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Ecological rationality: relational abilities and the post-decisional value of logical reasoning

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Abstract: In this article I introduce the thesis that logical reasoning has a particularly important function as a confidence-boosting device, which acts after a decision has been made and is strictly linked with environmental features of ecological reasoning contexts. To analyse and support this thesis I first argue for the need for a better explanation of the evolutionary functions of reasoning, in light of the *bounded rationality* program and what I call *restricted reasoning* (as opposed to *limited reasoning*). Then, in order to show why it is important to focus on the post-decisional value of reasoning specifically, I briefly introduce my reading of the dual cognitive system developed by D. Kahneman. After having discussed the most influential theories on the evolutionary function of reason, I make my claim about how the development of several relational abilities is both presupposed by this model and a consequence of it.

Key words: confidence-boosting, ecological rationality, bounded rationality, relational abilities, logical reasoning, restricted reasoning, responsibility-sharing, cognitive miser

Introduction: bounded rationality and the cognitive miser.

The term "bounded rationality" was introduced by the economist H. Simon in his seminal work "A Behavioral Model of Rational Choice"[1] in order to paint a clearer picture of how human rationality and the human decision process work. Before the introduction of this notion, decision theory was constructed around the so-called "maximising thesis" (MT), which describes how abstract entities *ought* to make decisions in order to maximise their gain in a variety of situations.

> **(MT):** the goal for a decision maker is maximising the result of a choice by evaluating the possible alternatives that are available and using the proper rules to determine the best possible strategy to obtain that result

The main idea behind (MT) is that only an agent who follows this guideline can be considered rational:

1 - SIMON 1955.

any other behaviour, being intrinsically irrational, cannot be considered acceptable or normative in any way. As shown, (MT) is comprised of three different sub-thesis:

1) the goal is to maximise the possible outcome of a choice (in terms of gain that a reasoner can achieve from an action);
2) in trying to achieve the selected goal the reasoner needs to evaluate all the logically possible strategies and all the information that is available;
3) reasoners need to adhere to rules, specifically rules from game and probability theory and logic, to evaluate the alternative strategies.

All three these sub-thesis are essential in defining the meaning of (MT), but the introduction of bounded rationality has shown that not all of them are intrinsically necessary to define a behaviour as rational. In particular, the last three decades of research in economy, psychology and practical philosophy have clearly demonstrated that humans do not reason and make decisions like abstract models claim they should, favouring quick and flexible strategies over long and mechanical ones. This is perfectly captured by the intuition that humans are to be defined as *cognitive misers*: our computational, mnemonic and logical abilities and resources are limited and we are regularly out-performed by a variety of artificial intelligences. Examples of this phenomenon can be found in activities notoriously mechanical-bound, such as strategic games (e.g. chess) and calculations, but also in more surprising fields, e.g. language and image detection[2]. To overcome these limitations, humans adopt strategies that trade accuracy for ease, and are simply *good enough* when they need to be.

Bounded rationality is the study of how human rationality can be described and defined within the realm of human cognition and capability: it tells us what is *humanly rational*, given the bounds of our cognition. Adopting this kind of consideration on rationality has driven researchers to reconsider the role of (MT): is it still possible to consider someone rational when humans so clearly trespass the limits imposed by (MT) on rational behaviour? In other words, is it possible to consider bounded rationality as not only good-enough, not only good-enough, but, rather, properly rational?

To solve this kind of questions Simon introduced the notion of *satisficing* (a port-manteau of the verbs "to satisfy" and "to suffice"). A reasoning strategy is satisficing (albeit maybe not optimal) if it satisfies a particular goal and is sufficient in a specific context, where not all the information available might be considered. For this reason, (MT) can be modified in a weaker version, i.d. the Satisficing Thesis (ST):

> (**ST**): a decision maker needs to reach a goal that is *good enough*, by evaluating the possible alternatives that are *easily available*, i.e. within the reach of her abilities, and using some *criteria* to determine the strategy that is most *appropriate* in that particular context.

