

On Deductive Inference

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[Draft - Comments Encouraged]

Despite its centrality to logic, it is surprising how little foundational work has been done on the topic of deductive inference. Even though there is some work on the question of what is an argument and what makes an argument deductive, no similar work can be found when we turn from argument to inference. There is a lot of work in both cognitive psychology and epistemology regarding the nature and justification of different sorts of inferences: deductive, inductive, causal, to the best explanation, etc. However, there is little work on the more basic question of what is an inference¹ and when is an inference deductive rather than inductive, abductive, etc. These are questions that have not been properly addressed in the literature.² Here, I will offer an answer to these questions and perhaps start a similar debate regarding inferences.

The issue is not idle, for it directly bears on the question of what normative standards to apply to which inferences. Good deductive inferences need to be valid; inductive inferences, not.³ Without a clear line dividing deductive inference from other sorts of inferences, we run the risk of misdiagnosing the rationality or logical status of our

1. Since their hypotheses tend to be existential, they are content with using paradigmatic examples like conscious uses of *Modus Ponens* like the one described further ahead in the paper.

2. For example, even though the title of Paul Boghossian's article (2014) is "What is inference?", what he is actually interested in is just a peculiar kind of inference, closer to what is commonly known in cognitive science as "reasoning" (Marcier and Sperber 2011). Cf. Wright (2014).

3. From now on, in order to avoid confusion, when I talk of validity, I will mean *deductive* validity.

inferences. Besides this main philosophical concern, the question is important, among other reasons, because of its relevance to a lot of well-known epistemological issues like the characterization of ideal epistemic agents, the justification of inferential knowledge, the closure principle and transmission failure. It would be hard to properly settle these discussions without a clear understanding of what are we talking about when we talk of deductive inference. Given the lack of such precision in the philosophical literature, one must be open to the possibility that, maybe, there is no such single thing as deduction, and that different discourses and traditions might mean something different by that term. Perhaps what the logician means when she talks of deductive inference is not the same as what the epistemologist means when she uses the same term. Yet, before embracing such pessimist conclusion, one must be careful to determine whether there is something that satisfies both our pre-theoretical intuitions and theoretical presuppositions about deduction, as a cognitive process. The goal of this paper is precisely to determine what is that we, humans, do when we engage in deduction, leaving aside for the moment the also important question of whether other (plural, artificial or non-human animal) agents are also capable of deduction or not.

The paper is structured in two parts: the first one deals with the issue of what is an inference. There, I will defend the hypothesis that an inference is a causal process where an initial cognitive state causes another in such a way that the causal translation depends essentially on the content of the involved states. In other words, in an inference, a mental state A causes another B, partially because they have the content they have. Based on the conclusion from the first part, I will develop an account of deductive inference in the second part of the article. In order to achieve this, I will start by setting the stage and

developing four constraints that an adequate account of deductive inference ought to satisfy. Then, I will present six different hypotheses that one might propose to characterize inferences of this kind. I have divided the proposals in two groups, the first one – which I will call the “logical proposals” – assume that whether an inference is a deduction or not depends exclusively on the content of the mental states involved in the inference, while the second – which I will call the “cognitive proposals” – reject the aforementioned assumption and instead recognize that extra cognitive information is required to determine whether an inference is a deduction or not. I will evaluate each proposal in turn, according to whether they satisfy the constraints introduced at the beginning of this second part. As a result of such evaluation, I will conclude that only one of the cognitive proposals actually satisfies the four constraints and therefore should be considered to give an adequate characterization of deductive inference.

I. What is Inference?

First, as it has been widely recognized, an inference is primarily a psychological process, one that enables human beings to acquire new cognitive states on the basis of previously held states. However, for such a process to be properly inferential, the informational content available in the initial cognitive state must play an essential role in determining the informational content of the acquired state. Most of the times, the kind of cognitive states we are interested are beliefs, and thus a lot of theoretical work has focused on what I will call *doxastic inferences*, i.e. processes where one acquires a new beliefs on the basis of previous beliefs. Thus, for a belief *A* to be acquired on the basis of a set of beliefs *B* in the relevant inferential sense, two conditions must be met: first, *B* must be a psychological

cause of *A*, either directly or through a chain of other inferences, (Harman 1973, Goldman 1979, Millar 1991, Mercier and Sperber 2011, Boghossian 2014); second, in the process of acquiring *A* on the basis of *B*, the contents of *A* and *B* must play a determinant role, i.e., one must be able to explain why *B* psychologically caused *A* by invoking (among other things) the contents of *A* and *B*. From now on, when I talk about inference, I will mean doxastic inference, even though what I have to say here must be easily extendable to other sorts of inferences.⁴

