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Inferential trends towards error, scientific literacy and critical thinking: Pedagogical implications

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Abstract

In this paper I review the thesis set out by Thagard (2011) and some of the ideas taken on again in Thagard and Nussbaum (2014) about the existence of bias or tendencies towards error in human inferential activities, which lead us to make mistakes and move us away from scientific knowledge. I will analyze their main proposals and, specifically, their implications on decision making and on scientific literacy through critical thinking. In particular, I will focus on the revision of motivated inference and inference driven by fear through which the intent is to demonstrate the need for guiding us towards overcoming beliefs so, in this way, we make correct decisions about what we must believe and do in day-to-day and academic environments.

Keywords: motivated inference; inference driven by fear; critical thinking; decision making; scientific literacy.

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Tendencias inferenciales al error, alfabetización científica y pensamiento crítico: Implicancias pedagógicas

Resumen

En este trabajo revisamos la tesis planteada por Thagard (2011) y, algunas de sus ideas retomadas en Thagard y Nussbaum (2014), sobre la existencia de sesgos o tendencias al error en la actividad inferencial humana, que nos llevan a cometer errores y nos alejan del conocimiento científico. Analizaremos sus principales propuestas y especialmente sus implicancias en la toma de decisiones y en la alfabetización científica a través del pensamiento crítico. En particular, nos centraremos en la revisión de la inferencia motivada y la inferencia impulsada por el temor con las que pretende demostrar la necesidad de encaminarnos hacia la superación de creencias para, de este modo, tomar decisiones acertadas sobre lo que debemos creer y hacer en ámbitos cotidianos y académicos.

Palabras clave: Inferencia motivada; Inferencia impulsada por el temor; Pensamiento crítico; Toma de decisiones; Alfabetización científica.

INTRODUCTION

It is undeniable that nowadays diverse higher education entities explain, whether in their curriculum's structure or through their corporate values, the encouragement of critical thinking as an important form of intellectual reflection which contributes to sustaining academic knowledge. These intentions appear to be consistent with the capacities and abilities of reflection, which are required for autonomous and comprehensive learning as essential competences in higher education. In general terms we can, therefore, appreciate that critical thinking is essential for scientific knowledge and the intellectual autonomy of individuals achieved in the development of their analytical and reflexive capacities. However, the way in which the scientific and day-to-day reality is interpreted differs from the ideal of comprehensive thought which is intended in the academic setting. Because of this, it is necessary to pay proper attention to the proposals which emerge from cognitive science,

with respect to the development of human inferential activity and their implications on decision making and scientific literacy through critical thinking. It is in this way that currently research about human reasoning shows that in human thought and in decision making, bias intervenes (Evans, 2003; Kahneman; Slovic and Tversky, 1982). However, the form in which people's rational performance is produced and how this is affected in tasks which imply making decisions is not completely clear.

In this way, diverse positions which try to explain the role of logical regulation and the use of bias in human inferential activity are put forward. These proposals debate the phenomenon of human rationality, trying to resolve the controversies in relation to the application of logical regulation, the use of heuristics or bias and its implications on decision making. Although there is no consensus between the diverse positions, I believe that the constant search for responses enhances the field of research in cognitive science and allows us to find more optimal application guidelines for pedagogical practice.

Bearing in mind the aforementioned outlines, I intend to exhaustively review the controversies proposed by Thagard (2011) and some of his ideas picked up again in Thagard&Nassbaum (2014). Among these, those associated with the proper use of behavioral patterns which avoid the tendency to reason through motivated inference and inference led by fear, the idea that the human mind does not follow the provisions of logic and to his proposal in terms of the disappearance of certain relevant beliefs for the teaching of critical thinking and the scientific literacy of the individuals.