(ST) seems quite reasonable, given that it should describe agents that are inherently limited. The problem of whether we usually follow (MT) or (ST) thus becomes uninteresting. However, there is still a question of whether we really *should* follow (ST). Simon's approach tells us that bounded rationality is a rationality that pertains to limited beings, and thus is not *true* rationality: we might have good enough intuitions, but we should look up to (MT) as the only standard of rationality (which we can never reach). The decision to uphold (MT), even if cognitively unobtainable, has philosophical significance because it is rooted in some very strongly held notions on the normative structure of our reasoning and of our knowledge. In particular, within the philosophical research in logic and epistemology, the need to keep (MT) as a standard comes from the decision to focus mainly on deductive reasoning, modeled with the very clear rules of classical logic. The aim of logicians is to adopt mathematical rigor as the rule on what is to be called good reasoning. On the other hand, omniscience (and, therefore (MT)) has influence on epistemology because this line of research is continuously riddled with sceptical questions (e.g. how could it be possible to have knowledge when there is nothing one can be completely sure of?). In order to eliminate these sceptical claims, epistemology has focused on the concept of justification, which is supposedly what leads our true beliefs to become pro-

2 - An example could be that of deep learning AI used to detect melanomas at an expert level, as shown in SOENKSEN et. al. 2021.

per knowledge[3]. It follows that, in epistemology, (MT) becomes an imperative: all available information must be considered because within this information there might be some that render us susceptible to sceptical observations.

The philosophical approach on the matter, then, seems quite straightforward: we make use of (ST), but our goal should be to use (MT). However, with the contamination of approaches that follows from an interdisciplinary look on phenomena, recently there has been an interesting shift in how the problem has been considered. The introduction of experimental work on human reasoning and decision making has given rise to a heated debate, which, in turn, has triggered the so-called "rationality wars", i.e. theoretical discussions on whether humans can be considered truly rational. All the authors involved in these theoretical wars are proponents of the bounded approach on rationality, but in my opinion they have a radically different way of interpreting the term "*bounded*". In particular, I call one group that of the proponents of "*limited rationality*", and their counterparts as those of "*restricted rationality*". For the purpose of this article, I believe it is interesting to mention these approaches because they have a strikingly different way of understanding the evolutionary functions of reasoning.

Limited rationality: two levels of reasoning

D. Kahneman has been the most prominent proponent of the approach that I call "limited rationality": in his opinion[4] there is a profound difference between rational behaviour, which is very rarely exhibited by humans, and irrational behaviour, which is to be found in our everyday reasoning strategies. With A. Tversky, Kahneman has first become known for his experiments proving that humans are consistently victims of reasoning biases and, therefore, are usually prone to accept information based on criteria of availability and relevance, rather than because of actual structured reasoning. The model developed by Kahneman to describe this phenomenon is that of dual reasoning: our cognitive processes can be divided into *intuition* and *reasoning*, two very different mental processes with a variety of different features. Intuition is quick, un-bound by rules, unconscious, automatic and particularly error-prone. Reasoning, on the other hand, is slow, rule-oriented, prevalently conscious, mechanical (as in "intentionally applied") and usually correct. Such a description has led Kahneman to use the terms "slow thinking" and "fast thinking".

Thinking Fast	**Thinking Slow**
fast	slow
unconscious	conscious
automatic	mechanic
rule-less	rule-oriented
error-prone	correct

The examples given by Kahneman apparently show two things: (1) that fast-thinking is extremely more common than slow-thinking; (2) that fast-thinking is intrinsically linked to activities that are inherently simple for the reasoner. For instance, we think fast when we have to make simple arithmetical calculations (e.g. 2 + 2 = 4), or when we drive a car on an empty road or recognise that a "meek and tidy soul with a passion for detail" resembles an occupational stereotype. We think slowly when we park in a narrow space, compare two washing machines for overall value, fill out a tax form or check the validity of a complex logical argument. Because of our learning abilities, activities that initially require slow thinking become fast-thinking material (e.g. playing a strong chess move, which is considerably easier for a chess master than for a novice). For this reason, it should be obvious that there is no clean cut between fast and slow thinking: it is a matter of how and when cognitive strategies are (or can be) internalised and automatised by a reasoner. However, it is clear that, in Kahneman's opinion, fast and slow thinking can be considered on opposing sides of the descriptive-prescriptive gap: we do think fast, but we *should not*.

3 - Justification is particularly important within the epistemological framework that considers knowledge a "justified, true, belief" because it shows that there is a reason to believe one thing rather than another. If a sceptic were to follow Gettier's lead (GETTIER 1963) and try to show our beliefs are only held by chance, the only solution would be to produce more beliefs that are in themselves justified and that justify the original one, thus creating a justification chain as long as possible.

4 - KAHNEMAN 2011.

