the system's initial conditions remain the same.[20] The paradigmatic example is the functioning of a lotto machine: though the machine's initial conditions remain the same, on one occasion ticket number,

[19] Many natural phenomena are inertial: the river flowing within its bank; a rock sitting quietly for millennia in the same position, etc. Many human-dependent processes also fall in this category. Suppose I park my car down the street; it will stay where I parked it until someone or something moves it: the owner, a thief, a traffic officer, a hurricane, etc. Another example are routine processes. They are processes whose outcome has been stable over a number of iterations and whose functioning is well-understood. Examples are the sun rising and setting, driving a car, flying an airplane, etc.

[20] See, among others, von Mises (1957).

say, 243536 is drawn, and on another occasion, ticket number 454950686 is drawn. On this objective characterization, chancy processes exist only if determinism is false. But we need not settle the question of determinism here; what matters are not *de facto* chancy processes, but processes that appear to us as chancy, given our available evidence about them. So, a *de facto* deterministic process might appear to us as chancy because we have incomplete information about its initial conditions or its functioning. The lottery drawing mechanism is not a chancy process in itself; it appears to us as chancy because of our limited information about its initial conditions.[21]

In short, my proposed account of the phenomenon of asymmetry in our knowledge attributions across ordinary and lottery propositions is as follows: (a) we are unwilling to take ourselves to know a proposition or its negation whenever it is about an event or a state of affairs which is the outcome of what appears to us as a chancy process; (b) we do not display the same unwillingness whenever a proposition is about an event or a state of affairs which is the outcome of what appears to us as an inertial, non-chancy process. Importantly, this distinction between chancy and inertial processes should be understood given the assumption that our grasp of reality is mediated by simplified models, and our reliance on inertial processes is the result of our need to simplify and predict the outcomes of reality.

Some might object that all events and state of affairs are the outcome of a chancy process. If so, the account of the asymmetry that I've just formulated would be empty. There are two ways to interpret this objection. The first is to think of it as a denial that there is a *de facto* distinction between chancy and inertial processes, especially if we endorse the statistical and probabilistic picture of the world that part of contemporary physics offers us. But I need not be committed to a metaphysical view about how things actually are; all I need is that the conceptual distinction between chancy and inertial processes can be of service in accounting for our asymmetry in knowledge attributions.

[21] Equipped with enough information, even a lottery drawing might not be chancy any longer: collecting detailed information about the functioning of a lotto machine and its initial conditions should enable us to predict the result of the drawing. A less paradigmatic example of a chancy process is car theft; again, it isn't a chancy process in itself, but it appears to us to be one given our available evidence. Car theft is chancy for car owners, because its outcomes are unpredictable—i.e., one day John's car is stolen, another Janine's, and yet another Andrew's—but at the same time, it might not be chancy for a thief or a police officer who have a better understanding of the dynamics of car theft. Alike observations can be made for the occurrence of heart attacks: for a qualified cardiologist the occurrence of a heart attack is less the result of chance than for someone who is ignorant of medicine.

The distinction, as emphasized earlier, is confined to our simplified cognitive models of reality.[22]

A second way to interpret the objection is to say that, in the way we naively conceptualize the world, all processes are chancy and all events are the result of chancy processes. A fully satisfactory answer would need extensive empirical research. My response, then, can only offer a clarification on the distinction itself and on how it is supposed to work. A plausible picture is one in which we conceptualize the influence of chancy processes in varying degrees: we think of certain events and state of affairs as primarily dependent on chancy processes, and of others as primarily dependent on inertial processes. Think of whether you'll be able to afford a vacation. You will naturally think of how much money is in your bank account, what sources of income you have, etc. When someone asks you if you can afford a certain product, do you first think of your wallet, bank account, and salary, or do you rather start fantasizing about lotteries, casinos, and inheritances? Whether or not one can afford a product, I think, depends on certain inertial processes and state of affairs (salary, employment, bank account, etc.), and only secondarily on chancy processes such as winning the lottery or inheriting a fortune.[23] The difference between ordinary and lottery propositions, in other words, is that the truth of the latter is thought to depend *primarily* on the outcome of a chancy process, whereas the truth of the former is thought to depend primarily on the outcome of an inertial process and *only secondarily* on the outcome of a chancy process.[24]

[22] A further worry arises: what is the ontological status of the distinction between chancy and inertial processes? If it is not about things in the world, does it in fact guide ordinary people when they entertain propositions and engage in conversations? This is far from clear, and empirical research would be needed to settle this question. For the time being, I can only claim that the distinction between chancy and intertial processes is a plausible one and its application can correctly predict the asymmetry in knowledge attributions across ordinary and lottery propositions.