What this two-conditioned account of inference tries to capture is the common intuition that when one infers *A* from *B*, her belief in *B* is not only cause (first condition) but also reason (second condition) for her believing *A* (Boghossian 2014, Wedgwood 2006, Pollock and Cruz 1999).⁵ The inclusion of each condition is necessary to exclude non-inferential causal relations among beliefs. Empirical research has shown that the psychological causal relations between our cognitive states extend far beyond those of inference. Cognitive processes that share cognitive resources can causally affect each other,

⁴. This means that even though the cases of deductive inference I will explore in the rest of the paper all involve acquiring new beliefs by deduction, I am not assuming that all deductions result in the acquisition of a new belief (Cf. Harman 1989 and Wright 2014).

⁵. For a belief *A* to be inferred from a second belief *B*, belief *B* must be in principle available (even if not necessarily to the agent itself from a first person perspective) as a reason for the agent to believe *A*. Thus, in the example ahead, María's belief about her mom was not inferred from her beliefs about flowers because these do not provide her with reasons to believe that it had been a long time since she last called her mom. Notice that this condition does not require that all inferences be conscious. That is why the accessibility condition is required only in principle. Most of our cognitive states and processes are not only unconscious but inaccessible even from a third person perspective. Thus, this condition could be re-formulated as follows: If a (rational) agent were to know that the agent *S* held the belief *B* before acquiring *A*, then *S* could rationally explain why *S* believes *A* by appealing to her belief *B*. Notice also that, even though necessary, this third condition is not enough by itself. Cases of rationalization are cases where beliefs are given as reason even though they are not the ones that actually caused the belief in question. Thus, causality is also a necessary condition.

not inferentially, but by restricting access to those resources. Engaging in complex reasoning while performing other cognitive tasks usually affects the results of these later tasks. For example, I might misremember a random sequence of letters I try to memorize while performing another complex cognitive task like, say, performing long multiplications. This way, thinking that 7 times 4 is 28 might cause me to mistakenly believe that the third letter on the sequence was an “R”; yet I would not have inferred this false belief from 7×4 being 28. This means that causality is not sufficient for inference.

Cases like this are excluded by the definition’s second condition. My belief that $7 \times 4 = 28$ caused my misremembering the sequence of letters, yet it was not in virtue of it having the content it had that it had such an effect on my subsequent cognitive state. Any similar complex thought might have strained by working memory in a similar way with very similar effects. Thus, the relation between both mental states, though casual, cannot be qualified as inferential. Requiring that the causal relation be directly psychological aims at excluding other spurious cases, for example those where a belief causes an association or an action which, in turn, directly causes the acquisition of a second belief. My thought that the person sitting at the end of the bar is my former girlfriend might be distracting enough to cause me to spill my coffee on my lap and thus realize that it is scalding hot. This does not mean, however, that what just happened was an inference from “the person sitting at the end of the bar is my former girlfriend” to “my coffee it is scalding hot”. In cases like this, beliefs are causes of other beliefs without there being an inference linking them directly.

Restricting the inferential process to cases where new beliefs are acquired is also important to rule out other non-inferential causal relations among cognitive states, like

associations. Consider the following case: working on her botany homework, María's thoughts on the evolutive function of flowers might remind her of her mom and realize how long has it been since she last called her. In this case, her thoughts on flowers caused María to believe that it had been too long since she last called her mother, yet we do not want to claim that she inferred her belief about her mom from her belief about the evolutive function of flowers, even though the content of her initial belief played a central role in causing her subsequent belief, i.e., if she had been thinking about something else, she would probably not have been reminded of her mom. However, the relevant belief was not actually acquired in the process of association, it was remembered. It went from dispositional to occurrent (Audi 1994).