1. THEORETICAL DISCREPANCIES BETWEEN INFERENCE AND ARGUMENT ACCORDING TO THAGARD'S VISION (2011)

From Thagard's point of view (2011), evidence coming from psychology and neuroscience shows that there is not such a great relationship between inference and argument, as theseare based on erroneous ideas about the nature of both. In this sense, Thagard (2011) confirms that philosophical tradition is supported by the common view that inferences are based on arguments and therefore it should be possible to improve human inferential processes by developing in people the capacity to build and value good arguments to avoid fallacies. It is in this way that, for Thagard, philosophers have tended to adopt, starting from Aristotle, the contemporary logic of Frege and Russell to deductive

reasoning as a central model of inference. According to his opinion, this type of reasoning is applicable only in mathematical tests; however, it is not very relevant to understanding how people acquire beliefs and make decisions. Frequently he states that rationality mainly implies using good arguments and identifying bad ones. Thagard (2011) tries to explain an alternative vision to the traditional one arguing in his thesisthe difference that exists between inference and argument. In this way, to reach critical thinking it is necessary to proceed based more on psychological research than on the theories of informal logic. This is, without a doubt, his fundamental assumption and I will focus on the analysis of his proposals starting from this.

In general, in his opinion, the arguments are seen as linguistic entities integrated by a group of sentences set out in series which gradually advance, step by step, following this structure: premise 1, premise 2, premise 3, ... premise n; therefore, conclusion. For Thagard (2011), if the inference were the same as an argument, it would have to have a similar linguistic and serial structure. All this seems to confirm, from Thagard's point of view, that we have wide-ranging evidence from cognitive psychology and neuro-science showing us that inference is a different process. For this reason he suggests that inference is a parallel process and, therefore, not serial. He adds that it is multimodal as it is not based on language and, at the same time, is characterized by being more emotional than cognitive. In other words, by being a parallel process it forces the brain to carry out several processes simultaneously; this means, on one hand, that the representations used by the brain include visual images and not just linguistic representations. Hence, by being emotional, this also implies the integration of psychological evaluations and perceptions. For inference, emotion is as important as cognition, as the brain uses the emotions to assign values to the representations which are crucial for making an important decision or for deciding which beliefs are beneficial. To support his opinions, Thagard(2001) refers to diverse works, amongst which are some of his previous ones, like Thagard(2000, 2005, 2006, 2010), as well as Barsalou (1999, 2009), Clore& Palmer (2009) or, once again, Thagard& Findlay (2011).

The statements of Thagard (2011) regarding the evidence that inference is a multimodal, parallel and emotional process as well as being cognitive, has serious implications for the study of critical thinking. In accordance with this, it is evident that instead of assuming that inferences are based on linguistic arguments, the complex processes which allow people to be successful or to fail in creating beliefs or making decisions must be considered. Finally,

from his view, human rationality does not simply refer to the use of good arguments and to the rejection of the fake onessince, in actuality, the adoption of thought and behavioral patterns is possible, which contribute to satisfying their legitimate objectives in terms of what they believe and what they must do. The fact is that, in his option, a good use of rationality has to be directed towards critical thinking that is capable of provoking the disappearance of certain beliefs that are very extensive in the North American population, like global warming not being a problem, that human beings did not evolve from apes, that according to what Plait (2002) said, the Moon was never really landed on or that the Earth is the center of the universe, and the eradication of less fortunate determined decisions that people tend to make, like smoking, overeating, paying exorbitant interest on credit card purchases or voting for politicians acting in favor of their own interests. Because of this, more than in the fallacies, Thagard (2011) is interested in the inferential tendencies towards mistakes, this being the thought patterns towards which we, human beings, naturally manifest a clear propensity and that, still, often lead us to accept false beliefs and to carry out actions that go against our interests. He is convinced that there are more than fifty tendencies of that ilk, which are relevant for teaching critical thinking. However, Thagard (2011) basically focuses on two: motivated inference and inference guided by fear. I describe in the paragraph below, before going into a detailed analysis and further depth of Thagard's approach (2011), how he conceives of these two tendencies.