[23] If it makes things clearer, the point can also be put in the Aristotelian language of substance and accidents: the inertial process is primary because it is the underlying substance, whereas the various chancy processes are secondary because they are the accidents inhering to the substance.

[24] Here is another example. When someone asks you about the location of your car, do you first think about where you parked it or about where a thief or a hurricane might have taken it? In contrast, think of whether your car has been stolen. What's at issue now is still the location of your car, but with an emphasis on the possibility of theft. When you were plainly wondering about the location of your car, theft was in the background; now, it has come to the foreground. Theft is the chancy process whose outcome primarily decides whether your car has been stolen or not; instead, the outcome of the inertial process of cars-remaining-where-they-were-parked is what primarily decides your car's location.

7 COMMONSENSICAL MODELS

I hope the reader is now convinced that by relying on the distinction between chancy and inertial processes, we can make sense of our asymmetry in knowledge attributions across ordinary and lottery propositions. What we need now is a way to make sense of our asymmetry in knowledge attributions across ordinary and heavyweight propositions. In other words, why do we take ourselves to know propositions such as '*Mark has hands*,' but we don't think we are in a position to know propositions such as '*Mark is not a brain-a-vat*'? Once again, my suggestion is that by examining our simplified cognitive models of reality we may find an answer to this question. Preliminarily, notice that in the context of, say, micro-biology or physical research, no one will claim to know that we have hands, at least as far as the methods and findings of micro-biology or physics are concerned. The reason is that, in these fields of inquiry, the concept of a hand is not well-defined; other concepts or entities, such as gene, protein, atom, positron, etc. are routinely used and statements are made about them. Assertions such as '*Mark has hand*' are not encountered in scientific conversations, and this is why my discussion is confined to the cognitive models we use in our everyday life. As I mentioned earlier, such models have three salient features: they are commonsensical, causal, and inertial. The inertiality of these models has helped us explain the asymmetry between ordinary and lottery propositions. To explain the asymmetry across ordinary and heavyweight propositions, I shall elaborate on what it means for a cognitive model to be *commonsensical* and *causal*.

Very flatfootedly, a commonsensical view of the world consists in our ordinary, simple-minded grasp of reality. We ordinarily see (and believe in the existence of) hands, trees, people, feet, legs, bodies, tables, chairs, etc. It goes without saying that our commonsensical understanding is not immune from criticism. Among the philosophers who doubt it are the skeptics, and some scientific findings can be construed as to challenge it in various ways.[25] An important question—but one which I cannot answer here—is whether we should still maintain our commonsensical picture despite the challenges that come from skepticism or the sciences. In response to this question, a number of philosophers reasoned that abandoning our commonsensical picture, or important as-

[25]For instance, Quantum Mechanics (or some interpretations of it) challenges our common belief in causality, and neuroscience may challenge our common belief in free will.

pects of it, would make our lives, our ability to communicate and orient ourselves in the world nearly impossible; or at least, it would require of us to "reinvent" ourselves as very different creatures.[26] But whether or not we are justified in endorsing our commonsensical standpoint, there is no doubt that an essential ingredient of it is the notion of causality. We see ourselves as situated in a world which has causal effects on us and our senses, and in turn, we see ourselves as having the power to causally modify the world around us through our actions. Very little of what we do and talk about would make sense without this basic understanding.

Sense perception is a causal process we commonly believe in, at least as far as our simplified cognitive models are concerned. We think that the external world acts upon our sense organs, modifies them, and as a result, we apprehend the shapes, colors, motions, etc. of what surrounds us, physically or socially. We treat sense perception as a process that yields its intended outcome—i.e. representing our surroundings—*unless* some unexpected causal failure occurs. Thus, we typically believe in a principle along the following lines:

Perceptual presumption. If we perceive that p, then p obtains, *unless* the unexpected occurs.

