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Cultural and environmental changes: Cognitive adaptation to global warming

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Abstract

The present paper uses a methodological and theoretical perspective on cognitive and cross-cultural psychology as its basis. Our research covers an important area: the role of cognition on the human adaptation to global warming. We draw the general hypothesis that human cognition, mediated by culture, can adapt to changes in the environment. However, we believe that accelerated global climatic changes create cognitive vulnerability because culture cannot provide proper knowledge and cognitive tools. We present some results of our fundamental research on cognitive adaptation to climate change from a cross-environmental and cross-cultural perspective. We specifically highlight some preliminary comparative analysis between adults of New Caledonia and Paris on the representation of climate and climate change followed by the human capacity to adapt to this condition. In addition, we provide an intra-cultural comparison on representation of climate, taking into consideration important geographic and climatic differences in France. Preliminary results suggest that culture and environmental experiences have focal impacts on cognitive adaptation. Our findings show that Parisian adults present greater cognitive vulnerability, thus less adaptive cognition. In the light of cross-cultural psychology, we consider that this fact is due, on one hand, to the analytic way of thinking dominated by an urban occidental population and, on the other hand, to the absence of bi-metric representations.

Keywords: cognitive adaptation, cognitive vulnerability, cross-cultural cognitive psychology, climatic change, global warming

The present paper attempts to contribute, within the perspective of cross-cultural psychology, to the growing concern focused on recent climate change by proposing to review human cognitive adaptation to this phenomenon. Human beings, for the first time in their history, seem to modify climatic forces and movements (Hassan, 1992, 2009; Redman, 2004). Abrupt climatic changes can be observed already in the environment and even more substantial modifications are predicted due to global warming (ICPP, 2007). However, different scenarios of climate change confirm that the manner in which these modifications will occur is unpredictable.

At the cultural level, researchers also observe the unpredictability of scientific, political, technological, economic, religious dynamics and initiatives which contribute to the unpredictability of the capacity of resilience of human beings not only at a local but also at a global level (e.g. Crate, Nuttal, 2009; Leary et al., 2008). We consider that recent changes and further provisions of modification in the environment combined with the lack of appropriate

cultural responses can produce cognitive vulnerability, which in turn can accentuate the difficulties of adaptation to recent environmental changes.

Even if some theoretical studies point out the importance of research on the underlying cognitive processes in the understanding of climate changes (e.g. LevyLeboyer et al., 1991; Pawlik, 1991), psychological literature focuses on the perception of climatic risk (Bohm & Pfister, 2000; Sundblad, Biel & Gärling, 2007), behavioral responses to climate change (Nilsson, Borgstede & Bie, 2004; Whitmarsh, 2009) and motivation to mitigate global warming (Whitmarsh & O'Neill, 2010). In didactic science, several articles analyze the individual understanding of climate change mechanisms (e.g. Anderson & Wallin, 2000; Boyes, Stranisstreet & Papantoniou, 1999; Rajeev Gowda, Jeffrey and Magelky, 1997; Rya, Rubba & Wiesenmayer, 1997). These studies argue that climate change is an extremely complex matter and produce real difficulties of comprehension for children, youth and even for adults. In addition, several studies from a sociological perspective, investigate public perception of climate change in relation to behavior, by exploring answers from open-ended interviews or pre-constructed questionnaires (e.g. Henderson-Sellers, 1990; Semenza, et al., 2008). Recently, an increasing number of studies in anthropology present indigenous, local knowledge on climate change in several areas throughout the world (Dube & Sekhwela, 2008; Huber & Pedersen, 1997; Krupnik & Jolly, 2002; Orlove, Chiang & Cane, 2002; Vedwan, 2006). In spite of these studies, to our knowledge, there is not substantial research on how human cognition can handle climatic change and what the role of cognition plays in the adaptation to global warming.

The present paper introduces the theoretical framework of the notion of cognitive adaptation to global warming and puts forward our underlying research model, followed by the presentation of some results from our current empirical studies.