Now that we have a working characterization of what is an inference, we can move on to our main issue, i.e., what is deductive inference? The first step to answer this question must be to differentiate deductive inference from other kinds of deductions, in particular, deductive arguments and deductive reasoning. In some literature, the word "reasoning" is used to refer to the ability to perform inferences, so that humans are considered to possess reasoning because we have the capacity to infer (Portoraro 2011). However, in much of the cognitive science literature, the term "reasoning" is commonly reserved for a specific sort of inferences, i.e. those where either the goal of the inference or at least some of the initial contents are conscious (Sperber & Mercier 2011, Evans 1993). In this sense, deductive reasoning is a kind of deductive inference, one where either the goal of the deduction or at least some of the initial contents are conscious. Both inference and reasoning (as a subset of inference) are psychological processes. Arguments, in contrast, are complex speech acts, by which agents present evidence in favor of a thesis (Groarke

2012). Thus, what I am interested here is neither in deductive reasoning, nor deductive argumentation, but deductive inference. The question I will try to answer for the rest of the article is what makes a particular inference be deductive instead of, say, inductive or abductive.

II. What is deductive Inference?

Consider a case where, following my intension to perform a *Modus Ponens* I explicitly reason from my belief that p and my belief that p entails q to a belief that q in such a successful way that, thanks to my good schooling, there takes place in me a causal process the terms of which are mental states whose contents, taken together, conform to *modus ponens*. Indeed, having explicitly aimed to guide my thought in accordance with *modus ponens*, there takes place in me a causal process leading *from* my desire so to so guide my thought, my belief that p , my belief that p entails q , and my belief that *modus ponens* prescribes that I come to believe q , to my coming to believe q with the certainty that my deduction warrants, taking my beliefs in p and the entailment from p to q to support this new belief. [Adapted from Johnston 1988, 87]. There is no doubt that I have just performed a deductive inference: I have competently deduced q from my belief that p and my belief that p entails q . Examples like these are completely uncontroversial. It is also highly uncontroversial that not every deductive inference is quite as explicit and conscious as this. It seems very clear that before we started formulating explicit rules of deduction, people were already performing deductions, so some features present in these non-controversial cases must be eased to get an appropriately broad conception of deduction. The open question regards exactly how much and exactly what can be removed while

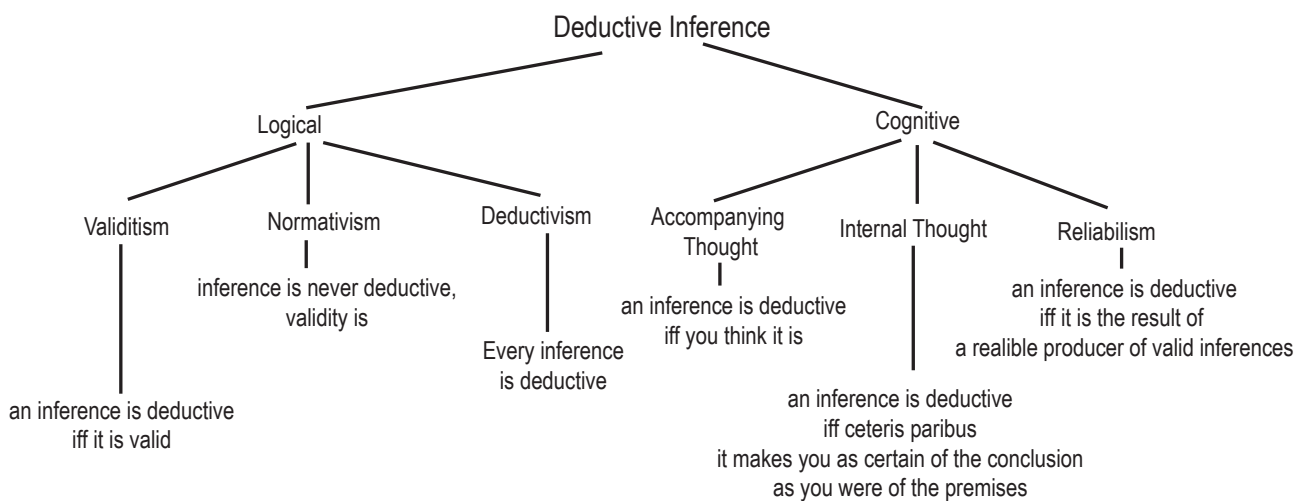
staying within the realm of deductive inference.