The principle of perceptual presumption offers a rationale for why we think we know the propositions '*Mark has hands*' and '*this is a red lamp*.' They are true in our simplified cognitive models of reality and they are the result of what our sense perceptions tell us about the world out there. On the other hand, heavyweight propositions such as '*Mark is not a brain-a-vat*' or '*this is not a blue lamp which appears red because of a rare optical illusion*' bring us beyond our sense perceptions. No sense perception can tell us anything about the truth of heavyweight propositions, and thus, the principle of perceptual presumption does not apply to them. Heavyweight propositions bring us beyond our commonsensical understanding of reality, just like lottery propositions bring us beyond the realm of inertial processes. This, at least, is my proposal for explaining our asymmetry in knowledge attributions.

Some might object that although sense perceptions cannot tell us anything about the truth of

[26]For instance, although we could be brains-in-a-vat, Hilary Putman (1982) famously argued that attempting to articulate or assert such possibility goes beyond our linguistic and conceptual abilities. Along similar lines, Tyler Burge (1993) argued that although the deliverances of our senses could be deceiving, we have a *prima facie* entitlement to believe them. Such entitlement is grounded in the fact that our conceptual and linguistic abilities are inevitably rooted in the deliverances of the senses.

heavyweight propositions, reasoning and inference suggest that heavyweight propositions must be true, so long as they can be inferred from ordinary propositions. I agree—and this objection brings us to our final topic: the role of epistemic closure and its reconciliation with asymmetry.

8 Bracketing, switching, and bounded resources

My account of our asymmetry in knowledge attributions rests on a simple idea. We conceptualize the world in different ways, depending on whether we entertain an ordinary proposition or a lottery/heavyweight proposition. In one case, we think of it as mainly governed by predictable inertial and causal processes (e.g. earning a stable income; perceiving our surroundings); in the second case, we step beyond our commonsensical understanding of the world and we are suddenly more aware of the role chancy processes and far-fetched possibilites play (e.g. lottery drawings; unexpected inheritances; skeptical scenarios). I've illustrated how these different conceptualizations of the world affect our knowledge attributions, but I've said little or nothing to explain how they cohere together. I do so in this section.

I've already pointed out in section 3 that our assertions are variable and not fixed. This variability should apply to our knowledge attributions as well. Consider the proposition '*I will not be able to afford a luxury vacation*.' In normal circumstances, we think that the truth of that proposition depends on how much the speaker earns or keeps in her bank account. In particular circumstances, however, our knowledge attributions might be more restrictive. For example, suppose we are aware that the speaker might soon be promoted or that she is venturing into a possibly profitable investment; then, we might refrain from taking ourselves to know the proposition in question and wait for further information. The shift in our epistemic attitudes toward the same proposition is presumably triggered by the fact that the incidence of chancy and unpredictable processes, such as a possible promotion or a monetary gain resulting from a financial investment, became more prominent.[27] All in all, the degree to which an event or state of affairs *is regarded as* the outcome of a

[27]Here is another example. In normal circumstances, we think we know the proposition '*John car is parked around the corner*' provided John parked his car around the corner. Normally, a car parked in a certain location will remain where it is until the owner moves it; in determining the location of the car, the inertial process is typically thought to take priority over the chancy process of e.g. car theft. But in a neighborhood that is well-known for a high rate of car theft, if John parked his car there, we might refrain from unproblematically taking for granted that John's car is still parked where he

chancy or unpredictable process affects our knowledge attributions: whenever the incidence of a chancy or unpredictable process on the occurrence of a highly probable event or state of affairs is thought to take priority, we refrain from claiming to know a proposition about the event or state of affairs in question, or else we normally do not exercise such restrain.

Our variability in knowledge claims is explained by how much evidence we have available; as we gain more evidence, our attitudes change. But this is not the whole story, for entertaining certain propositions and not others make us endorse different perspectives. As we have seen, when we entertain ordinary propositions we focus on a different model of reality than when we entertain lottery or heavyweight propositions. What is going on? What might be going on is that we switch from one conceptualization or perspective to the other by "bracketing" and "un-bracketing" aspects of the world. On this picture, when we entertain ordinary propositions, we bracket a number of aspects of the world that may affect their truth or falsity: we bracket e.g. the chancy processes that may falsify them, and we focus on the inertial and causal processes that make them true. The effect of bracketing, instead, is reduced when we entertain lottery or heavyweight propositions because these bring to the foreground their dependence on chancy and unpredictable processes which are the very target of bracketing. The phenomenon of bracketing and un-bracketing is dynamic and continually changing, and it is the result of our need to get by in the world by making it simple and predictable as much as possible.