Cognitive adaptation and cognitive vulnerability

We consider that human cognition (understanding, mental representations, conceptualizations, predictions, elaboration of strategies, decision-making) plays an important role and constitutes an essential element in the relationship between human beings and the environment. A large number of studies in archeology, history and anthropology give evidence of the basic role of cognition in the human adaptation process. These studies have enabled us to develop the concept of cognitive adaptation interrelated with the environment and culture. We consider that to understand the capacities of cognitive adaptation of individuals and human groups to global warming, it is necessary to take as a theoretical framework, the historical-cultural approach of cognition (Vygotsky, 1997; Wertsch, 1985, 1991).

We define human cognitive adaptation as a procedure of change in information processing, mediated by culture, to provide better accommodation between the organism and the environment. As such, culture is an active mediator between human populations and their environments. The most adapted cognitive process to the environmental constraints will be retained by humans through a kind of progressive selection. In this way, our approach allows us to integrate the characteristics of the environment where the subject lives, the characteristics of culture, but also the transition between the individual and the group.

From a cultural-historical perspective, we can admit that, individuals and human groups are currently experiencing a situation in which radical climate change is occurring at a reduced time scale and at a global level. Nevertheless, neither the individual nor the culture/society has sufficient knowledge and modes of information processing required to adapt to rapid climate changes. One can already observe cognitive conflicts, difficulties of

comprehension and failure of the strategies of problem solving, in sum, cognitive vulnerability (see for example the conflicts between climate-skeptics and the partisans of the IPCC report (2007)). Cognitive vulnerability is defined as a mental state characterized by deficient information and knowledge as well as by the lack of methods of information processing required in the understanding of climate change. Cognitive vulnerability can be a major obstacle to optimal adaptation. It is therefore necessary to identify the factors that influence cognitive vulnerability either at an individual or at a collective level.

We drew up a theoretical framework (Figure 1) based on our previous research (Katz, Lammel & Goloubinoff, 2002; Lammel, Goloubinoff & Katz, 2008) and psychological models illustrating the reciprocal relationships between organisms, behavior and environment (Bandura, 1986; Wohlwil, 1974). Our model enables one to understand interactions between elements that determine cognitive adaptation as well as to explore variables involved in cognitive vulnerability to deal with climate change.

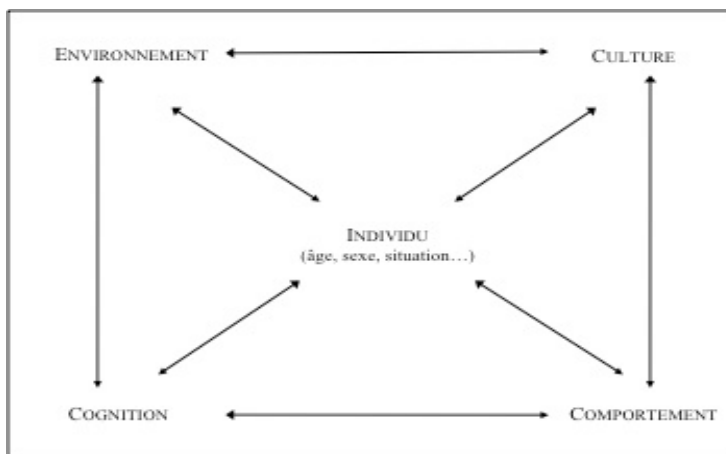


Figure 1. Interactive model of cognitive adaptation

This model integrates the environment, culture, cognition, behavior and the specific characteristics of the individual. The subject is situated at the center and he/she contributes through his/her cognition and behavior to the way in which culture and environment operate. Different components are in constant interaction and constitute a process. Thus, the individual him/herself has an impact on all these elements.

Research project on cognitive adaptation to climate change

In the following section we will present some preliminary results from our research project "ACOCLI". Financed by the National Agency of Research of France, the project ACOCLI, directed by Lammel and Jamet, examines how human cognition treats climate and especially climate change, according to individual characteristics (age, sex, education level) and based on different cultural and environmental contexts.

We believe that climatic conditions and the level of environmental climate risk influence the cognitive adaptation of individuals and groups. Moreover, by taking into account the culture, it is necessary to pay particular attention to inter-cultural differences in cultural backgrounds among the inhabitants of various regions. To address these questions, we selected different sites of study based on weather conditions and exposures to risk in France (Paris, Alpes, Ile de Re) and French overseas territories (French Guiana and New Caledonia).

