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ENTERING INTO THE UNEXPECTED: MANAGING RESILIENCE IN EXTREME SITUATIONS

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Abstract

This article introduces the concept of the extreme situation, which is tightly linked to the concept of resilience and more specifically, entry into resilience. The latter is defined as the moment when an individual (or group) gradually resumes normal business following a period of immobility due to a shock of unprecedented brutality. The classical approach is the well-known concept of sensemaking drawn from the work of Karl Weick. Nevertheless, this historical perspective merits a fresh look that incorporates new sources of hitherto untapped data and/ or a review of existing material. The accident at Fukushima Dai Ichi serves as a demonstration for this new interpretation.

1. INTRODUCTION

Accident management is usually associated with the unexpected, notably through the process of sensemaking [1]. In an extreme situation, the ‘surprise’ (‘reality shock’ [2]) takes the form of stupor or stunned shock. The individual is suddenly unable to act, blindsided by an event that is beyond their frame of reference [3]. Astonishment marks a time when individual concerns are no longer relevant. For those in this state of shock, time may appear to be suspended or futile. Those affected are overwhelmed by an ongoing unprecedented situation and lose the ability to understand or take action. This powerlessness leads to anxiety, fear and dizziness. Such feelings gripped Masao Yoshida, the director of the Fukushima Dai Ichi power plant, and his teams, who were struck on 11 March 2011 by two natural disasters (an earthquake and a tsunami) in under an hour. These events caused a technological failure on an unprecedented scale (the loss of most on- and off-site power generators which would lead, in the course of the following days, to the release of radioactive materials from several reactors), “*at the time, to be quite frank, I was destroyed. Myself, I mean. I said to myself that we were facing a terrible situation*” [4].

However, on 11 March, this phase was particularly short. Yoshida and his teams quickly became aware that they were facing an extreme situation and had to find a way to cope [5] (“... *feeling sorry for ourselves would serve no purpose*” [4]).

In phenomenological terms, the extreme nature of a situation is affirmed when living conditions become inordinately intense, or unbearable [6]. The person who undergoes the experience is on the verge of an abyss [7]; they are faced with violence of unprecedented brutality, a radical upheaval that threatens life itself. In psychosocial terms, the extreme situation leads to the loss of the usual points of reference and can undermine identity. This is because individual identity is shaped by the relationship with current social norms, hierarchical relationships, adherence to shared values, responses to social expectations, etc. The rupture of the (past) value system causes irreparable change and results – or not – in the emergence of a new system of shared values.

The analysis of the extreme situation therefore focuses on subjects who must face the unthinkable [6] and what holds them together. At Fukushima Dai Ichi, the unthinkable took the form of three “*entities*” that became uncontrollable as they were “*unleashed*”.

Faced with this exceptional adversity and predictions of “*certain death*” [4], Yoshida and his teams successfully entered into a positive dynamic, through mobilizing resources which, although limited, allowed them to survive, then to recover an acceptable level of control over a devastated nuclear facility. This process can be described as ‘entry into resilience’.

2. FROM RESILIENCE ‘IN GENERAL’ TO ENTRY INTO RESILIENCE ‘IN PARTICULAR’

Words, ideas and concepts do not have exactly the same definition from one scientific discipline to another. The concept of ‘resilience’ is no exception to this rule. The English word ‘resilience’ comes from the Latin verb ‘resilire’ that means to ‘bounce back’. As the word does not exist in Japanese, the English term is used. Some approximations are *kaifuku-ryoku* (buoyancy or power to recover), or *fukugen-ryoku* (the power of restitution), *dan ryoky sei* (elasticity), or *teikou-ryoku* (in the context of disease).

Given these multiple meanings, the scientific community looks like the famous biblical description of the Tower of Babel. This myth provides a useful way to talk about resilience. In the Bible, after the Deluge, men began to build a city and a tower that reached to the sky. Seeing their arrogance, God confused their language so that no-one could understand each other anymore. He then spread them over the whole of the Earth. By creating a multitude of languages, God created confusion and misunderstanding. Like the Babel fish (the fruit of the imagination of the genius English writer, Douglas Adams [8]), Google translate still has a lot of progress to make. Rather than develop a universal language, humankind, and particularly scientists have developed a ‘preferred’ language – English – to build a taxonomy.