Kahneman supports this conception by attributing a secondary role to *heuristics and biases*: in his model these two processes are essentially one and the same[5], i.e. rules of the thumb that can be contingently useful, but are more often than not harmful (and are, therefore, called heuristics when they succeed and biases when they fail[6]). Therefore, although it is not explicit in the author's model, the distinction between fast and slow thinking can be interpreted in a normative light:

Fast thinking	**Slow thinking**
Fast	slow
Heuristic / biases	logical and probability reasoning
predominantly unconscious	predominantly conscious
fairly automatic	effortful
error-prone	precise and effective
what is	what ought to be
coherence-creator	**coherence-striving**

Restricted rationality: the ecological approach

The problem with Kahneman's dual system approach is that there seems to be no criterion that is clear enough in distinguishing what constitutes fast-thinking or slow-thinking, other than our intuitive understanding of the two. Specifically, recent research in cognitive psychology and neuro-philosophy very strongly suggests that the distinction between mechanisms involved in simple tasks and those involved in more complex ones is much more nuanced than expected. In order to prove this thesis it is necessary to show: (1) that heuristics may be more pervasive than thought; (2) that logical/probabilistic reasoning is not only employed in highly complicated activities (e.g. problem solving). The most reliable work on the first branch of the problem is being conducted by the *fast and frugal* research group on rationality, founded by G. Gigerenzer. Their goal is to prove that very often the most effective (and, therefore, most rational) strategy is one that is fast and frugal (i.e. that only takes into consideration a subset of the available data) and employs heuristics. In order to make this point they have developed a series of heuristics, with semi-formal structures[7], that show how to make decisions in uncertain or risky contexts. Their results are impressive, as they have shown that experts usually employ heuristics, rather than more complex probabilistic and logical rules, and that, even when heuristics are used by non-experts, they yield a higher success rate than that of logical and probabilistic reasoning (this is particularly evident for the *take the best* heuristic, which is also the most widely accepted heuristic in the literature on the subject). Showing that heuristics are intentionally employed in complex tasks fills the gap between fast and slow thinking.

The second branch of the problem (i.e. to show how logical / probabilistic reasoning is used in day-to-day activities) has produced a great deal of literature showing that there is such a thing as *logical intuition*: we automatically and unconsciously use logical rules (albeit, maybe not classical logical rules) and we are extremely prone to subconsciously recognise whether an argument is structurally and logically sound or not. Particularly interesting examples of this phenomenon are the ones shown by W. De Neys and G. Pennycook[8]: with a variety of experimental with a variety of experimental conditions, they found found that coherent arguments are statistically preferred to incoherent and fallacious ones. This seems to be in contrast with the very well known result from the selection task developed by P.C. Wason in 1966. His experiment was designed to show participants four cards, each with a number on one side and a letter on the other. The four cards show the following: E, K, 6 and 3. The participants are asked to answer the question "Which card or cards need to be turned in order to verify the statement 'If a card has a vowel on one side, then it has an even number on the other side'?"[9].

5 - This thesis is controversial, as Kahneman does not equate the two. However, the description given to heuristics is somewhat vague and Kahneman's most famous heuristics (e.g. the availability heuristic) can very easily be transformed into examples of biased reasoning.

6 - Kahneman does not explicitly equate the two, but the definitions he uses point to the same phenomenon in different contexts.

7 - Their structures are semi-formal because they are algorithmic, but contain some instructions that are rather vague. For this reason they have starting and stopping rules, which make them effective, but they appeal to the discretion of the reasoner in other points.

8 - DENEYS - PENNYCOOK 2019.

9 - KELLEN - KLAUER 2019.

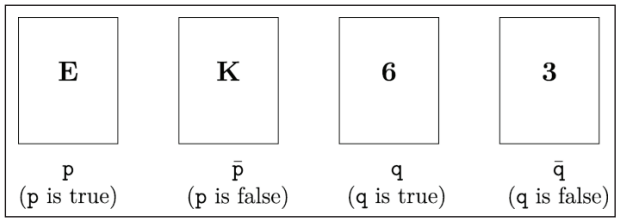

Figure 1.

The correct answer is to turn the cards showing the 6 and the K. However, more than 90% of the participants fail this test. Seemingly, failing to follow such a simple and pervasive rule as a material conditional should suggest that we are intrinsically disconnected from logical rules when we think fast. However it is possible that the incorrect solutions are a matter of interpretation and not of rule-following, as the participants usually interpret the conditional in the rule as a biconditional. For this reason, it does not follow from the results of the Wason Selection Task that we do not employ logic, but rather that there are some *contextual restrictions* to our understanding and interpretation of the data we use.