2. INFERENTIAL TENDENCIES TOWARDS ERROR: MOTIVATED INFERENCE AND INFERENCE LED BY FEAR

We begin by explaining motivated inference, starting from Thagard's (2011) consideration, who when citing Kunda (1990[1], 1999) tells us that this type of inference is produced when individuals distort their opinions subject to their underlying personal goals. In his opinion, this deals with an emotional bias which is detrimental to rationality and which can be seen in many types of practical and interpersonal judgments. However, motivated inference must not be confused with an untrue argument similar to an illusion such as: if I want something, therefore, something is true. In addition, he tells us that the motivated inference implies, for people, a detailed and selective revision and an evaluation of the evidence based on unconscious processes led by emotional considerations, the latter being related to their own goals, these being clearly differentiated, in this way, from the purely cognitive reasoning. Below I have included several examples of motivated inference from the diverse scenarios presented by Thagard (2011, pg. 157). Let's look at them:

Table 1. Examples of motivated inference

SCENARIO	EXAMPLES OF MOTIVATED INFERENCE
Romantic relationships	My lover treats me poorly, but he/she will change
Parenting	My child hates school, but will settle down and straighten out eventually
Medicine	This pain in my chest must be indigestion, not a heart attack
Research	The article I'm writing is my best ever and will get into a top journal
Economics	This rapid economic growth is a sign of a new kind of economy, not a bubble

In all of these cases Thagard (2011) thinks the inference is based on limited evidence. However, for many people the conclusion seems plausible because it meets their goals. And this is, fundamentally, so because motivated inference is based on wishes, not on facts. In Thagard's opinion (2011), motivated inference proceeds mainly from unconscious mental processes rather than explicit reasoning. From his point of view, to overcome this research in the field of psychotherapy can help more than disciplines like informal logic, since the identification of the conscious and unconscious goals that individuals havecan decisively influence their neutralization. From this principle comes the way of remedying motivated inference, as the identification of conscious and unconscious goals is required to explain the reasons why people are inclined to adopt beliefs in spite of overwhelming evidence against them.

In the case of inference due to fear it seems, according to Thagard (2011), that this is somewhat paradoxical, as it does not cause subjects to create something they desire but something that terrifies them. Thagard and Nussbaum (2014) give an example of the case of Othello, lead character of Shakespeare's classic of the same name, who is guided based upon weak evidence to conclude that his wife, Desdemona, has been unfaithful. Even though Othello is deeply distressed by this belief, he

cannot help being more and more convinced by this assumption, which he does not want to be true. Othello's conclusion is an example of inference due to fear, where people believe something although only the events they fear are true, while at the same time fearing they are true. In this way, the authors conclude that people feel inclined towards this paradox which implies believing only what they least want to believe. Thagard (2011, pg.159) also gives us examples of this type of inference in different scenarios. We have chosen some of these:

Table 2: Examples of inference motivated by fear

SCENARIOS	EXAMPLES OF INFERENCE MOTIVATED BY FEAR
Romantic relationships	My lover looks distant, so he/she must be having an affair
Parenting	I haven't heard from my teenager for a few hours, so he's probably in trouble
Medicine	This rash means I have leprosy or some other serious disease
Research	The editor's delay in responding to my article means he/she hates it
Economics	The economy is doomed to perpetual recession and depression

In this way, Thagard and Nussbaum (2014) comment that inference motivated by fear arises in many areas that are very important for people and that, therefore, generate anxiety. This is the case of the examples presented by Thagard (2011) where cases related with health, the economy, politics, religion, family relationships, studies and research are found. Recognizing that, although using other denominations, some authors like Mele (2001) or Elser (2007) have also referred to this type of inference, Thagard (2011) maintains that inference guided by fear is irrational in two ways, from a theoretical and practical perspective, given that this causes the subject to be both unhappy and to have erroneous beliefs. Thus, it is less suitable for argument-based analysis than motivated

inference because this comes from complex, emotional and parallel psychological processes it is not only linguistic, serial and conscious. Thagard (2011) states that psychotherapy is also more pertinent here than the findings of informal logic, building awareness of the emotional roots of the inferences themselves being also necessary. In this sense, Thagard and Nussbaum (2014) suggest that, for example, if people are helped to understand how their emotions constitute an integral part of the judgment and decision making, they could overcome the problems of irrationality that can accompany the decisions guided by emotionality. Therefore, according to their view, people are more prone to motivated inference if they have a high self-esteem and a positive attitude in life. On the contrary, if they are more pessimistic and have a low self-esteem, they are naturally inclined to make decisions adapting to and being guided by inference motivated by fear.