The ‘resilience’ taxonomy takes many forms depending on the discipline. In science, the concept enjoyed its first moment of glory in 1901 when French engineer Charpy attempted to measure the resistance of a material [9]. In the 1970s, the term reflected the capacity to absorb and overcome the effects of significant, unexpected and brutal ecological disruption [10]. Hybrid definitions have since emerged in many disciplines: geography [11], psychology [12], sociology [13], organizational science [14] and, more recently, ergo-psychology [15].

Despite this plethora of definitions, the concept can usefully be summarized into two complementary representations that can be given different weights – leading to a radical change in the nature of scientific knowledge. An allegory illustrates the point; rather than Plato’s cave, we use an Indian and the Indian elephant.

Figure 1 very schematically summarizes two perspectives of resilience. On the top, a blind Indian man balances on the back of an elephant. Why is he there? We do not know. To keep his balance, his body and mind continually respond to stimuli of varying intensity that come from the elephant and the environment. Whether the road is in good or bad condition, or whether there is wind or rain, he strives with all his might to stay balanced on the elephant’s back. The keywords here are balance, anticipation, adaptation, etc. and are usually found in the field of ecology [10] or cognitive ergonomics [15].

In the drawing on the bottom, the Indian is on the ground, but he has lost his glasses and his cane. Here again, please do not ask what has happened. We do not know. Perhaps an unforeseen sequence of complex interactions has occurred [16]. The key point here is that the Indian must quickly find his glasses and cane. If he does not he will be in real trouble. He will face an extreme situation, to the point that his life is at stake [6]. He might never find his way and could starve to death. On the other hand, he could find himself on a tiger’s dinner plate. The blind Indian is forced to go beyond his limits if he is to survive and return to a normal life. Here, this means finding the elephant and balancing on its back.

In the context of our work, we exclude the first perspective and focus on the second. The concept of resilience is therefore considered in the context of damage, loss, accident or trauma. Pre-accident, prevention, precaution or prudence takes priority. Resilience is an accessory to survival. The concept has positive connotations and represents an asset or progress.

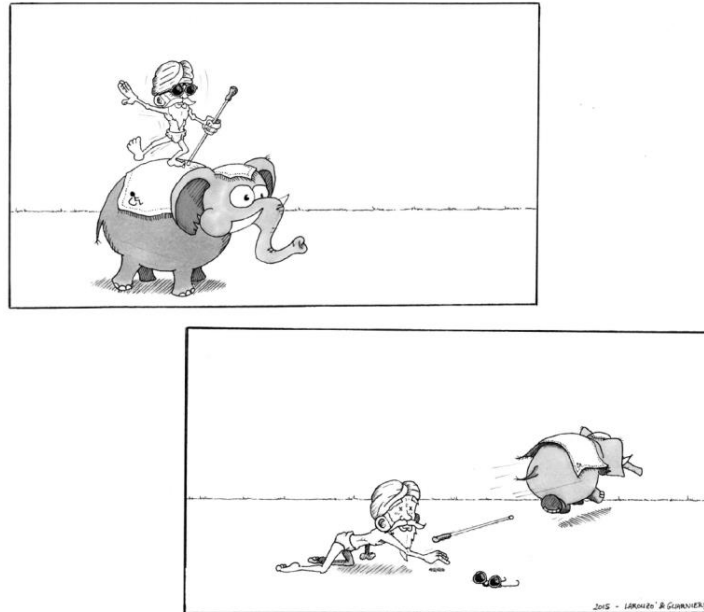


FIG 1. What is “resilience”?

3. ENTRY INTO RESILIENCE: A HEURISTIC APPROACH

The term ‘entry into’ usually describes the passage from one place to another and underscores the transitional situation that characterizes it. The question of the place through which one enters is another issue, which leads to the question of the direction of the transition. The temporal dimension is important as ‘entry into’ implies a dynamic, leading to a change in state [17].