When mentioning the term "restriction" it is fundamental to describe exactly what is meant by it. In 1982 D. Marr[10] revolutionised the study of brain and cognitive functions by showing that mental activity needs to be studied at different levels (specifically: computational, algorithmic and implementation). Marr's computational level of analysis of mental activity is based on the idea that to analyse a particular information-processing system, researchers need to first focus on the problem that the system solves. From an evolutionary point of view, this is exactly the same as shifting the perspective on the study of vision from "what can the eye / brain, structured as it is, do?" to "what is needed from the eye / brain of an organism that lives in this particular way?". The same shift in paradigm can be applied when studying reasoning. It is fundamental to model not how reasoning can work given our limits (which, as shown, was the main goal of bounded rationality in its origin), but rather what is needed from our cognitive abilities, given the ecological and environmental features of the context we live in. Since the ecological features are specific to each context in which we use our reasoning skills, it is necessary to find what cognitive strategy is most appropriate in each context. By applying this shift we find that rationality, rather than inherently limited, must be considered *restricted*, in the sense that each cognitive and reasoning ability is tied (restricted) to the specific environmental context that has rendered that ability evolutionarily useful. In other words, there can be no talk of rationality *per se*, devoid of considerations on why that particular strategy is adaptive (or at least not harmful) to the reasoner in certain circumstances. Rationality can be described as situational when the goal is to find what means are rational to achieve a particular fixed end. However, rationality seen as *restricted* is not merely situational: it is not a matter of *choosing* the best strategy available in a context, but rather one of recognising that we automatically and unconsciously adopt different types of reasoning in response to our reasoning environment[11]. Moreover, our reasoning environment is made up of informational content[12] and pragmatic constraints (such as time or the *importance* of the topic we reason about in each context): for this reason, rational strategies are dependent on the type of information that is being used.

Pointing out these features of our environment also raises an interesting question on how cognition can be defined. Ecological rationality (here in the form of *restricted* rationality) is generally associated with moderately embodied cognition, i.e. the thesis that rationality and reasoning should not only be linked to representational and abstract features of cognition. If it is necessary to consider the role of environments and ecological needs, then it is fundamental to extend cognition outside the pure representational level, which only takes into account the beliefs that are present in a reasoner's mind. In other words, environments (and all that constitutes them) are not merely *there* during the reasoner's cognitive life, but are *part of that life*. Since it would not be possible for a reasoner to reason *in abstracto*, then the environment is essential. This is particularly true when considering the role of the body in

10 - PEEBLES-COOPER 2015 and RESCORLA 2020.

11 - This is the description of the functioning of logical reasoning that can be found in PIAZZA 2016.

12 - BOYER 2018.

our reasoning strategies. Traditionally, there is no interest in analysing the role of the body in reasoning, as it is generally assumed to have no influence on our reasoning abilities. However, it is clear from Gigerenzer's work, that the formal heuristics and abstract reasoning strategies that we develop are not intrinsically different from cognitive strategies that heavily involve perception and are evidently linked to our bodily abilities. The most notable example is that of the *gaze heuristic*[13], a heuristic that helps birds, pilots and athletes alike understand the trajectories of falling objects: the role of perception in heuristics of this kind, which are based on our vision, becomes obvious. Gigerenzer's approach does not go further than this link between reasoning and our perceptive abilities, however in the next sections I will show how the main thesis of this article could be linked with another, more radical approach: extended cognition. At that point, it will become clear why these considerations on non-representational cognition play a role within this research.

Why we reason: the known hypotheses

The fast and frugal program gives a very clear model of how heuristics work[14], but doesn't say much on the other level of Kahneman's dual system: logical and probabilistic reasoning. The relationship between logical and probabilistic reasoning is somewhat blurry, with some authors maintaining that logical reasoning is nothing more than probabilistic reasoning in disguise[15]. However, in my opinion it is apparent that logical reasoning and probabilistic reasoning are different phenomena which use different cognitive tools: logical reasoning makes do with *all-or-nothing beliefs*, probabilistic reasoning uses *degrees of belief*. The former is structured according to the model "A believes S"[16], the latter like "A believes S with a probability P". A common subtext in the literature on the subject, which is strongly hinted in its name, suggests that all-or-nothing beliefs are the elliptic forms of beliefs such as "A believes S with a probability P = 100%" (or 0%) : this conception is associated with the idea that in logic a belief can either be held or rejected, without other alternatives, because of the excluded middle principle. However, I argue that there are at least three (somewhat obvious) aspects of the matter that need to be considered: (1) there is a difference between the sentence's probability of being true and the degree of probability with which the reasoner holds the sentence, (2) the probability of a sentence being true affects how strongly the reasoner will believe in it, but the reverse does not hold, (3) the excluded middle principle only relates to the truth value of a proposition, without having any influence on the degree of the belief with which it is held. For these reasons I do not accept the mentioned subtext. All-or-nothing beliefs, then, are to be understood simply as beliefs that the reasoner holds, without having necessarily thought about how strongly they are held. As such, all-or-nothing beliefs are absolutely fundamental both in reasoning about our beliefs without taking into account second-level beliefs (i.e. beliefs about beliefs themselves) about them and in communicating our beliefs in a clear and efficient way. Having established that there is a difference between logical reasoning and probabilistic reasoning, it is my choice, for the purpose of this article, to focus mainly on the role of logical reasoning. The first caveat that needs to be made is that when talking about logical reasoning one has to say *which* logic she is talking about. I do not want to commit to a particular logic: following Marr's approach, I hold that the logic of reasoning is contextually dependent. For this reason I simply refer to something that is deductive, mechanical, slow, predominantly conscious and precise, yet bias-prone.