Our preliminary analysis, based on nearly 600 semi-structured interviews, highlights the importance of cultural differences as well as the influence of environmental characteristics in the organization of knowledge of climate and climate change. The results of the first preliminary analysis already allow us to conduct systematic experimental studies in order to identify the elements of cognitive vulnerability that hinder optimal adaptation.

Cognition, vulnerability and cultural contexts

In the above presented model, the interaction between culture and cognition is an essential factor. In this section, we present some data on the effect of culturally established ways of thinking on the mental representation of climate and climate change.

Our previous research projects in the field of perception and representation of climate and pollution (Katz, Lammel & Goloubinoff, 2002; Lammel, Goloubinoff & Katz, 2008; Lammel & Kozakai, 2005; Lammel & Resche-Rigon, 2007) have demonstrated the importance of systems of thought in the relationship between humans and their environment. Psychological literature (Nisbett, Peng, Choi & Norenzayan, 2001) demonstrates that social and cultural differences between groups do not effect just their beliefs on different aspects of the world, but also their metaphysical systems, their epistemologies and at a deeper level their cognitive processes. Two principle systems of thought can be identified. The holistic way of thinking is based primarily on knowledge acquired by experience and not through abstract logic. The holistic way of thinking takes into account the context as a whole and the relationships of the object with it, explaining and anticipating events from these relationships (Nisbett, 1998; Peng & Nisbett, 1999; Kozakai & Lammel, 2005; Nisbett & Miyamoto, 2006). On the contrary, from an analytical perspective, objects are isolated from their context, and focus is paid to understanding the characteristics of the object to determine its category membership, to explain and predict events from its own rules. Regarding the "object climate", studies in anthropology have shown that traditional societies dominated by a holistic way of thinking consider climate as a whole, whereas in Western societies with an analytic way of thinking, climate is taken as an object isolated from the environment (Sahlins, 1964; Katz, Lammel & Goloubinoff, 2002; Strauss & Orlove, 2003). Since climate and climate change are a holistic and complex phenomenon, we consider that the analytic way of thinking can be a barrier to understanding them and can create cognitive vulnerability in individuals and in societies.

We firstly present, through the analyses of a definitional task, an example concerning the mental representation of climate and climate change. The definition is a fundamental and natural activity. It is not univocal, is not necessarily reversible, and can "take time". There are several ways to make definitions depending on whether the referent is visible or invisible, abstract or concrete (François, 1985). In other words, definitions according to the cognitive approach, can grasp the basic frame of representations. Thus, definitions seem to be good markers to identify the mental representation of concepts, while also identifying cultural differences, particularly between holistic and analytical ways of thinking.

In an open-ended interview, we asked participants to firstly respond to the question "What is climate for you? Secondly, we asked the question "What is climate change for you? Example 1 – (Female 40 years old, mother tongue: Kumak, New Caledonia) *Definition of Climate:* "Climate for me is nature, the seasons and nature, I have no other words to say. In my culture, climate works with culture (agriculture), it works with our lifestyle, our habitat. Climate is also for crops such as yams, all works together. Personally, climate makes it a lot. We have a story in our clan, I had a great grandfather who had power over the sea, on the wind, and I cannot go into details because it is something that belongs to

us. So climate is all that, but now all is coded and everything is displayed. But before old persons walked a lot with the weather observing trees from flowering, compared to all that." (New Caledonia, 2010)

Definition of climate change: "It is warming, a hole in the ozone, global climate change is the change in temperature. What I can say? In our level here, there are things we live today and we did not experience 10 years ago. And climate change is also that we do a lot of prevention with children, even at the population level to try to change things in order to improve, not improve, but in order to stop what has already happened. And at our level do some things that are helpful for better living. (New Caledonia, 2010)

Example 2 – Female of 37 years, mother tongue: French - Paris, Ile de France)

Definition of climate: "It's just weather." (Paris, 2010)

Definition of climate change: "It's the weather that causes flooding." (Paris, 2010)

These examples are representative. They present essential differences in the definitions according to contextual variables (culture, environment, exposure to risks). In the first example, the holistic aspect of climate is clearly expressed. Climate, humans and plants are interconnected, they constitute a whole where if one element changes the system will be modified. This holistic view of the climate produces the same type of vision on climate change. Although in her answer, she made a mistake concerning the cause of climate change (ozone hole); she has already experienced changes in the environment to which she belongs. In her representation, people as being part of the climate, must work actively for its protection or at least reduce the risks. The definition of climate and climate change are consistent and demonstrate the participant's involvement in the climate system.