The most relevant consequences of their approach to the issue that we are considering here seems to be that the human brain does not have clear limits between emotion and cognition and that, therefore, through emotional reaction people can evaluate the situations and be guided in decision making, thus leaving human rational activity relegated. One of the fundamental arguments taken on by Thagard (2011) is based on stating the impossibility of applying rigorous logical rules and principles in human rational activity, as these underlie processes governed by a series of biases that make their application impossible, above all in fundamental aspects of the individuals' day-to-day lives. On reaching this point I believe it is necessary that although I do not subscribe to the contrary, neither do I defend the possibility that logic is the sole and fundamental element that governs human mental activity. However, I am convinced that Thagard's arguments (2011) do not conclusively demonstrate his assumptions, nor do these directly lead to rejecting the thesis that is more or less close to the idea that the human mind sticks to the logic regulation.

3. CRITICAL REVIEW OF THAGARD'S APPROACH

The assumptions defended by Thagard (2011) in relation to motivated inference and inference motivated by fear are based on a theoretical perspective that, in my view, confuses the premises with the inferential conclusions. Therefore, if we consider the beliefs which Thagard (2011) alludes to, not really as conclusions of motivated inferences or those led by fear, but simply as assumptions which the subject accepts as premises, ones which they reason from, it is possible to continue speaking about

logic rationality in the human being. In relation to this, Ithink that it is not difficult to admit that, adhering to examples of Thagard (2011), the beliefs related to global warming being produced on Earth not being a problem, that human evolution did not start from primates, that our child will improve their behavior at school, that I have a serious illness due to a rash that appears on my skin, that the heliocentric theory is correct, are hypotheses that we accept and, from which we reason.

In my opinion, the adoption of beliefs and the constitution of premises to make inferences are based on erroneous information and, therefore, do not mean that people do not use logical inferential processes. In this way, the use of bias and heuristics would only be presented in phases before the inferential action per se and in those where we create hypotheses that operate as initial elements which are restored in the content to which we apply our inferences. This would mean that the arguments and examples set out by Thagard (2011) continue to allow the possibility of making a valid and rigorous logical reasoning after accepting our personal assumptions and those of irrational processes which, without a doubt, take place in human mental activity, not eliminating or impeding making suitable logical inferences. Likewise, I suggest that I do not dispute the idea put forward by Thagard (2011) that the adoption process of beliefs can be parallel, multimodal and emotional. In this sense, I suggest that even if they were, this does not mean that human inferential activity can be illogical and be guided at the margin of the precepts of formal logic solely by bias or, if one prefers, by heuristics.

On the other hand, as we have stated, distinguishing several phases in human intellectual activities does not constitute an artificial or excessively forced way of proceeding with my arguments against Thagard'sstance (2011) with respect to the conclusions derived from motivated inference and inference led by fear. In this respect, I allude to works like that of Almor and Sloman (2000), which show us with their experimental results that, before reasoning logically and inferring, other intellectual processes take place in the human mind, for example, those referring to assimilation and interpretation of the information that is received. However, I indicate that the position of Thagard (2011) is notcompletely wrong in terms of its defense of the parallel, multimodal and emotional nature of the process to acquire beliefs. Nevertheless, in spite of this, we cannot forget that other contemporary epistemologists, admitting the difficulty of setting up a characteristic logic of the processes of discovery and creation, have differentiated these from the inferential activity that takes place starting from and after these.