Figure 2, inspired by [18], is a schematic of what we understand by ‘entry into resilience’. It illustrates the dynamics of autonomous agents and institutions in crises. Referring to Hurricane Katrina studied in [18], the red curve depicts the action of teams of volunteers who spontaneously tried to re-establish communications. They acted autonomously and auto-instituted their action framework. The black curve shows the evolution of the formal organization, i.e., institutions which formalize a social mode of being and evolved throughout the crisis. Note that the amplitude of the curves and their development over time does not have an absolute value and is shown only to illustrate the positioning of the phenomena. The parallel with what happened at Fukushima Dai Ichi is obvious, at least for the period from 11 to 15 March 2015. Here, the entry into resilience occurs during the emergence of a radically new ephemeral organization in response to the consequences of the accident and the physical and social disorder that ensued. It ends when new institutions take over responsibility for collective action and ensure the long-term control of the recovered situation.

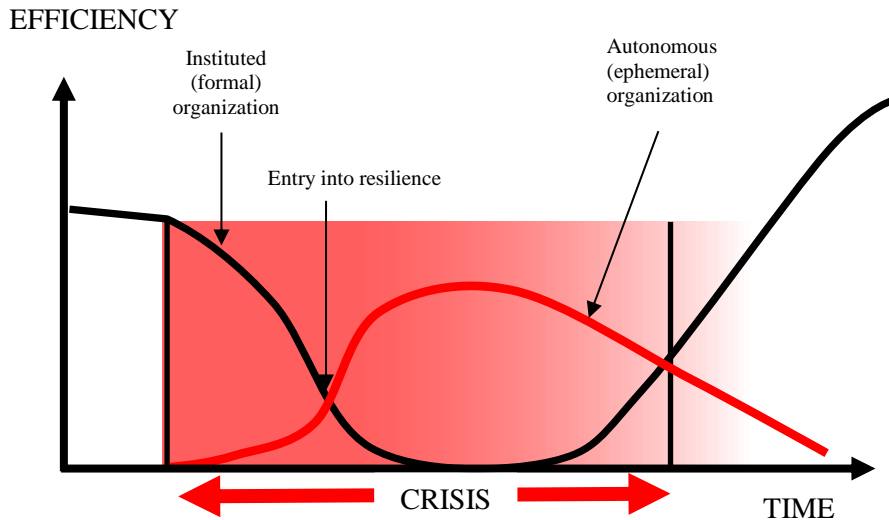


FIG.2. How to explain what “entry into resilience” is...

Entry into resilience appears as a window in the usual space-time, a period of exploration in which the aim is to understand sequences in order to better manage them. A learning phase and re-appropriation of the environment is necessary. It is difficult to rationalize this exploratory phase before or during the process as it is essentially a form of cognitive do-it-yourself that is very different to the usual rational-instrumental understanding of the world (which does not mean that it cannot be effective) [19]. At best, it may be possible to define some principles that enable people to react in an extreme situation. While this would not eliminate risk, it would reduce it to a level lower than that resulting from the substantive rationality [20]. However, it is not possible to define strict rules that would ensure the entry into resilience, as creativity play a role in the process. Entry into resilience translates into the *de facto* creation of a new system [21] when the ecological, economic or social structures make the initial system untenable.

Given our lack of knowledge, it is clearly very difficult to characterize the determinants of entry into resilience. Some disciplines have made more progress than others. This is the case for psychology [12] and ecology [10] for example. These disciplines have the advantage of developing a ‘clinical’ approach by studying extremely well documented cases.

In the latter case, a further challenge lies in the need to generalise the study of a particular situation. In the field of management science and human resources, the work of Powley [22] is particularly interesting as the author proposes both a data analysis methodology and a useful model for understanding the mechanism by which collective action can be reconfigured following a trauma.

Alongside these innovative avenues, the classical route used to decipher the mechanisms implemented by individuals (or groups) when faced with adversity is

sensemaking, meaning the ongoing, *a posteriori* construction of a sense of 'reality', which enables people to find direction and decide on the actions to be taken.

4. WHEN SENSEMAKING DOES NOT MAKE COMPLETE SENSE

According to the sensemaking perspective, as classically described by Karl Weick [1], action plays a determining role in cognition, notably through a verbal understanding of a part of the range of experience. Based on their preconceptions, individuals extract cues from the endless stream of events and develop a plausible representation of the overall situation. This authorises societal action; through actions that are consistent with this representation, individuals 'enact' their own world. "*Enacted environments contain real objects such as reactors, pipes and valves. The existence of these objects is not questioned, but their significance, meaning and content is*" [23]. Therefore, "*the concept of sensemaking keeps action and cognition together*" [1]. The result of the enactment is itself added into the course of history, as a tangible and orderly social construction that is subject to multiple interpretations.