In the second example, we notice a typical definition in which the participant confuses climate with weather. She substitutes the word "weather" for the word "climate" in a direct way: 1 = 1. There is no relationship, but the application of a simple logic, characteristic of the analytical way of thinking. The definition of climate change is built on the initial identification between weather and climate. It is an extremely simple causal explanation devoid of real meaning. This person represents a prototypical object isolated from the context, floods, according to the method of analytical thinking. This suggests that the participant has no mental representation of climate change.

As the demographic profile of the two participants is similar (females, close in age, equivalent educational level (University), studied in the French school system, identical social status and similar interests highlighted by a questionnaire), we can attribute the differences concerning the representation of climate and climate change to contextual variables. Without drawing any hasty conclusions, these examples suggest that the influence of cultural patterns between the relationship to the environment and of the ways of thinking participate in the construction of mental representations. We believe that between these two people the second is experiencing increased cognitive vulnerability and we can also suppose that this prevents an efficient cognitive adaptation, which may then affect behavior.

To illustrate the influence of culture on cognitive adaptation, we will present a second comparison, on mental representations of human adaptability to climate change, between new-Caledonian and Parisian participants. In the semi-structured interviews we asked the question: "Can human beings adapt to climate change?" This question enables us to obtain an argumentation of the subject. The argument allows identifying qualitative reasoning and ways of thinking about the subject, as well as its mental representations. From a sample of 48 participants living in Paris and New Caledonia, we conducted a thematic analysis of interviews. Our analysis points to five types of representations of human adaptation to climate

change

(Table

1).

Table 1. Categories of human adaptation to climate change

Adaptation	Representation
Evolutionary adaptation	"Human beings have always been able to adapt in the past, so now they are able to do so too"
Partial adaptation	"Rich countries can adapt, we can move, but not others"
Conditional adaptation	"Human beings can adapt if they change their lifestyle, if they find renewable energy"
Temporal adaptation	"Human beings will have increasing difficulties in the future to adapt"
Disappearance	"Human beings will disappear"

Although we found some similar explanations in the distribution of responses, the results, presented in Figure 1, highlight important divergences between the two populations.

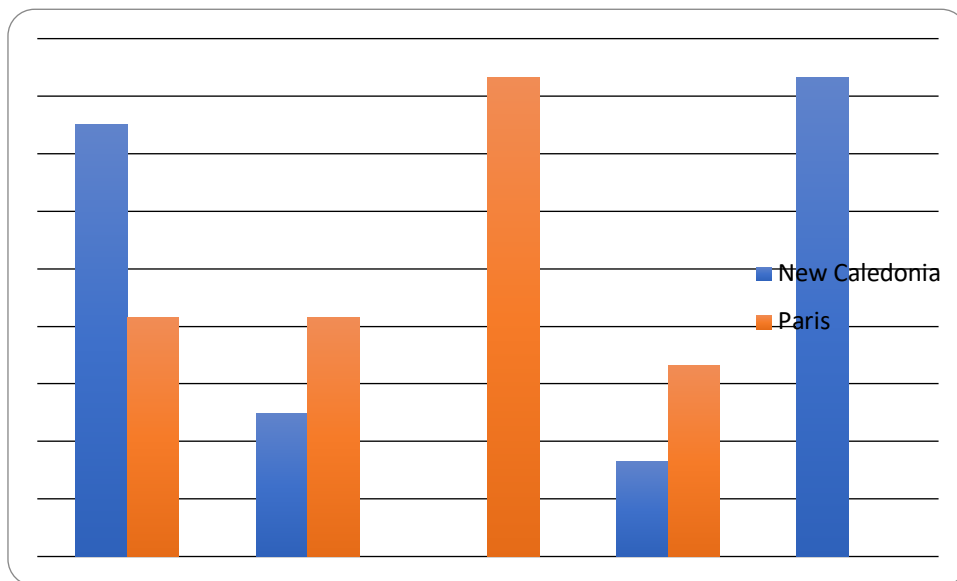


Figure 1. Percentages of participants by categories of responses to the question "Can human beings adapt to climate change?"