Before getting into the different proposals we will discuss in this paper, we must say at least a little bit about what criteria we will use to judge whether a competing characterization of deductive inference is satisfactory or not. With this purpose in mind, here are some *prima facie* desiderata any satisfactory account of deduction ought to satisfy:

1. Sometimes, when we engage on inference, we deduce, i.e., the phenomenon of deductive inference is genuine, it is something we sometimes do.
2. Not every inference is deductive, i.e., there are abductions, inductions and other sorts of non-deductive inferences.
3. There is normativity to inference, i.e. some inferences are flawed, while others are fine (in the sense that rationality is incompatible with too many flawed inferences) so that a good deduction (but not a good abduction or induction) must be (at least) deductively valid.
4. Knowledge (and probably other epistemologically valuable beliefs like justified, or warranted beliefs) can be sometimes extended through valid deduction (Kvanvig 2006).

As I mentioned before, the question of what makes an inference deductive is one that has not actually been raised in the philosophical literature, thus I have compiled the following list of competing hypotheses borrowing heavily from the current debate surrounding the notion of deductive argument. On this basis, I have divided the proposals in two main sorts: *cognitive* and *logical* proposals. The basic tenet of logical proposals is that whether or not an inference is deductive or not depends exclusively (at most) on the

contents of the initial and acquired beliefs, and not on any accompanying thoughts or features of the underlying cognitive process or mechanism.⁶ Cognitive proposals, in contrast, consider that accompanying thoughts and features of the underlying cognitive processes and mechanisms play a substantial role in determining whether the inference in question is deductive or not. Let's see each sort of proposal in turn:



A Logical Theories:

Validitism. The simplest logical proposal takes “deductive inference” to be synonymous with “deductively valid inference.” Following Weston (1987) Salmon (1973) and others, we may take an inference from B to A to be deductive iff it is deductively valid, i.e. if A follows with logical necessity from B.

Normativism. After Skyrms (1975), Hitchcock (1980) and others, we may say that inferences are neither deductive nor not. Deductivity refers primarily to a way of evaluating an

⁶. Including both what Boghossian (2014) calls the inference’s “taking condition” and any other accompanying epistemic feeling or emotion (Arango-Muñoz 2014).

inference. But just as we can evaluate an inference deductively, we can evaluate the very same inference from different normative standpoints: inductively, abductively, from the standards of probability theory, etc. Thus, an inference can be deductively valid or deductively invalid, but not deductive itself (Govier 1987, 37).

Deductivism: Finally, following Groarke (1999), we may also want to say that all inferences are deductive, i.e.. that the best way of evaluating an inferences necessarily involves evaluating its deductive validity.

Logical proposals have the virtue of providing a relatively easy to apply criterion for determining whether an inference is deductive or not. In validitism, since validity depends exclusively on the propositional content of the beliefs involved in the inference, once determined the content of the relevant beliefs, it is relatively easy to determine whether one follows deductively from the others or not. and thus whether the inference is deductive or not. Normativism and deductivism propose even simpler criteria, given that for them either all inferences or no inferences are deductive. Unfortunately, no logical proposal satisfies the four constraints presented above. Normativism and deductivism violate constraint (1) and constraint (2) respectively. Normativism violates constraint (1) by making “deductive inference” a misnomer. Deductivism, in turn, violates constraint (2) by making every inference deductive. Validitism, however, fares a little better. Since performing a deductively valid inference is neither a trivial nor an impossible task, Validitism satisfies criteria (1) and (2).

On the other hand, whether any of the logical proposals satisfies criteria (3) or not is not as easy to determine. Notice that, since validity is built into the definition of deductive inference, in validitism, the very notion of an invalid deduction becomes a contradiction in terms. Yet, it remains true that good deductions must be valid (otherwise, they would not be deductions). Thus, constraint (3) is satisfied by validitism after all, albeit in a trivial way. The same can be said about deductivism. Whether or not this respects the spirit of constraint (3) depends on whether it demands the existence (or, at least, the possibility) of invalid deductions.

To illustrate the difficulty in determining whether the logical proposals satisfy constraint (3), consider a new example similar to the uncontroversial deduction above. Once again, following my intension to perform a *Modus Ponens* I explicitly reason from a couple of my beliefs, but I mistake their logical form – so that they are not of the form p and p entails q , even though I treat them as such in my reasoning, resulting in an inference that fails to be a *Modus Ponens* and, furthermore, where the content of the acquired belief does not actually follow from those of the causing beliefs. Even if not valid, it is hard to reject the intuition that the inference I just performed was a (failed) deduction. However, according to normativism and validitism, no such failed deduction took place. Thus, neither of them satisfies constraint (3).