Although the construction of meaning in the world and the "world" itself is retrospective, at the same time, it prospectively directs action or the search for cues. This process is invoked to explain the control that humans can have over an environment. Control means acting on the environment, while 'acting' is understood in the sense of enacting, thus both representing and constructing meaning. Actions are linked by preconceptions, while actors react to the environment that is enacted by others; these two factors structure the response to failure and may trigger a crisis (if the failure is exacerbated). Decision processes, as such, are of secondary importance in the study of accident dynamics, and the conditions under which individuals can pursue their activities in a way that makes sense to them takes precedence.

This approach is inspired by social constructivism [24,25], according to which experience and knowledge of reality are constructed from a particular social position. However, management sciences typically bypass a major ontological problem – namely absolute relativism that prohibits any form of generalization – instead pragmatically noting the existence of organizations, 'objectified' perennial institutional figures based on a complex set of representations (myths, rituals, procedures, cult objects, etc.).

According to this view of sensemaking, the individual is described as unique and idiosyncratic, rather than a simple object that can be decomposed into factors. Enactment has two inseparable facets, one public and the other private. The public version is the visible part of the process, and is at the origin of social constructions; the private version refers to if-then mappings that are constructed from individual experience [26]. However, sensemaking theory gives a dominant role to communication processes and thus to language and the cognitive dimension of action [27]. At the level of the organization, individual actions that contribute to

the group's work, the representation of this work and the resulting subordination of their own actions embody an overriding schema of the whole that Weick and Roberts [28] refer to as the "collective mind".

Reduced to a logic of control and therefore performance evaluation, the sensemaking process is inevitably associated with a managerial ideal, to the point that the origins of a catastrophe begin to resemble the 'Failure of Foresight' model [29]. The accident is explained by a departure from the ideal, and 'causes' are found, for example, in the weakening of the social structure that authorises sensemaking [30]. In this context, 'resilience' is the capacity to adapt in order to preserve shared interpretive schemas by adjusting (in particular) formal and informal social links (hierarchies, roles, etc.), and the associated communication flows. However, to the best of our knowledge, there are no studies that demonstrate the usefulness of these requirements for the entry into resilience of a group that has been hit by upheavals on the scale of those experienced by Fukushima Dai Ichi personnel. This clearly shows that in the extreme situation, the intensity and variety of stimuli should not be ignored.

The most recent approaches argue that the concept of sensemaking must take more account of emotions [31] to reflect the scope of 'sense' more accurately. The historical Weickian [32] perspective would benefit from distancing itself from an overly restrictive view of the retrospective nature of sensemaking, and focus more on the goals, expectations and projections of the individual in the future [33]. For some, sensemaking should be defined as the process by which "*an individual [...] grasps external reality through cognitive elements, the aims of the individual and the emotions and sensations that they feel*" [34]. Furthermore, it should include the social dimension that creates the 'individual', and interactions between different objectives, expectations or representations [35]. Consequently, the Fukushima Dai Ichi accident provides an excellent opportunity to demonstrate the merits of a revised and expanded definition of sensemaking.

5. THE VALUE OF SENSE IN-THE-MAKING IN AN EXTREME SITUATION

Our demonstration is based, *inter alia* on an in-depth analysis of the many official reports produced following the accident [36–42]. However, it goes beyond the reconstruction of facts and recommendations to examine the raw testimony of actors in the crisis provided to the various investigators. The value of this corpus is unprecedented and considerable. On 11 September 2014, the Japanese Government published the hearings of the plant's director, Masao Yoshida (400 pages reflecting 28 hours of examination). On 25 December of the same year, it published 127 new hearings.

Yoshida's testimony is both edifying and instructive. The director of the plant unambiguously reports the fear and pain experienced by on-site personnel as they battled with the facility and tried to contain the damage. His lexical register attests to this; he speaks of "*three entities*", "*three nuclear units that were*

unleashed” against which he attempts the “*impossible with very few staff*” to “*tame this thing*” [4]. In this context of a new awakening of the senses, his impressions and perceptions would have a strong impact on his decisions. His order to evacuate the site is one example.