After Gigerenzer's introduction of the notion of *ecological* rationality and its analysis regarding heuristics, it is important to try to make an hypothesis about the ecological application of logical reasoning. This is particularly true for at least two reasons. (1) In Kahneman's model logical reasoning is used for complex problem solving tasks (although he believes it should *always* be used), but since I have argued that there

13 - GIGERENZER - GRAY 2017.

14 - GIGERENZER 2001.

15 - For the debate on the relationship between logical and probabilistic reasoning see LEITGEB 2017.

16 - I here use the terms introduced by LEITGEB 2017, which give rise to an ambiguity between **-belief* (i.e. all-or-nothing-belief and degrees-of-belief, which refers to how strongly a reasoner holds a specific belief S) and *belief* which refers to the propositional content of the belief held. Therefore, depending on the context the term "belief" will be used to mean both things, even though it should only indicate the second.

is such a thing as *logical intuition* and that it goes beyond such complex activities, it is necessary to say what lies in that *beyond*. (2) Intuitions cannot be communicated, as they require to be immediately understood by reasoners with a certain expertise. For this reason, language and communities seem to play no part in intuition (excluding, of course, forms of practical and tacit knowledge). They do, however, have an extremely big role in logic and argumentation, with philosophical argumentation having originated directly from public speaking. For this reason it is especially important to understand what links reasoning abilities and society, and this task has not yet been done in the previously mentioned models.

If logical reasoning is to be conceived as a strictly verbal activity, intimately connected to the ability to use language, as it is normally understood, the context of application of reasoning has to be found primarily, but not exclusively, within settings that are themselves language-related. Most theories on the evolutionary role of human reasoning posit that it emerged as an adaptive tool in collective social settings. As to *why* exactly it might have emerged, the hypotheses are many and fairly well supported.

(1) *Cheater-detection tool*: L. Cosmides and J. Tooby[17] showed that reasoners did not respond homogeneously to different kinds of information when presented with various versions of the Wason Selection Task. They found that people respond much better to stimuli where the context is one where a member of their community is cheating them. For this reason, they postulated the existence of a cheater-detection mental module and they identified the evolutionary function of reasoning in cheater-detection. This model is corroborated by a great deal of empirical evidence and it is extremely selective in attributing a function to reasoning: in talking about *one* mental module it only analyses one specific way logical reasoning works. The value of this model is that it finds a specific context of application of reasoning strategies. However, it ignores all other contexts and it suffers from the problematic theoretical consequences of the theory of mental modules.

(2) *Lie detection*: J. Dessalles[18] holds that the improvement of shared knowledge cannot be the main function of reasoning. Since biological creatures are by nature selfish, Dessalles agrees with Cosmides and Tooby's analysis and holds that reasoning could plausibly have been selected to help them detect lies within their community. Reasoners are prone to detect inconsistencies within belief-sets when they are operating with logical rules. The strongest feature of this model is the fact that its collective nature is apparent both in the historical origin of reasoning and in its social value: it is based on the idea that biological entities are selfish, but it shows that lie-detection is advantageous both for the individual and for its community. While theoretically convincing, however, the notion of inconsistency-detection is questionable: often enough we are affected by biases which create coherence within our reasoning processes, and these biases must first be explained.