All of this suggests that, contrary to what Thagard (2011) thinks, inferences are similar to the arguments and, because of this, we can have the structure that this attributes to the latter and that I explained above. Said structure is, clearly, obviously validated by the rule of *modus tollens*, since, in this the premises provide reasons to justify the conclusion and are followed serially from premise 1 ('If A occurs, then B'), through to premise 2 ('Not B') to derive, finally, said conclusion ('Not A').In my opinion, the reference Thagard (2011) makes to support his thesis on the not very advisable decisions that we as people make, could be inappropriate. Among these decisions he names smoking, overeating or voting for politicians that do not work in our interests. Decisions of this nature do not prove anything, in my opinion, with respect to inferential human activity, as individuals can smoke knowing that this is harmful for their health, overeat knowing the dangers of doing so or vote for certain politicians suspecting that they will not improve their living conditions. This is so because by knowing certain pieces of information at a theoretical level, which may have been acquired through logical inferences, does not guarantee that we act practically in terms of these. We can know perfectly what is right and not do it due to laziness or due to comfort. On this point we believe that Thagard (2011) confuses two planes or two areas that are not necessarily identical the one which we know in theory and the one we do in practice.

It can likewise be illustrativein what refers to this point, to consider the suggestions of the dual reasoning theory, which can be found in other works such as Stanovich (1999), Reyna (2004), Inglis and Simpson (2006) or Evans (2008). From this theory it is derived that many conclusions that lead us to make decisions do not come directly from logical deductions or inferences. On diverse occasions and according to the defenders, we do not use our capacities of analytical reasoning. Rather we recur to heuristic capacities, many of them acquired through experience, which allow us to move forward relatively quickly to decision making.

A priori, one could think that approaches like the dual reasoning theory assume a clear support for Thagard's theory (2011), since ultimately they show us the existence of conclusions that are not necessarily the result of an analytical logical thought activity. However, the approach of the dual theory is very different fromThagard's (2011). First of all, the dual reasoning theory does not necessarily assume that conclusions are obtained from non-serial, multimodal or emotive processes. In fact, many of the heuristics which according to their supporters, we can use to proceed from experience and repetition by carrying out activities which,

at the beginning, can be perfectly rigorous from the logical point of view and which, progressively, become automatic. In this sense we can think about situations like those of the first time student who does mathematical exercises or learns a foreign language. At the beginning, they do these activities slowly and in detail, making an effort and using their analytical capacities to a maximum. However, as they become comfortable they build up speed and fluidity until they solve similar exercises in much less time and almost intuitively. This cannot be that different, as I understand it, to the situation of doctors described by Reyna (2004) when they lack experience, they cover all the symptoms in one way or another related with an illness or an infection. Their professional experience can lead them to consider, quickly and without needing important theoretical efforts, certain symptoms as critical, while relegating others to a second plane since although it is possible, their action tends to be pretty limited. In respect to this matter of automation of what is learned in the framework of dual theory, the reading of works like that of López Astorga (2011) can be very enlightening.

On the other hand, the authors who state they follow the dual reasoning theory, as is shown for example in Inglis and Simpson (2006), frequently maintain that analytical and logical reasoning can review and, if necessary, rectify intuitive processes. This means that this theory does not discard the permanent role of a purely logical inference, but that simply it admits it along with this, as another mental system that also operates in the human mind, the intuitive area and that of heuristics, whose results can be corrected at any time by the logical-inferential activity.

Therefore we seethat not even dual theory puts forward a duality consisting of heuristics and logical reasoning in human intellectual activity, authorizing us to reject the logical nature of inference. Starting from what is explained in this section, we can confirm that the arguments of Thagard (2011) are not solid enough to break down the idea that inferential activity follows certain logical guidelines. From my point of view, accepting this thesis implies a double confusion, as it assumes considering premises as conclusions and not dissociating the plane of the theoretical knowledge of the practice action's area. As a result, its approach is not firm enough so as to lead us to admit tendencies towards error in human reasoning, nor does it force us to accept the existence of the motivated inference and of motivated by fear.