It is instructive to contrast two standpoints. One is ours, which is *simplified, dynamic and multiple*, in the sense that it brackets and it un-brackets aspects of reality, and it switches from one perspective to another, by first focusing on some aspects, e.g. inertial processes, and then on others, e.g. chancy processes. Call this our *subjective standpoint*. It differs dramatically from what we might call the *objective standpoint*, which is *complex, stable and unitary*, because in it no bracketing or switching occurs.

To illustrate, consider the lottery proposition '*my ticket is a loser*' and the ordinary proposition

left it, provided we are aware of the high rate of car theft. This shift in knowledge attribution is presumably triggered by the fact that the incidence of the chancy process of car theft became more prominent for determining whether John's car would remain where it was parked. Conversely, if John parks his car in a neighborhood with an extremely low rate of car theft or in which theft is unheard of, people might be more willing to flat-out assert that John's car has not been (and won't be) stolen.

'*I will not be able to afford an expensive vacation*' (hereafter abbreviated as *loser* and *unable-afford*). From the objective standpoint, the proposition *loser* describes a more circumscribed state of affairs than *unable-afford*. For, while my lottery ticket is a loser, I might inherit a fortune, suddenly find a considerable amount of money in my bank account, etc. These are all situations that can falsify the proposition *unable-afford*, but not the proposition *loser*. In this sense, *unable-afford* is *more ontologically demanding* on the world than *loser*, and consequently, if *unable-afford* is true, the situations that can falsify *loser* must not occur, so *loser* must be true as well. Importantly, the implication '*unable-afford* implies *loser*' holds unquestionably from the objective standpoint, and this implication is what makes the principle of closure gets off the ground. Let us now turn to our subjective standpoint. While, objectively speaking, *unable-afford* is more ontologically demanding than *loser*, subjectively speaking, the relation is reversed, for we more easily take ourselves to know *unable-afford* than *loser*. It is as though the evidence we (think we) need to assess *unable-afford* is less demanding than the evidence needed to assess *loser*. So, while *unable-afford* is more ontologically demanding on the world than *loser*, it is less evidentially demanding on us. What is going on here? The answer is that when we entertain lottery propositions, we un-bracket a number of aspects which we instead took for granted while entertaining ordinary proposition.[28]

The same applies to ordinary and heavyweight propositions. Ontologically speaking, '*Mark has hands*' entails '*Mark is not a brain-in-a-vat*.' From the objective standpoint, settling the question of whether Mark has hands would seem to require settling the question of whether skepticism is true or false. But from our subjective standpoint, this is not the case. We seem to be perfectly happy thinking that Mark has hands without having solved the problem of skepticism. Although '*Mark*

[28]Another example. Consider the lottery proposition '*my car has not been stolen*' and the ordinary proposition '*my car is parked around the corner*' (hereafter abbreviated as *not-stolen* and *parked*). From the objective standpoint, the proposition *not-stolen* describes a more circumscribed state of affairs than *parked*. For, while my car might not have been stolen, it might have been towed away, fallen down a crack in the road, blown away by a hurricane, etc. These are all situations that can falsify the proposition *parked*, but not the proposition *not-stolen*. In this sense, *parked* is *more ontologically demanding* on the world than *not-stolen*, and consequently, if *parked* is true, the situations that can falsify *not-stolen* must not occur, so *not-stolen* must be true as well. Importantly, the implication '*parked* implies *not-stolen*' holds unquestionably from the objective standpoint, and this implication is what makes the principle of closure gets off the ground. Let us now turn to our subjective standpoint. We saw that, objectively speaking, *parked* is more ontologically demanding than *not-stolen*. But subjectively speaking, the relation is reversed, for we more easily assert and take ourselves to know *parked* than *not-stolen*. It is as though the evidence we (think we) need to assess *parked* is less demanding than the evidence nedded to assess *not-stolen*. So, while *parked* is more ontologically demanding on the world than *not-stolen*, it is less evidentially demanding on us.

has hands' is more ontologically demanding, the same proposition is less evidentially demanding. The reason for this, once again, is that we adopt a subjective standpoint point in which we switch from one perpective to another. In the case of '*Mark has hands*' we focus on our commonsensical view of reality, whereas when we entertain '*Mark is not a brain-in-a-vat*' we are suddenly brought to entertain skeptical scenarios of various kinds.