(3) *Self Justification*: the model developed by H. Mercier and D. Sperber[19] is referred to as the "*argumentative theory of reasoning*". It employs the concept of *my-side bias* and collective correction to demonstrate that the main function of reasoning is self-justification. The two authors very strongly support the idea of a dual system of reasoning, where logical reasoning is strictly conscious, and the claim that most of our decisions are taken completely unconsciously. Reasoning, therefore, in their opinion must have a very limited[20] role in our lives, and it must be a specifically *social, post-decisional one*. A my-side bias (a particular version of the well known *confirmation bias*) is precisely the bias that forces reasoners to defend claims that they hold, have held or believe to have held. Citing experiments where people have exhibited the my-side bias and have tried to justify all their choices, even unconscious ones, in a logical way, Mercier and Sperber derive that logical reasoning is essential in protecting the reasoner's reputation from the critiques of other reasoners. While this model is one of the most fascinating ones from the point of view of its originality, it might suffer from a lack of consideration of the social properties and social functions of reasoning: it is nurtured by the idea that reasoning emerged socially, but it

17 - COSMIDES-BARRETT-TOOBY 2010.
18 - DESSALLES 2011.
19 - MERCIER-SPERBER 2011, MERCIER-SPERBER 2017.
20 - Limited in terms of pervasiveness and not of value.

does not show any obvious collective gain that logical reasoning would create.

(4) *Intention-alignment*: A. Norman[21] developed his model on reasoning as a way to critique the argumentative theory of reason. His claim is that thinking about a strong dichotomy between heuristics (or, rather, a vague unconscious reasoning as Mercier and Sperber argue) and logical reasoning is detrimental in the understanding of the pervasiveness of the latter in our everyday life. Furthermore, being a socially adaptive strategy, reasoning cannot only be fruitful to the individual reasoner, like it seems to be in Mercier and Sperber's model. Therefore, Norman proposes that we use logical reasoning to communicate and share our intentions, as a way to align them in the community to reach a shared goal. The most effective example that he uses is the one of collective hunting in primates and early humans, which would have necessitated some kind of instrument to decide what to do together. As a consequence, though not explicitly, this model is intrinsically connected with the concept of group decision making. This model follows the line of research that connects the emergence of linguistic abilities to problem solving. A weakness of this approach is that it does not take into account two aspects of group interactions. First of all, reasoning is not necessarily effective enough in driving people together (where brute force, charisma and leadership seem to be more persuasive than good arguments), and this might undermine its role. Secondly, when talking about common goals one needs to take into account that different dynamics emerge depending on whether the goal is communal or individual (even when people work together to achieve it): recent literature, in fact, shows that self-serving incentives to group decision making actually hinder reasoning processes[22]. For this reason it is important to give a more nuanced account of the cognitive role of reasoning that takes into account all these mentioned observations.

21 - NORMAN 2016.

22 - This is how BAZAZI ET AL. 2019 can be interpreted when focusing on reasoning processes (the authors focus on the behavioural side of the problem).

Confidence-boosting and the development of relational abilities

All of these theories have some truth in them: it is not possible to establish clearly which is the main adaptive function of reasoning. Nonetheless it is possible to say that there is at least a pervasive function that is still not accounted for: logical reasoning, as a verbal and structured strategy, works as a ***confidence boosting device***. Confidence, as defined by cognitive psychology[23], is the *feeling of knowing* that is associated with our beliefs. Turning back to what I said about the degrees of belief, all beliefs have a certain degree of stability given by all sorts of processes. When this stability is put to scrutiny by the reasoner (i.e. when the reasoner reasons about why and how much she believes something) this degree of stability can be defined as confidence: confidence, therefore, is a property that can be expressed by second level beliefs that are linked to the first level belief addressed via a logical argument, that, therefore, acts as a confidence boosting device.

> **First level belief**: I believe that the cat is in the garden.
> **(Logical justification)**: If I have seen the cat in the garden it implies that the cat is in the garden. Five minutes ago I saw the cat in the garden. Therefore, the cat is in the garden. {Modus Ponens}
> **Second level belief**: Given my (Logical justification) for my first level belief that the cat is in the garden I believe that the cat is in the garden with a certain degree of certainty, i.e. I have a certain degree of confidence in my first level belief.

Where there is no self-reflection there cannot be confidence, but only an unknown degree of stability: I might be *dispositionally* certain that the cat is in the garden, but have no conscious opinion whatsoever on the matter. Dispositionality is an interesting theme because it allows us to take into account what would happen if a reasoner were questioned about her beliefs. Being dispositionally aware of the fact that the cat is in the garden means that, when questioned, the reasoner will become aware of her, previously nonexistent, belief about the cat.

23 - NAVAJAS, BAHRAMI, LATHAM 2016.