To me, his approach also seems to be unjustified in another sense. On confirming, as we have commented, that areas similar to that of psychotherapy can help remove tendencies towards mistakes it can lead

to us stigmatizing to a certain measure disorders to the act of assuming determined beliefs contrary to what is officially established. His proposal is accompanied by the danger that it can be used to discredit discrepant policies or ethical opinions without further counter-arguments. His thesis is that it is not correct to proceed so that we reach conclusions based on our personal objectives or our fears such as quick economic growth being a sign of a new economy, and not of a bubble, or that the economy is eternally dominated by recession and depression. According to my analysis, the assumption of beliefs like these is not the result of a conclusion obtained after an inferential process, but rather an acceptance of premises due to motives that are difficult to explain since we do not have a clear panorama with respect to the processes of discovery or the generation of hypotheses. Gaining clarity about this, the problem may be that if we understand that the behavior of everything that it creates to continue with the same examples, that the quick growth reveals a new economy which is always governed by recession and depression which must be analyzed from those close to the psychotherapeutical point of view, we may be preparing the way to limit true critical thinking and free expression of ideas or visions or reality. It may be very positive that ideas are proposed, regardless of where they come from, with the purpose of reasoning about these and of then contrasting them with the reality.

It is very interesting that Thagard (2011) insists on the role that emotions and wishes can play in human cognitivist activities, but I do not feel it is suitable that, starting from this, a conception is proposed which seems to assume the existence of a single objective reality for everyone that does not accept different aspects or perspectives other than the one being covered.

If it is said that something similar to psychotherapy is required so that people do not consider that a rapid growth of a new economy or that in some economy we are always going to be able to see recessions and depressions, this is, in our opinion, because it is accepted that there is an underlying truth in the economical setting that is independent from our objectives, from our wishes and from our fears. The defense of positions in this direction seem curious to me, in which theoretical positions of this nature are questioned even in the field of physical sciences. It is enough to refer to the interpretation of Copenhagen about quantum theory or to Heisenberg's principle of uncertainty (see Holton, 1962, to illustrate this point) to understand that, for some time now, it is known that physical reality is not independent from the subject observing it, because the latter, in some way, elaborates it in their act of observation.

It is this that demonstrates from what I have explained in the preceding pages, logical inference can be an aspect of human communication unconditioned by the processes of observation and the recording of evidence, which can be tremendously loaded with subjectivity. This is precisely one of the aspects which, in my opinion, Thagard (2011) does not correctly visualize. It seems for him that inferential logical processes, which can be strictly rigorous, are mixed and merged with the adoption of assumptions and beliefs. For me, I reiterate, both processes are different and therefore the logical validity can perfectly coexist with the subjectivity of the beliefs and opinions.

4. CRITICAL THINKING, SCIENTIFIC LITERACY AND PEDAGOGICAL ACTIONS

It is evident from the approach of Thagard (2011) that critical thinking must be understood and studied starting from the approaches of psychological research. According to this, the theories of informal logic must not be resorted to, since the fallacies of human reasoning are rarely committed by people in real situations. His idea is simply that people are prone to a multitude of tendencies towards mistakes that lead human thinking and that have been demonstrated by psychological research. Therefore, critical thinking must be led by overcoming these tendencies towards mistakes, as is the case of the motivated inference and inference led by fear. For example, he suggests that critical thinking requires a psychological understanding of motivated inference plus an understanding of the logical structure of the argumentation. In line with this, according to Thagard, critical thinking requires the motivation of using what is known about the cognitive and emotional processes to improve the inferences about what to believe and what to do.

With respect to scientific literacy, Thagard (2011) confirms that this is an important part of critical thinking, as in his opinion it is impossible to make reasonable judgments about matters like the environment, technology or economic development without a suitable appreciation of the content and of the scientific methods. He suggests that his approach to critical thinking can be a contribution to the scientific literacy project, since this project needs to deal with the structure of scientific knowledge, the nature of scientific thought and the sources of resistance to science, both in general and in respect to particular theories like global warming or the theory of evolution.

Thagard (2011) criticizes that scientific literacy campaigns are frequently led by scientists or sociologists who, in his opinion, are not

aware of the psychological complexity that scientific knowledge involves. In addition, he states that with the basic information about the theories, the scientific information must include an understanding of the nature of the concepts and their representations, as well as a suitable appreciation of the emotional obstacles involved in the science. According to him, the search for scientific literacy needs to adopt a psychologically broad vision of the structure of the knowledge and of the reasoning, along with an in-depth understanding of the cognitive and emotional barriers involved in good scientific thinking.