I should briefly say that my account is a *contextualist* one in many respects. First, I believe that different conversational contexts are governed by different epistemic standards, e.g. I believe that the standards in science and in our everyday life are different. Second, I believe that depending on the task at hand and on what is at stake, we construct different cognitive models and gather more or less extensive evidence to support such models. Finally, I believe that depending on the proposition we entertain, we are led to focus on certain aspects rather than others, e.g. sometimes we are led to disregard unexpected events or other times we are led not to disregard them. At the same time, however, I also believe that our knowledge attributions must exhibit *some invariability*. What is invariable is that we take a proposition p to be known so long as it is true in the simplified cognitive model which we take to be adequate.[29]

Beyond being partly contextual and partly invariantist, my account is primarily an attempt to take seriously the idea that our cognitive resources are bounded; that whenever we entertain a proposition, we can only examine a finite number of aspects and variables. Our human, bounded rationality inevitably forces us to switch from one perspective to another, because we are unable to embrace an all-compassing, God-like perspective on the world. My discussion on heavyweight, ordinary, and lottery propositions is an illustration of the phenomenon of "perspective switching" which is closely related to the fact that our cognitive resources are bounded.

9 Non-monotonic logic

It is now time to sketch a formal framework that can solve the tension between asymmetry and epistemic closure. The standard framework that is used in epistemology consists of classical logic

[29] Along similar lines, John MacFarlane has recently proposed a semantic of knowledge ascriptions which is partly contextualist and partly invariantist; see MacFarlane (2005).

augmented with modal operators such as 'knowledge' or 'belief.' This formalism, however, is too rigid, and unsurprisingly, it triggers a tension between asymmetry and epistemic closure. Here I suggest that we adopt a formal framework based on non-monotonic logic. This will allow us to dissolve the tension, and at the same time, maintain (a weaker version of) epistemic closure.

Classical logic is monotonic. This means that if a conclusion follows from a set of premises, it will still follow even from a larger set of premises; non-monotonicity denies that. Monotonicity works well e.g. in modelling mathematical proofs: once a theorem is proven, it should hold no matter how many more premises are added. Monotonicity might also be a plausible constraint to describe events and states of affairs from the objective standpoint of what goes on in the world: if an event occurs at a certain time, then its occurrence at that time is given once and for all. In everyday life, however, it is more appropriate to draw tentative conclusions. For instance, as a pragmatic matter, I should tentatively conclude that I will not be able to afford an expensive vacation, given a number of premises, although such conclusion may turn out to be false in light of additional premises. While in monotonic logic proven conclusions are stably true, in non-monotonic logic proven conclusions are only tentatively true; they are true only until new premises come into play which may render them false. Given this background, it is not surprising that non-monotonic logic is better suited than monotonic logic to model the phenomenon of bracketing and switching. Let us see how this works.

I suggested that we interpret an ordinary proposition ρ as 'ρ *unless the unexpected occurs*.' If we were in classical logic the connective '*unless*' could only be interpreted in terms of a negated antecedent. In other words, the expression '*unless* φ *occurs*' (with φ some proposition) would simply mean '*IF* φ *does NOT occur*.' In non-monotonic logic, instead, we can give '*unless*' a more intuitive meaning, namely: φ is presumed to be false until proven otherwise.[30] This logical interpretation of '*unless*' fits well with what I have been suggesting in this paper—i.e. that when we entertain an ordinary proposition, we tacitly assume that we did not win the lottery; that we did not inherit a fortune; that we are not systematically deceived; that we are not brains-in-a-vat; etc. Crucially, we simply tacitly assume certain things without any directly supporting evidence. Non-monotonic

[30]The semantics of *unless* boils down to *negation as failure* in logic programming; see **?**.

logic offers a natural framework to formalize the idea that we take certain things for granted; we assume certain occurrences not to occur *unless* the unexpected occurs.