In both samples, we can observe responses which we call "representations ready to integrate", as for instance, "Human beings have always been able to adapt in the past, so now they are able to do so too." This sentence is devoid of evidence or further reflection. The most significant differences were observed between the responses of participants from New Caledonia, who consider that human beings can disappear from Earth as well as certain plants or animals, and the Parisians who evoke the possibility of conditional adaptation.

The sample's demographic equivalences showed that the differences can be attributed to contextual variables. Data on the representations held by Parisian participants suggests that they provide a special and privileged place for human beings amongst other life forms. This is consistent with the analytic way of thinking characterized by the idea that the world is made up of discreet elements. In the representations made by Caledonian participants, human beings are as vulnerable as plants or animals. On the other hand, the vision of Parisians reflects anthropocentric values while that of New Caledonians reflects eco-centric values (Gagnon Thompson & Barton 1994). In the first situation, humans are considered superior to the forces of nature which they dominate, whereas in the second situation humans are part of the ecological system and should respect it. From this point of view, the two populations show opposite positions.

However, we can identify a "cognitive vulnerability" in both cases. With the exception of the "representations ready to integrate", they reflect a high degree of uncertainty. Indeed, in both cases, the participants express the powerlessness of the individual, that is to say that the future escapes them, and power is delegated to exterior forces (technologies, Nature). However, we believe that the holistic vision can reduce anxieties with regard to this uncertainty, while accepting that humans are one of the components of the climatic system.

Environment as a factor of cognitive vulnerability

Our model (Figure 1) integrates another fundamental element: the environment (climate, geography). We suppose that local geographical and climatic conditions will influence the processing of information concerning climate on an intra-cultural level. To test our hypothesis we firstly collected data from open-ended interviews in three geographic and climatic environments in France: Paris (urban / gradient oceanic climate) Ile de Ré (island / oceanic climate) and Alps (High Mountain / high mountain climate). Secondly, we took into account the degree of climatic experience of Parisian participants and created two groups: (a) so called "monoclimatic" persons who lived their entire lives only in Paris and (b) so called "biclimatic" persons who lived in Paris and in other climatic conditions.

In the first study, data consisted of definitions of climate given by 30 participants per environment ($M = 29.2$) Thematic analyses of data (using the method of an independent judge) enabled identification of categories corresponding to four levels of complexity (Table 2).

Table 2. The different responses to the question "What is climate for you?"

Responses	Example
Binary climate	"Climate is the temperature, it is hot or it is cold. "
Climate/ weather	"Climate is the weather, the wind, the rain, the sun, etc."
Climatic system	"Climate is all that is around us, the atmosphere, nature, plants, animals but also the ocean.... "
Climate change	"Climate is changing right now, there is global warming, temperatures rise and weather deteriorates."

Firstly, we analyzed the data of the persons who have lived all their lives under the same climatic and geographic conditions. The different responses show several levels of understanding the complexity of the climatic system. The binary climate category is the most basic level followed by the three other categories. The results shown here (Figure 2) indicate that people living in Paris and its suburbs have the most basic representations. The results point out that persons living in the Island of Ré and in the Alps perceive the climate as a system. Therefore, we can suppose that the protected urban environment is not favorable for constructing a complex and correct representation of climate. These results reveal that direct experience of the participants with the natural environment allows the construction of more complex representations, in this case of systemic, bi-metric representations of climate. The concept of "bi-metric representation" (Lammel, 1989) enables one to identify the relationship between the participant's cultural knowledge and the direct experience with the environment.