In this context, emotions should not be seen simply a disruption of the surrounding order and well-regulated planning. Damasio [43] shows that they are an essential component in the development of rationality. Several experimental results have since confirmed the need to rehabilitate emotion as part of the process of conceptualization. It has been demonstrated that individuals produce concepts according to their perceptual experience [44]. These studies show that the embodiment of emotion serves as conceptual grounding. As an illustration, Yoshida testified that after the explosion of reactor 1 building (when pressure was about 500 kPa), the number “500” put him “*ill at ease. I knew this was totally irrational, it was just a feeling*” [4]; this feeling would influence his decisions about the other reactors.

Such considerations appear in the work of Leontyev [45], for whom human activity is the substance of consciousness. It is a back-and-forth process between a subject and an object, guided by a schema and determined by physical contact with the outside world. Beyond these circular processes that guide interactions between the organism and the environment, Leontyev argues that mental representations are governed through physical contact with the real world and the subject obeys its intrinsic properties and relations. The object’s resistance breaks the circle of internal mental processes and provides an opening to the outside world. Similarly, Vygotsky [46] showed that activity, aided by tools and signs, is social in nature and always occurs in the presence of others. Recent studies characterize the moderating role of social relationships in the subject’s relationship with their body as a tool for conceptualization, the “*current (social or other) context influences the way in which a concept is represented in a conceptual task and the extent people recruit embodied information to solve it*” [44].

In line with these theoretical results, embodied embedded cognition (EEC) theory considers that meaning is grounded in the bodily processes of perception and action. The organism’s bodily interaction with the environment is of crucial importance to its cognitive processes [47]. What is meant here by the ‘body’ is not the body as a functional system with input and output, “*but rather the body as an adaptive autonomous and therefore sense-making system*” [48]. The ‘first technical object’ [49], the body appears as a support for and creator of sense. “*It is impossible for a man to not be permanently changed and transformed by the sensory flow that runs through him. The world is the emanation of a body that translates it in terms of perception and sense, one does not exist without the other. The body is a semantic filter*” [50].

However, the influence of the physical world on individual and social representations is not as determinant as usually suggested. The subject should be considered as a whole, characterized by their intentions, affect and capacity for

representation. In this context, representation concerns the “*presentation by and for the living being, by means of which the living being – starting from what are for it only mere shocks [...] – creates its own world*” [51]. The imagination is at the centre of meaning processes. The above examples illustrate the importance of the imaginary in the on-site management of the Fukushima accident. Moreover, Castoriadis [52] showed the articulation between the individual imagination and the social imaginary through sublimation. In turn, the social imaginary that holds the group together orients emotions in order to provide a coherent way of being and representation of the world. This was seen at Fukushima, where a group that was determined to fight together experienced powerful emotions. Thus, after the explosion of reactor building 3 on 14 March, Yoshida “*experienced one of the greatest emotions of [his] life. They all wanted to return to the field, they even pushed each other out of the way*” [4].

The decisions of the plant’s director were influenced by the need to preserve the physical and mental integrity of his employees [4]. When the manual opening of a valve located in a highly radioactive zone proved to be the only option for venting reactor 1 and preventing its explosion, technicians were ready to take action. The director explained, “*we decided to do the operation by hand, as a last resort. We decided to do this because we thought we would succeed if all that was needed was to be exposed to radiation*” (ibid.). The economics of the situation could have dictated such a decision from the start, as the loss of a few employees could have resolved the crisis without jeopardizing remaining resources. However, such a decision could only be made acceptable following a personal and interpersonal progression, through action, which constituted a particular value system that made suffering acceptable.

Immersed in an unprecedented sensory universe, Fukushima Dai Ichi operators had to make the world make sense again. High levels of radioactivity, unbearable temperatures, debris, seismic aftershocks, floods, darkness and reactor building explosions formed the apocalyptic scene in which they were required to act. Action was shaped by physical contact with this material and social reality through physical challenges, and the mutual care and attention of teams at the scene.

A group is organized around an object, a representation of its activity (the “collective imaginary” [53]). This imaginary object enables (or not) subjects to invest in the group, to the extent that it facilitates the identification process. Based on this theoretical framework, it could be said that the tsunami swept through, not only the relevance of operational procedures, but also the collective imaginary of operators at Fukushima. To act, subjects had to restore an enabling imaginary. Yoshida immediately paved the way for action by sending the teams on site to collect information on the status of reactors and prepare for the injection of water using fire trucks. This action plan provided an initial fixed point for the emergence of a collective imaginary, while it subsequently evolved as a function of the hazards and operational constraints.