Furthermore, normativism and deductivism also go against our widespread intuition that some inferences are better suited to deductive evaluation than others and thus that when we deductively evaluate some inferences (but not all), we are not just imposing some external normative constraint on the inference, but actually evaluating it in its own terms, i.e., evaluating whether it accomplished its intrinsic goal or function (or at

least one of them). Consider the following example: Walking along the beach, you see what looks like a picture of Winston Churchill in the sand. Without even considering that, as in the opening pages of Hilary Putnam's (1981), what you see could actually be the trace of an ant crawling on the beach, you infer that someone intentionally drew a picture of Churchill in the sand.[Adapted from Douven 2011]. According to normativism and deductivism, what you just performed was an invalid deduction, just as in the case of the mistaken *Modus Ponens* in the example above. However, it seems like the two cases must be diagnosed differently and that the notion of "deduction" must play a role in diagnosing such difference. In other words, it seems natural to me to say that the difference between the mistaken *Modus Ponens* and the later inference is that, while the former is a flawed deduction, the later is not: it is an altogether different sort of inference, an abduction, i.e. an inference to a best explanation.

The intuition that considering only the contents of the initial and acquired beliefs does not seem enough to determine whether an inference is a deduction or not can be further strengthened by considering cases where a belief with a certain content can be inferred both deductively and non-deductively from beliefs (or from the same belief) with the same content. Consider someone who infers from her belief that she is drinking champagne that she is drinking a French wine [Adapted from IEP 2003]. Has she performed a deductive or inductive inference? It is hard to give a definitive answer considering only the contents of the beliefs involved. One can argue, for example, that if her concept of *Champagne* includes that of *French wine*, then what she has performed is a

deductive (material) inference, but not otherwise.⁷ However, this would require including extra information that goes beyond the contents of the initial and acquired beliefs.

One could try to defend the logical proposals by appealing to some inferential analogue to the notion of “enthymeme” in argumentation theory. The strategy would be to claim that there is some missing information or some other implicit or hidden content not taken into account, and depending on what that information is, the inference might be a deduction (if, for example, in the Champagne case the missing information includes something like “All Champagne is French”) or not (if the missing information includes something like “All the Champagne I have had so far is French.”) Consider the following analogous example: You happen to know that Tim and Harry have recently had a terrible row that ended their friendship. Now someone tells you that she just saw Tim and Harry jogging together. From this, you infer that they made up and are friends again. According to deductivism, the same inference would better be described thus: You happen to know that Tim and Harry have recently had a terrible row that ended their friendship. Now someone tells you that she just saw Tim and Harry jogging together. The best explanation for this that you can think of is that they made up. You conclude that they are friends again. (Douven 2011) Just as in the beach example above, it seems like the more complete (and deductively valid) description of the inference would require ascribing to you the extra belief that the much simpler, and therefore (you think) much better, explanation for what you saw on the beach is that someone intentionally drew a picture of Churchill in the sand. But even though there are good reasons to believe that we commonly under-describe the beliefs involved in our inferences, the real issue is how to determine whether these

⁷. On the notion of a material inference, see Sellars (1956) and Brandom (1998).

beliefs actually played a role in the relevant inferences in a way that is not question begging for deductivism (Garmendia *forthcoming*).

Cases like this motivate searching for other criteria for determining whether an inference is a deduction or not, criteria that go beyond the content of the causing and acquired beliefs. I have labelled proposals of this kind as “cognitive” for they incorporate extra cognitive elements. The main intuition behind these other proposals is that, describing an inference mentioning only the contents of its input and output beliefs, one has not said enough to determine whether such inference was a deduction or not. Thus, different cognitive theories recover different elements already present in the uncontroversial case presented earlier in the text.

B. Cognitive Theories:

Accompanying though proposals. Following Black (1967), Copy (1972), Vorobej’s (1992) and others’ proposal for defining deductive arguments, we could say that an inference from A to B is deductive iff it is accompanied by one or more thoughts (beliefs, acceptances, intensions, etc.) to the effect that A deductively follows from B . These thoughts could be of different kinds: they could be second order thoughts about either the deductive nature of the inference itself or about the logical or epistemological link between the first order belief states involved, or they could be first order thoughts about the entailment relation holding between A and B , maybe something like thinking that it is impossible for A to be true without B being true as well. The accompanying thoughts may even be thoughts about the certainty or tentative nature of the conclusion. Any inference accompanied by any of these thoughts seems to be deductive; in particular, it is somehow

flawed if the content of the acquired belief does not follow deductively from the content of the initial beliefs. Thus, it seems fairly uncontroversial that some accompanying thought of any of these kinds is a sufficient condition for deductivity. The relevant issue, of course, is whether this is also a necessary condition.