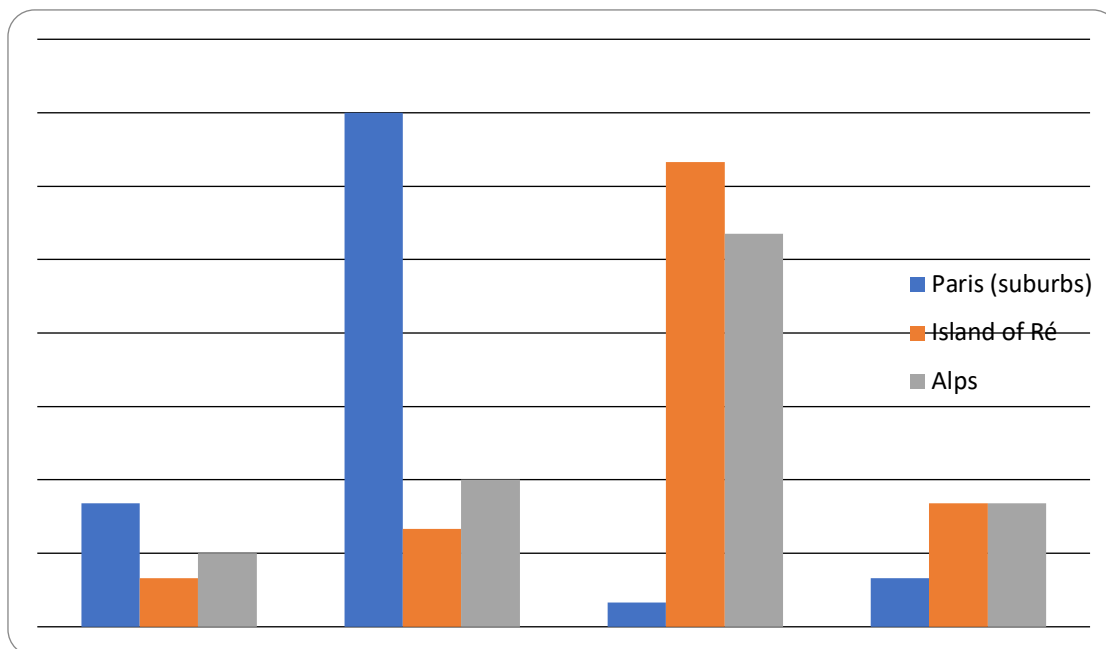


Figure 2. Distribution of climate definition answers by French regions

In the second study we compared the representations of "mono" and "bi climatic" participants (30 participants per group, $M=29.7$). The results presented in Figure 3 are consistent with those of the first study. The bi-climatic experience enables the development of more complex and less erroneous representations.