But what is the unexpected? In this paper, we have seen two instances of an unexpected event. It could be an event or a state of affairs that has a low degree of probability *and* it is the result of a chancy process. Examples are: winning the lottery, having one's car stolen, suffering a sudden heart attack. In addition, unexpected events could also be those that result from a far-fecthed scenario beyond our commonsensical grasp of reality. Examples are scenarios in which we are brains-in-a-vat or in which we are systematically deceived by our sense perception. Now, recall that lottery propositions are typically about events that are the outcome of a chancy process and are highly probable. Thus, they express the negation of an unexpected event: losing the lottery, having one's car not stolen, not suffering a heart attack. By the same token, heavyweight propositions also express the negation of an unexpected event, for a proposition such as '*Mark is not a brain-in-a-vat*' expresses the negation of the far-fetched, unexpected scenario in which humans are brains-in-a-vat. As a consequence, in interpreting an ordinary proposition ρ as 'ρ *unless the unexpected occurs*,' we can also be more explicit and say that an ordinary proposition ρ should be interpreted as follows: 'ρ *unless* the negation of a lottery or heavyweight proposition (or some other proposition about an unexpected event) obtains.'

Let us look at an example. Suppose Jack takes himself to know that he will not be able to afford a luxury vacation. On my account, Jack takes himself to know that he will not be able to afford it *unless* the unexpected occurs. Next, suppose Jack reasons that, since he will not be able to afford a luxury vacation, his lottery ticket must be a loser. To be sure, however, he can only claim to know that his ticket is a loser *on the tacit assumption that* the unexpected does not occur. This means that he can only claim that his ticket is a loser *unless* his ticket is not a loser; this is a mere tautology, much different from the more interesting statement that his ticket is a loser.

The moral is that we should always be wary that many knowledge attributions are conditional on the tacit assumption that unexpected events do not occur. As we draw inferences from the propositions we take ourselves to know, we should not forget the tacit assumptions on which they rest: any inference that amounts to the statement or denial of those tacit assumptions—e.g. an

inference from an ordinary to a lottery proposition—must be blocked; in all other cases, knowledge attributions can happily grow by means of reasoning and inference. Thus, a weaker version of epistemic closure could be as follows:

> *Non-monotonic epistemic closure.* If, at time t, a subject S is in a position to know $p_1, p_2, \ldots$, given certain tacit assumptions, and S competently infers q from $p_1, p_2, \ldots$, then S is in a position to know q at a later time t', *unless* q is entailed by any of the tacit assumptions at time t'.

The reader will have recognized that this new principle of epistemic closure is structurally similar to the weaker principle of conversational closure from section 4. The remarks I made there are applicable here as well. First, one can check that the principle above allows for knowledge claims to grow by reasoning and inference. For instance, if we are in a position to know p_1 and in a position to know p_2, by the principle of non-monotonic closure we are in a position to know the conjunction $p_1 \wedge p_2$ and the disjunction $p_1 \vee p_2$, provided we do not "overstep" beyond our tacit assumptions. Secondly, we should not forget that our tacit assumptions change over time. The reason is that new knowledge claims may be about the tacit assumptions behind other previous knowledge claims. If we view the process of knowledge acquisition dynamically, our tacit assumptions can become the explicit topic of a new knowledge claim. When this occurs, some assumptions switch from being in the background to being in the foreground, and consequently, they should not be counted as tacit assumptions any longer.

10 PROBABILITY AND COGNITIVE MODELS

Let me recapitulate my argument. My account of our asymmetric epistemic attitudes across ordinary, heavyweight, and lottery propositions invoked the notion of a simplified commonsensical cognitive model, constituted by causal and inertial processes. On such a model, I argued, an ordinary proposition turns out to be true, whereas a heavyweight or lottery proposition does not. I have also argued that, in order to reconcile asymmetry with epistemic closure, we should endorse a weaker principle of epistemic closure, based on non-monotonic logic. This weaker principle takes

into account the phenomenon of cognitive bracketing, and at the same time, can allow for knowledge claims to grow by reasoning and inference in some cases.