A major reason to reject accompanying thought proposals has been put forth recently by Boghossian (2008, 2014) (and Wright 2014). They have showed that if every deductive inference required an accompanying thought of some particular sort *S*, such that *S* was present only in deductive inference, a vicious regress would ensue. Boghossian's argument is complex and thorough, so I will not reproduce it here. Its main insight is that for an accompanying thought *S* to play this role, it has to be somehow *about* the deductive link between the contents of its initial and acquired states. In other words, for a thought *S* to make it that an inference from *A* to *B* deductive, it has to be about the deductive entailment relation between *A* and *B*. However, it is not clear how one could reach a thought about *A* deductively entailing *B* *prior* to deducing *B* from *A*.

Implicit proposals. A way out of Boghossian's problem can be to allow for something like implicit conditions that do not amount to an extra intensional state. For example, we can adopt a characterization of an inference from *A* to *B* as deductive if and only if as a result of the inference, the agent's degree of belief in *B* increases in accordance to our normative theories of subjective probability regarding deduction. So, for example, if, as a result of inferring *B* from *A*, one is not certain of *B*, even if one is completely certain of *A*, then the inference just performed cannot be a deduction, even if *de facto* *A* follows deductively from *B*. Thus, explicit thoughts, though sufficient for deductivity, are not necessary. Under this

new proposal, we can include invalid deductions like the mistaken *Modus Ponens* above, and rule out abductions like the aforementioned examples. Thus, it satisfies requirement (3). Furthermore, it is not vacuous in a way that would fail to satisfy constraints (1) and (2). Not every *Modus Ponens* is a deduction.

It might seem that we have finally found the characterization of deductive inference that we looked for. However, one might still have one final caveat regarding constraint (3). Consider a case, similar to the non-controversial case above, but where, thanks to my bad schooling, I lack some of the necessary skills to guide my reasoning in accordance to the basic rules of first order logic. I am mistaken both about what rules I should follow and I also regularly make mistakes about the logical forms of my own beliefs. Suppose I mistakenly take *affirming the consequent* to be a valid rule of deduction. Now, consider a case where, by a strange twist of fate I mistakenly believe that, in my belief that if A then B , B is the antecedent and A is the consequent. Thus following my intention to perform an *affirmation of the consequent* I explicitly reason from my belief that A and my belief that A entails B to a belief that B . Thus, thanks to my bad schooling, there takes place in me a causal process the terms of which are mental states whose contents, taken together, conform to *modus ponens*. Indeed, having explicitly aimed to guide my thought in accordance with *modus ponens*, there takes place in me a causal process leading from my desire so to so guide my thought, my belief that A , my belief that A entails q , and my belief that *modus ponens* prescribes that I come to believe B , to my coming to believe B with the certainty that my deduction warrants. Yet, have I performed a deduction? According to the cognitive proposals presented this far (and the logical ones too), the above inference is a valid deduction. However, most epistemologists today would reject

the claim that an inference like this would transmit knowledge, i.e. it seems pretty intuitive that even if the person who performed the inference knew both that A and that if A then B , she would still not know that B . Thus, what do we make of these non-knowledge transferring valid inferences? Are they deductions or not? I think it is safe to say that we do not have strong intuitions in this regards. Thus, we need to explore each possibility and find reasons to decide one way or the other. So far, we are left with two options, either to say that inferences of this sort are not deductions or to say that they are, albeit of a flawed sort. In what is left of the paper, I will try to show that the former option has enough undesirable consequences that it would be better to embrace the second horn of the dilemma – i.e., that an inference is deductive if and only if as a result of the inference, the agent's degree of belief in the content of the acquired state depends on her degree of belief in the content of the initial state in accordance to our normative theories of subjective probability regarding deduction – and accept that some valid deductions do not transmit knowledge.

In order to find a way out of our dilemma, notice that the previous hypothetical inference is a case where one makes many mistakes, yet ends with a deductively valid inference. In other words, we can characterize problematic cases like these as cases of *lucky validity*. How do we avoid such lucky cases? A fairly obvious proposal would be to adopt some sort of reliabilist solution. Just as epistemological reliabilism is motivated by concerns of epistemic luck, i.e. we might want to adopt some kind of cognitive reliabilism to exclude cases of lucky validity from deduction:

Reliabilist proposal. An inference is deductive if it is performed through an inferential mechanism or belief forming process that reliably produces valid inferences.