Mechanisms that produce both stability and confidence can be of various nature, mostly psychological, however there is a very specific way we interact with our beliefs that involves logical reasoning and that has a precise effect on our confidence. When we use logical reasoning we find how propositions interact and can be combined with each other, as well as the logical consequences that can be derived from them. This activity creates a net of beliefs that are connected in a structured way with each other, thereby inserting the original belief in a specific place within the net. A well connected belief is obviously much more stable, as the net needs to be reconfigured completely if the belief does not hold. For this reason, be it obtained by heuristics or logical /probabilistic reasoning, building a logical argument is the most effective way to boost our confidence in a particular belief, because it is intrinsically *normative and necessitating*[24] (i.e. it tells us which connections are well-formed and have to be necessarily accepted, and which are inconsistent). Because of our confirmation biases[25] we are not very good at decreasing the confidence in our beliefs: for this reason logical reasoning is apparently usually employed to give stability to our *preconceived* beliefs. As shown in figure 2, we make decisions quickly and unconsciously and, being part of a social community, we are intrinsically motivated (**m**) to defend them (and the associated beliefs). Because of our motivation (**m**), we engage in self justification, which, following Mercier and Sperber's model of argumentative reasoning and the previous example, can be achieved through logical justification. This justification creates second level beliefs which express a certain degree of confidence (**C**) in our original beliefs. Of course - since we have created new beliefs (specifically, a whole new level of beliefs) through self-justification, we have a *my-side bias* and we live in a social setting - we are again and again motivated to justify ourselves and our beliefs to others *without ever changing them*. This, as a consequence, boosts our confidence (**C**) in our beliefs more and more in time (here shown in progressing times 1, 2 and 3).

This model seems catastrophic from a normative point of view, as it seems to create an obstacle to self-correction. However it is obvious that creating wider belief-nets, with more connections, can minimise the importance of a single belief in favour of other alternatives. Since logical reasoning is used in creating many of these connections, it follows that it may also have a role in decreasing the confidence in a particular belief (which still needs to be investigated). The mechanism of confidence-boosting (and possibly that of confidence-decreasing) is therefore extremely pervasive. It underlies all the dynamics that I described in the previous pages, therefore it might be better to refer to it as *how logical reasoning works* rather than one of its particular functions.

The value of this model is that it is intimately connected with collective decision making, but it does not necessarily presuppose it. Of course, when more people are involved in reasoning (which becomes *collective* reasoning) the model seems more optimistic, as, when there is a *group incentive* (i.e. when the "prize" for the collective reasoning is dependent on the result of the group as a whole and then equally distributed) the reasoners collaborate and bring forward new claims (which the individual model did not account for). The idea is that the process does not change from what I have just described, but, since the stakes are high and reasoners are incredibly susceptible to other reasoners' mistakes, it will be possible for other people in the group to falsify claims that have been brought forward and to bring forward new ones. The process, shown in

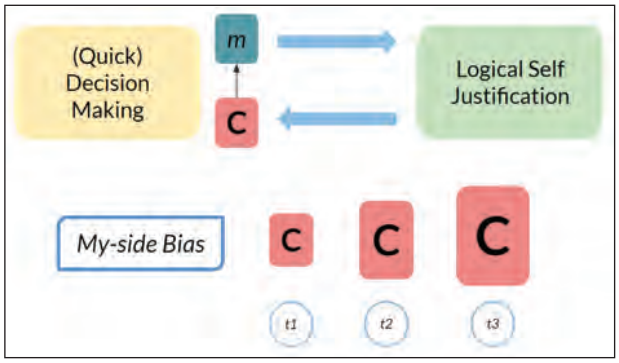

Figure 2.

24 - It is exactly this normative and necessitating character of logic that make it the best tool available for confidence-boosting: the more an argument is logically unimpugnable the more it is convincing, as it has been shown again and again in the literature on the subject.

25 - MERCIER-SPERBER 2017 claims that there is no statistical difference in the pervasiveness of the confirmation biases within the general population, therefore it is not true that educated people are less touched by the phenomenon.

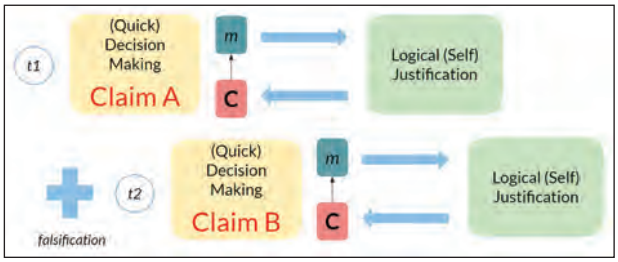

Figure 3.

Figure 3, then stops when there seems to be no external or internal falsification to a particular claim.