I wish to conclude with a few tentative remarks on how my approach differs from those based on probability and statistics. From this paper, a natural picture of how we take decisions and make plans emerges. Suppose we want to get on the other side of the street. What we do is to look right and left, make sure that no car is coming, and finally decide to cross and reach the other side of the street. To plan and take the decision to cross, presumably, we begin by collecting evidence and construct a simplified model of the situation and of how it will develop in the immediate future. It will be an inertial model, one in which cars or planes do not unexpectedly materialize themselves in the middle of the street; it will also be a causal model because the act of walking, together with a number of assumptions (clear street, no cars coming, etc.) is expected to yield a certain outcome, possibly the desired outcome of reaching the other side. In making the decision whether to cross the road, we begin with a model M_0 at time t_0 and we consider the action *cross*. Now, if the addition of *cross* to M_0 yields the desired outcome *reach-other-side* at some later time t_1, then we go on to cross the street; if otherwise, we wait until a later time and perform the same assessment with an updated model of the situation.[31] In short, the picture of decision-making I am proposing can be summarized as follows:

> First, given available evidence E at time t_i, construct model M_i of situation at time t_i in relation to intended outcome ω and action α.
>
> Next, if the cognitive computation of "M_i *plus* α" yields the intended outcome ω, then do α, or else reconsider.

This way of looking at decision-making will sound overly simplistic, especially for those who are sympathetic to statistical decision theory. There is no mention of probabilities nor utilities. In statistical decision theory, given the agent's evidence, a certain action is more or less likely to yield a certain outcome, and an agent associates to a certain outcome a degree of utility. Further, in

[31] A model M_i at time t_i is what as agents we take to be true at some point in time. Our models are constructed as a result of the evidence we have about the world around us and they change over time because our evidence changes. Models also change depending on the decision to take, on what is at stake, or on the intended outcomes, and consequently, some models are more or less specific and detailed, more or less carefully constructed on the available evidence.

statistical decision theory the norm is to choose the action which maximizes expected utility, i.e. the sum of the utilities of each outcome weighed by their probability given the action in question.[32]

Experiments have shown that people do not always maximize expected utility, so statistical decision theory is at least not always descriptively correct.[33] What the about the picture of decision-making based on intertial causal models? Extensive empirical investigation would have to be carried out to prove its descriptive adequacy. Leaving this for another time, here I want to emphasize that the picture I am proposing can be easily augmented with probabilities and utilities, and also, statistical decision theory implicitly relies on inertial causal models to get off the ground. The probabilities of outcomes or their utilities can be assessed only on the basis of a simplified model of a particular situation of interest. Probability and utility assignments make sense only within a set of simplifying assumptions about a situation. For instance, we are used to think that the probability that I win the lottery if I buy a ticket is 1 over n, where n is the number of tickets, provided the lottery is fair and only one ticket wins. But this probability is the result of a simplification. What if there is no lottery drawing? What if the lottery suddenly disappears? We typically assume that these things do not happen because we form inertial causal models of the situation at hand. In these models, lotteries are fair; they stay in place; lottery drawings happen; one ticket wins; etc. Within such models, the probability of winning is indeed 1 over n, but otherwise it would be some other value, which is ultimately impossible to estimate. In short, probability and utility assessments become intelligible and possible only within intertial causal models.

But there is more. If we need to begin with an inertial causal model of the situation anyway, it is not obvious that it is cognitively worthwhile to start assessing utilities and probabilities. In some cases, this might be advisable, but in others it might not. The process of utility and probability assessment might take too long or be too laborious, and thus people might in some cases do away

[32] The picture underlying statistical decision theory is as follows:

> First, given evidence E at time t_i, assign a certain utility U to outcomes ω and $\neg\omega$, and also, assess the following probabilities: $P(\omega|\alpha)$; $P(\omega|\neg\alpha)$; $P(\neg\omega|\neg\alpha)$; and $P(\omega|\neg\alpha)$.
> Next, do α if it maximizes expected utility, i.e.
> $U(\omega)P(\omega|\alpha) + U(\neg\omega)P(\neg\omega|\alpha) > U(\omega)P(\omega|\neg\alpha) + U(\neg\omega)P(\neg\omega|\neg\alpha)$,
> or else reconsider.

[33] See the seminal work by Tversky and Kahnemman (1974).

with utility and probability assessments. In these cases, they would follow the simple two-step procedure which I illustrated above with the example of crossing the street. I think that the ordinary propositions with which I began this paper depict situations in which it would be too laborious to come up with exact utility and probability estimates. These situations are best modeled by means of commonsensical intertial causal models.[34]

[34]For another argument to the effect that probability estimates need to rely on more basic models and heuristics, see Williamson (2009).

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