Thagard'sstatements (2011) in respect to critical thinking and scientific literacy are formulated from his personal vision of science. This can be translated into reductionism which only conceives scientific activity marginalized from subjectivity and close to absolute objectivity. It is given that he believes that it is possible to refine the science of trends and the bias which can be given in the inference. Therefore, in my opinion, he does not bear in mind that scientific activity also covers beliefs, values, prejudices and assumptions of the researchers, above all when the hypothesis of an investigation is formulated.

For Thagard (2011), the way of improving critical thinking in the area of formal education must be in line with the neuropsychological perspective as, according to him, although educators interested in their improvement should continue supporting students in understanding the difference between good and bad arguments, the motivation to use what is known about the cognitive and emotional mental processes and to improve and test inferences about what to do is more important for critical thinking. His criticisms are directed at the idea that giving information does not improve critical thinking, as he states that all learning requires motivation to overcome falsehoods and bad decisions. Therefore, his proposal in the educational setting is only applicable to overcoming falsehoods through the use of emotional abilities, which means that those conceptual contents proposed in formal education will not be enough to overcome the epistemological beliefs of the students who support their decision making. I can say, therefore, in the works of Valenzuela and Nieto (2008), that critical thinking does not primarily work on the basis of acquired automatisms, as it has a reflexive and intentioned nature in which the individual activates and uses cognitive resources, exercises a metacognitive control and applies the rules and logical principles that govern reasoning or over habitual bias that induces mistakes in the reasoning. The acquisition of knowledge is important for the application of critical thinking since, in spite of the fact that the study plans and the

teacher's own bias can have an impact on the epistemological beliefs of the students, it is necessary that the students themselves, on a base of information, are capable of achieving autonomy in their beliefs and can reflect about the diverse scientific and social theories as well as about their own cultural reality. I believe that Thagard's vision (2011) once again moves away from the perspectives of reasoning, and the way in which information is acquired and processed. As it appears, it is centered more on ending the subjective visions and opinions of people by overcoming the emotions implied in the use of inferences. It seems that Thagardinsists on relegating the complex cognitive components implied in critical thinking to a second plane. Intending to broaden critical thinking to the merely emotional setting, as Thagard does, could be a mistake derived from not suitably understanding the setting of the inferential human activity.

5. CONCLUSIONS

In this paperI have tried to make a presentation of Thagard's proposals (2011) in terms of his approaches on tendencies towards mistakes which operate under human inferential activity, as well as a critique of some of his more controversial theses in terms of the use of logical regulation, the differences between inference and argument and, finally, his vision about critical thinking and scientific literacy.The critical revision of his proposals leads me to conclude that, in spite of the reasons that he presents, he does not manage to show that the inferences can be dominated by recurring bias towards error, nor what really happens in the case of motivated inference and inference motivated by fear. As a result, in my opinion, he does not manage to prove that inferences are different to argumentseither. More conclusive tests are needed in this respect, as well as on his ideas about the use of logical regulation on human beings, where although he is right in saying that human intellectual processes are complex, it is precisely because of this that care must be taken in the statements based only on comments and decisions of the individuals. However, it must be recognized in his proposals that the emotional is also a fundamental part of cognition and this can even be so when he mentioned the parallel and multimodal processes. Nevertheless, in the application of emotionality in human inferential activity, his approach is not clear, as he leaves the role of logic in these processes on one side. As I have indicated, the adoption of premises can be done in a first phase and the inferential activity of this in a second one. In this way, it is possible to reach mistaken conclusions making a rigorously logical reasoning. This possibility, therefore, does not imply that there is a lack of logic, but, at

least, of beliefs based on reality that are duly contrasted. These are, from my point of view, the first planes that Thagard (2011) confuses: the one of premises and the one of conclusions.