Empirical evidence amply shows that, given the right circumstances, we are pretty reliable at making deductively valid inferences, even when we are not explicitly following valid deduction rules (Mercier and Sperber 2011), thus it seems very psychologically plausible that at least some of our cognitive mechanisms and processes reliably result in deductively valid inferences. It is very tempting, therefore, to hypothesize that what makes an inference deductive or not is whether it is the output of a deductive cognitive mechanism, i.e., one that reliably outputs deductive inferences.

As attractive as this cognitive proposal is, it shares with epistemic reliabilism the usual problems resulting from the difficulty of individuating cognitive mechanisms and processes (Goldman 2011). According to the predominant theories of cognition – both theories of massive modular architecture and dual process theories –, one can acquire the same belief, based on the same beliefs, through different processes (and most likely, through different mechanisms as well). This makes it very hard to determine what belief has been produced by which (or by which kind of) mechanism or process. Without this information, it is very hard to determine both whether a mechanism or process is reliably producing deductively valid inferences and whether a particular inference has been performed by one of those mechanism or processes.

However, the reliabilist proposal faces a further and more substantial problem: it fails to account for what would seem uncontroversial cases of actual deduction. Thus, it is not materially adequate. Consider the already mentioned case of mistaken *Modus Ponens*.

On the face of it, it is a (non valid) deduction resulting from a process that is *not* reliable in producing valid inferences. After all, misapplying a deductive rule at the personal level is not a reliable way of coming up with deductively valid inferences. Yet, we want this sort of flawed deductions to still be deductions. Thus it seems that reliabilism is too restrictive as a characterization of deduction. But how do we make justice to the reliabilist intuition without embracing full on reliabilism? The proposal I want to put forward here is to say that reliabilism is right about something: a valid deduction that is not the result of a reliable producer of valid deductions is still a flawed inference (and that is why it does not transmit knowledge), but its flaw is not that it is not an actual deduction, but something else that must be required of a good deduction. Notice that constraint (3) states that validity is a necessary, but not necessarily sufficient condition for good deduction. It seems that reliabilism has identified a further condition that should also be expected from a good deduction— which following Williamson (2002) we might call “competence”. In other words, validity is not the only virtue of good deductions. There is a further virtue that makes a difference between those valid deductions that transfer knowledge, from those that do not. Thus, we can complement condition (3) to restrict knowledge transmission to competent valid deduction and allow for non-competent deduction, i.e., just as we have deductions that are not valid, we must also allow for deductions that are not competent. This would explain why lucky validity is epistemically different from competent validity and only this later sort of validity transfers knowledge.

Once we realize that some deductions are flawed because they are not valid, and others are flawed because their validity is the result of luck, the *implicit* proposal above no longer seems counter-intuitive and we can embrace it as a good characterization of

deduction: An inference from A to B as deductive if and only if as a result of the inference, the agent's degree of belief in B increases in accordance to our normative theories of subjective probability regarding deduction.

III. Conclusion

In this paper, I have raised and tried to answer two questions that I consider have not been properly raised and address in the current philosophical literature: what is an inference? and when is it a deduction? regarding the first question, I have advanced a characterization of inference where, for a belief A to be inferred from a set of beliefs B , B must be a psychological cause of A , either directly or through a chain of other inferences, and in the process of acquiring A on the basis of B , the content of B must play a determinant role. Regarding the second question, and after considering several alternatives, I have defended the claim that an inference from A to B is deductive if it is accompanied by one or more thoughts (beliefs, acceptances, intentions, etc.), explicit or implicit, to the effect that A deductively follows from B . Thus, some inferences are deductive, even if they are not valid, and some deductions are still flawed (they do not transmit knowledge), even if they are valid.