In a social context a confidence boosting device is necessary to justify ourselves, to align our intentions and to share the responsibility for our actions, which has been shown to be one of the driving forces behind group-decision making[26]. Responsibility sharing is particularly important in human cooperation because, while there are means to persuade and control other people that do not necessarily employ reasoning, it is fundamental to have a way to determine who is responsible (and how much) for the well-being of a structured community, and the most effective way is by explaining why people act as they do. Responsibility sharing, furthermore, is a means to unburden the individual from the cognitive and psychological weight of his own agency, rendering him a productive member of a community. The model of logical reasoning as a confidence-boosting device, then, is not only based on the assumption that our reasoning abilities are evolutionarily dependent on our social environment, but is also descriptive of how our relational abilities (e.g. self-justification, responsibility sharing, social argumentation) are formed and structured.

Furthermore, there is a growing body of evidence to empirically and theoretically support this view on reasoning. First of all, recent research programs are trying to show experimentally that the uttering of conditionals can increase the confidence of listeners in the consequent of the conditional given the antecedent[27]. It has also been demonstrated that, when decisions have been made unconsciously, it is possible to observe a modulation of the degree of confidence in already made decisions[28]. Something similar was demonstrated by J.M. Shynkaruk and V.A. Thompson[29], who show experimentally that the degree of confidence detected immediately after a decision is much lower than when detected after a longer reflection on the answer given. The accuracy does not change, and there does not seem to be a correlation between accuracy and confidence when making a claim, which is consistent with the idea that logical reasoning does not necessarily improve a claim, but mostly has an influence on its stability[30]. This is justified by the fact that more often than not it's a change in the information used that determines a betterment of a claim, rather than the reasoning on the claim itself.

From a cognitive and neurological perspective, furthermore, this is consistent with E. Fedorenko's findings, which indicate that language is primarily connected with information transfer rather than problem solving[31]. Moreover, it is possible to add some considerations about the relationship between cognition and environment, that I introduced in a previous section. As I have already mentioned, Gigerenzer's approach on ecological rationality leads us to move away from purely abstract and representational cognition: it shows that cognition needs to be considered embodied in order for the environment to have a role in it. Logical reasoning as a confidence-boosting device has the theoretical consequence of possibly driving us even further: since reasoning is to be understood as an intrinsically social and collective phenomenon, then the social and collective settings might be understood as *part of it*. In other words, the social dimension of reasoning cannot be considered merely a useful *instrument* that can help reasoners reach good solutions, but has to be seen as constitutive part of reasoning (i.e. there can be no reasoning without it). For this reason, from an historical, evolutionary and theoretical point of view, cognition needs to be *extended* beyond its traditional realm (i.e. the brain, or even the body) to incorporate this noti-

26 - ZEIN-BAHRAMI-HERTWIG 2019.

27 - COLLINS et al.. 2020. The study is still being made and its goal is to test something that is generally just held as an assumption.

28 - NAVAJAS-BAHRAMI-LATHAM 2016.

29 - SHYNKARUK-THOMPSON 2006.

30 - This is also consistent with the results found by BAGO-DE NEYS 2017 using the *two-response paradigm*, i.e. a method that makes reasoners respond twice to the same question in fast succession, first with no time for deliberation and after with time to think.

31 - FEDORENKO et. al. 2011.

on of reasoning[32]. This is particularly important when considering that relational abilities are in themselves both the foundation and the product of the reasoning process (and, therefore, reasoning can never be considered a solipsistic process[33]). It is, thus, not possible to evaluate the complexity of reasoning, and its consequences, without showing its social components from a philosophical and extended perspective.

Finally, this model is interesting because it opens a research direction that has not yet been thoroughly explored, as the most advanced empirical findings on the post decisional cognitive value of logical reasoning are concentrated on the value of conditionals, but not on other reasoning patterns. A possible development in this direction would be to test this model not on individuals, as this has already been attempted[34], but on a group of decision makers that work together.

Conclusion

In this article I have tried to show the possible role of logical reasoning after a decision has already been made within a collective setting. I believe that this thesis has to be considered within an approach that focuses on the *restrictions* of rationality, rather than its limits, because it allows us to concentrate on what has rendered it evolutionarily adaptive. For this reason, ecological (i.e. restricted) rationality is not just the best tool that is available to a *cognitive miser*, but also an appropriate social and collective evolutionary strategy that is intrinsically connected with the development of fundamental relational abilities such as self-justification and responsibility-sharing.

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32 - For the debate on embodied cognition and on the difference between moderately embodied cognition and extended cognition see PETRACCA 2021 and GALLESE ET AL. 2020.

33 - As is demonstrated by MERCIER - SPERBER 2020.

34 - See MERCIER-SPERBER 2017.

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