Nor does he reveal too much to us about the fact that people can make inappropriate decisions. Likewise, there are two different planes, that of theoretical knowledge and that of practical inferences and, in our judgment, Thagard (2011) also superimposes these two planes unjustifiably, as it is perfectly possible that the correct way to proceed is known and that, in spite of this, a different direction is taken. Logic is not necessarily missing when acting in a way that is not suitable or coherent to what is known. Simply by acting in this way, perhaps, maybe voluntarily, what is logical is ignored. With respect to this point, I believe in any case that one is hard pressed to argue that a subject can be seen to be driven to act in a the determined way in spite of being aware that this is not what their reasoning advises.

But what seems to be least appropriate in Thagard's (2011) approach is his opinion related to the point that research in similar settings to those of psychotherapy can help to correct the deficiencies in inferential activities and to eliminate bias leading towards mistakes. These statements are not appropriate, in my view, because they can cause one to think that certain ideas or visions of reality are associated with undesirable psychological states. I think that, in some way, defending positions like this can end up meaning that it is considered that, with a suitable psychotherapeutical treatment, certain opinions divergent from those commonly accepted can be eliminated. Approaches of this type appear to assume an absolute truth and an objective reality about those which cannot be discussed or have diverging opinions. The latter seems to be exactly, as I understand, the assumption which Thagard (2011) adopts, as we interpret that his conception of science is accompanied with conviction of the possibility of reaching an unquestionable truth in which neither values or personal assumptions have even the slightest influence. However, this conviction, plus the result of a solid demonstration seems to be the sign of adhering to a personal epistemological option, concretely, to an objectivist one, which suggests to me that Thagard (2011) himself is led more by bias than by evidence and, ultimately, that he is guided greatly by his own view *a priori* about the matter at hand than by conclusive tests.

On the other hand, his extrapolated ideas towards critical thinking and its teachings appear to be fairly controversial to me. Evidently his vision is unsuitable with in respect to this, as although emotionality is important to aid cognitive processes in academic learning, I do not feel that

the cognitive aspect implied in the acquisition of superior high abilities required in critical thinking should be left to one side. We must bear in mind that the proposals with respect to critical thinking look to work on two components: cognitive abilities and motivational willingness (see Nieto, Saiz and Orgaz, 2009; Nieto and Saiz, 2011). Therefore, I believe that his ideas must not be fully born in mind in the pedagogical setting, as they can throw the teaching-learning processes off balance and aim with this, to partialize and not understand their importance in the generation of knowledge and decision making of the students.

In spite of this, I believe that Thagard's work (2011) also has redeemable and valuable aspects. It is true that, as I have indicated, he confuses the plane of the premises with that of the conclusions, but if we stick to what I have aimed at above and we think that his explanation about the parallel, multimodal and emotional processes can be applied to the setting of adopting beliefs and the formation of premises and not, as he intends, to the extraction of conclusions, he can open up interesting fields for us in the investigation of capacities such as that of creativity and of the formulation of hypotheses. In this way, without necessarily accepting all his assumptions and circumscribing them exclusively to the scenario before the logical inference of acquiring beliefs, we can advance into more complete proposals about the day-to-day human cognitive dynamic and about the processes implied in scientific knowledge. The parallel, the multimodal and the emotional can perform their role in the phases before purely logical deduction, these phases in which the common individual suggests their personal hypotheses and in which the scientist, on their side, proposes conjectures with the intention that these reach the status of scientific. It is in these phases where the values, objectives and fears can exercise their action. However, this does not impede that, later, logical rigor can be done, both to reach conclusions in day-to-day life and to check if a scientific theory has basis.

In summation, it can be said that a fundamental aspect we cannot forget in this matter is that, however much we recur to the logic in the same way, we cannot reach the same conclusions if we start from different premises. Perhaps this is a clear line of research for cognitive science as the genesis of our assumptions and of the creative processes is a topic which we still need to go further into depth about.

Notes

1 In Kunda's opinion (1990), motivation can affect reasoning through the dependence of a partial set of biased cognitive processes, such as: strategies for access, the construction and evaluation of beliefs.

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