REFERENCES

- Arango-Muñoz, Santiago (2014), "The Nature of Epistemic Feelings", *Philosophical Psychology* 27 (2): 193-211.
- Audi, Robert, (1994), "Dispositional Beliefs and Dispositions to Believe", *Noûs* 28(4): 419-434.
- Black, Max, (1967), *Encyclopedia of Philosophy*, MacMillan, New York.
- Boghossian, Paul, (2008), "Epistemic Rules", *Journal of Philosophy* 105 (9):472-500.
- (2014), "What is Inference", *Philosophical Studies*, 169: 1-18.
- Brandom, Robert, (1998), *Making it Explicit: Reasoning, Representing, and Discursive Commitment*, Harvard University Press.
- Douven, Igor, "Abduction", (2011) *The Stanford Encyclopedia of Philosophy* (Spring 2011 Edition), Edward N. Zalta (ed.), URL = <<http://plato.stanford.edu/archives/spr2011/entries/abduction/>>.
- Evans, Jonathan St. B. T.; Stephen E. Newstead and Ruth M. J. Byrne, (1993) *Human Reasoning: The Psychology Of Deduction*, Psychology Press.
- Garmendia, Ekain (*forthcoming*), "Semantic Externalism, Rational Explanation, Identity Premises.
- Goldman, Alvin, (1979). "What Is Justified Belief?" in G. Pappas (ed.), *Justification and Knowledge*, Dordrecht: Reidel. Reprinted in A. Goldman, *Liaisons: Philosophy Meets the Cognitive and Social Sciences*, Cambridge, MA: MIT Press (1992).
- Goldman, Alvin, (2011), "Reliabilism", *The Stanford Encyclopedia of Philosophy* (Spring 2011 Edition), Edward N. Zalta (ed.), URL = <<http://plato.stanford.edu/archives/spr2011/entries/reliabilism/>>.

- Govier, Trudy, (1987), *Problems in argument analysis and evaluation*, Doris Publications, Dordrecht/Providence.
- Groarke, Leo, (1999), "Deductivism within Pragma-Dialectics", *Argumentation* 13, 1-16.
- Groarke, Leo, (2012), "Informal Logic", *The Stanford Encyclopedia of Philosophy* (Summer 2012 Edition), Edward N. Zalta (ed.), forthcoming URL = <<http://plato.stanford.edu/archives/sum2012/entries/logic-informal/>>.
- Harman, Gilbert, (1973), *Thought*, Princeton NJ: Princeton University Press.
- Harman, Gilbert. (1989) *Change in View*. Cambridge, MA: MIT Press.
- Hitchcock, David, (1980), "Deductive and Inductive: Types of Validity, Not Types of Argument", *Informal Logic Newsletter* ii(3), 9-10.
- IEP, (2003) "Deductive and Inductive Arguments," *The Internet Encyclopedia of Philosophy*, <http://www.iep.utm.edu/>, retrieved on June 5, 2012.
- Johnston, Mark (1988), "Self-Deception and the Nature of Mind" en McLaughlin, Brian P. (ed.) *Perspectives on Self-Deception*, University of California Press, pp. 63-91.
- Kvanvig, Jonathan L, (2006), "Closure Principles" *Philosophy Compass* 1/3, 256–267
- Mercier, Hugo & Dan Sperber, (2011), "Why do humans reason? Arguments for an argumentative theory", *Behavioural and Brain Sciences*, 34, 57–111.
- Millar, Alan, (1991), *Reasons and Experience*, Oxford: Clarendon Press.
- Pollock, John and Joseph Cruz, (1999), *Contemporary Theories of Knowledge*, second edition, Lanham, MD-Rowman and Littlefield.
- Portoraro, Frederic, (2011), "Automated Reasoning", *The Stanford Encyclopedia of Philosophy* (Summer 2011 Edition), Edward N. Zalta (ed.), URL = <<http://plato.stanford.edu/archives/sum2011/entries/reasoning-automated/>>.

Salmon, Nathan, (1973), *Logic*, Prentice Hall, Englewood Cliffs.

Sellars, Wilfrid (1956) "Empiricism and the Philosophy of Mind," in Herbert Feigl and Michael Scriven, eds., *Minnesota Studies in the Philosophy of Science, Volume I: The Foundations of Science and the Concepts of Psychology and Psychoanalysis* (University of Minnesota Press, 1956), pp. 253-329.

Skyrms, Brian, (1975), *Choice and Chance*, Dickenson, Encino.

Vorobej, Mark, (1992), "Defining Deduction", *Informal Logic*, 14(2&3) 105-118.

Wedgwood, Ralph, (2006), "The Normative Force of Reasoning", *Nous* 40(4): 660–686.

Weston, Anthony, (1987), *A Rulebook for Arguments*, Hackett, Indianapolis.

Wright. Crispin, (2014), "Comment on Paul Boghossian, "What is Inference", *Philosophical Studies*, 169: 27-37.