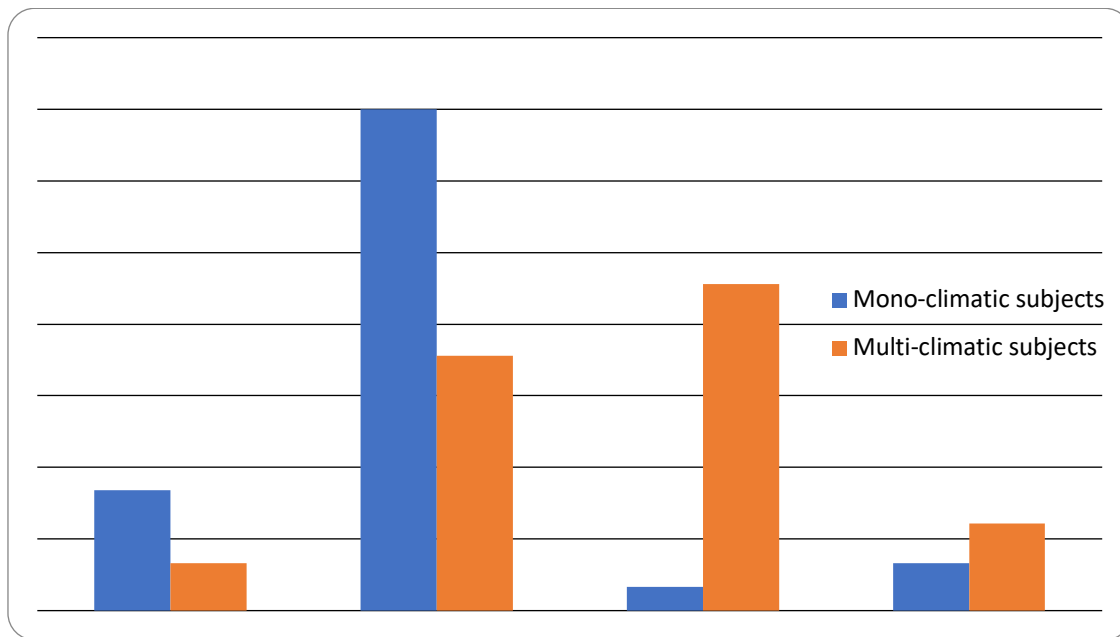


Figure 3. Distribution climate definitions in terms of climatic experiences

The analyses of our data suggest that the environment and climatic experience produce intra-cultural differences. However, we do not have any available data on the representations of climate change. The concordance that we observe between the conceptualization of climate and climate change taking into account the culture variable allows us to formulate the hypothesis that it will be the same with the environmental context and the climatic experience. In other words, we suppose that the mono climatic people living on the coastline or in the mountains will have more elaborate representations concerning climate change than people living in the suburbs of Paris. This difference will be more pronounced among people who have experienced contrasting weather conditions. We therefore think that people living all their life in an urban area (Paris, suburbs) without other climatic experience cannot develop bi-metric, complex representations, and will present the most pronounced cognitive vulnerability. This vulnerability can constitute an obstacle to establishing adequate cognitive adaptation.

Conclusions and Perspectives

Our article has attempted to provide some answers to the question of human adaptation to climate change. In the theoretical section, we argued that cognitive capacities mediated by culture have always helped human groups to adapt to different climatic conditions. However, even if in the past humans have already confronted abrupt climatic changes the current situation places them in extreme vulnerability. In the past, because of the low human population, displacements offered a realistic adaptive behavior and human needs were incomparably less significant. Nowadays, because of the increase in climatic change combined with over-population, important needs the lack of shared cultural knowledge, human beings are susceptible to cognitive vulnerability. This prevents them from accurate reasoning and from establishing some strategies for problem solving. Based on our model, we suppose that the variables "culture" and "environment" might influence cognitions and adaptive cognitions can be also identified. We consider that urban populations with a rather analytic thinking process with no real climatic experience will present more cognitive

vulnerability. This cognitive vulnerability slows cognitive adaptation that can be manifested in the absence of some behavior required for effective adaptation to climate change.

Our current studies attempt to identify the cognitive treatment of climate and of climate change. We consider that without a complex and correct representation of the climate as a system, people cannot develop adequate mental representations of climate change. The examples presented are consistent with our hypotheses and show that analytic thought can constitute an obstacle in the comprehension of climate and climate change. We also observed that this is sometimes associated with withdrawal and even unfounded optimism. As the individuals have neither knowledge nor the modes of dealing with this complex phenomenon, misconceptions develop. We also demonstrated that environment influences the organization of complex representations. These examples are for now only indicators and are part of the preliminary investigations of the ACOCLI research project, which attempts to identify in an experimental way cognitive adaptation to climate change.

Our preliminary research suggests that individuals in urban settings are predisposed to a very low level of conceptualization of climate and climate change and a very poor understanding of the mechanisms of this complex phenomenon. This fact produces cognitive vulnerability and can constitute a difficulty in the cognitive adaptation of human beings to global warming. We consider that cognitive adaptation is essential for all collective efforts to adapt. We think that if culture cannot enable the development of complex individual cognitive models on global warming, humans cannot adapt to important and rapid environmental changes. Proper understanding of climatic phenomena is necessary in view of drawing up pertinent strategies for problem solving at a local level. In addition, these local solutions can help in the global cognitive adaptation to climate changes.

The passage from an interview that follows, illustrates the extreme vulnerability with which individuals face climate change.

"The human species is that it can adapt? Well, the question is how far. It is the story of frogs, I always remember the stories of frogs. A frog that you put in water, fresh water and then water warms gradually, the frog adjusts to temperature gradually, time passes and the frog adapts, but in the end the frog is cooked. Its adaptation has led to becoming completely cooked and the frog dies. Does the adaptation of human beings lead to suicide? Maybe, but I hope not. After all, everything is possible. As for myself, I still want to believe that at least some humans, at least a few on this planet, experience wisdom. That humanity has given birth to at least some people who are able to move things to save us." (Lawrence, 37, New Caledonia)

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