The group's representation (the collective imaginary) are constructed from active social imaginary significations (among others). Individuals rework these significations depending on their situation. In this case, the representation of the Fukushima Dai Ichi accident in public opinion hinged on the incompetence of TEPCO [54]. This negative image contrasted strongly with the mutual respect of workers on site, and the heroic allegories they used to describe their actions, notably to save their families' land. It appears that the group that remained on-site became closer as the days went by; by distancing themselves from social stigma they created an ideal image of themselves that justified the sacrifices they were making. In fact, the actions of on-site operators were only fully acknowledged long after 11 March 2011. Three months after the accident, workers reported an unusually high level of psychological distress linked to the social discrimination they suffered in their contacts with the Japanese population [55].

In order to understand decision-making in extreme situations we must understand the development, necessarily mediated by the bodily experience of the situation, of the collective imaginary significations. The study of the dynamics of entry into resilience must focus on the mutation of imaginary meanings. At Fukushima, this enabled group action to develop around creative solutions that followed the initial period of stunned shock. Beyond sensemaking, i.e. repeated rounds of analysis, we are interested in sense-in-the-making, which includes the processes by which meaning initially arises.

6. CONCLUSION

Investigations into the accident at Fukushima Dai Ichi highlighted deficiencies in communication, and a lack of foresight and anticipation by some operators in some of their decisions. These analyses implicitly refer to a variety of possibilities that begin with a known state, and reduce decision making to an optimization exercise. The focus is naturally on the lessons learned from shortcomings in coordination between the operator's headquarters, the government and the plant, redundant measurement systems, or the effects of stress on behaviour. It is of course clear that we need to look more closely at the impact of stress or emotions on actions or decision making [56]. However, paradoxically, this approach (often found in the safety sciences) seeks to exclude those who act from a theory of humanity, and instead focuses on bloodless social mechanisms. In the case of nuclear power, managers are also sometimes tempted to resort to formalisms to demonstrate control, to the extent that they deny the problems operators face [57]. In extreme situations, the risk is that the factors that determine 'entry into resilience' are ignored [58].

The options in terms of normative conceptual models are legion. However, the fact remains that we know very little about the teams, groups and organizations that must face the unthinkable. This ignorance invites us to favour an on-the-ground approach that attempts to delve deep into the mechanisms at work in an extreme

situation. The Fukushima Dai Ichi accident is remarkable due to the profusion of data that has been published or will be released, notably the testimony of the plant's director [4]. This material, which is very much a personal account, makes it possible to understand the reactions of engineering teams who faced an unprecedented situation and provides some initial food for thought regarding the concept of engineering in extreme situations [58].

The lessons learned so far conceal some key processes related to how the action unfolded in the eyes of subjects who faced annihilation. The concept of the extreme situation invites us to supplement these lessons by reintroducing physical, emotional and kinaesthetic aspects, which constitute the socio-sensual structure for action, into our initial relationship with the world.

The study of action in extreme situations therefore implies decrypting accounts of such experiences; such experiences are punctuated by radical changes that cannot readily be globalized into a 'logical' description. It also means focusing on representations that are created by subjects themselves, rather than seeing them as fantasies that muddy the description of an 'objective' reality. These imaginary creations establish a new balance between individual impulses and social reality on the one hand; and between the infinity of individual perspectives and collective requirements on the other [51].

From this epistemic perspective, the 'extreme situation' refers to the collapse of meaning at group level, when control of the production facility is lost and group members are held responsible by society for an unavoidable danger. The subjects in extreme situations are torn between an urgent need to act (driven by society) and the physical impossibility of taking action within the established framework (crisis management procedures in particular) [59].

In extreme situations, the group reforms around a "magma" of imaginary significations [60] that can conflict with those created by institutions further from the action. At Fukushima, the difficulty of managing the on-site situation was compounded by instructions issued by a remote headquarters. In this context, the conflict between staff at the plant and the executive powers cannot be reduced to a failure to exchange information. Because actors had a very different relationship to a situation that was far beyond of what could be communicated, they were unable to understand each other. This highlights the need to give subjects autonomy to handle an extreme situation, and consequently to articulate the various registers of temporality and 'rationality'.

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