Beliefs: Our Map of the World

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Abstract

In this essay we focus on our vast web of beliefs that serves us as a rough and ready map of reality, generated more to give us comfort and confidence in an intimidating world than to be accurate. Maps of reality can never be accurate in any ultimate sense since reality itself is a convoluted entity that can only be accessed in never-ending layers. Our repertoire of beliefs, generated compulsively in the mind, span a huge spectrum in respect of ties to affect and emotions on the one hand and of their credibility in depicting reality on the other. The interaction between our affect-based psychological needs, our need for having a sound comprehension of reality, and the infinitely tangled reality itself, leads to the generation of a large diversity of types of beliefs, where these get revised under the impact of reality by overcoming the restraining effect of emotions in diverse ways and over diverse time scales—interestingly, the 'reality' includes the complex repertoire of affect and emotions itself that may, in certain cases, generate the impact for our beliefs to change. Beliefs represented by small clusters in our belief network (see below) are commonly prone to frequent revision in a more or less random manner, though there are beliefs acquired in early life that are intransigent to change because of overriding ties to emotions. Beliefs represented by larger clusters are comparatively durable, and their revision has a systematic aspect to it because of a greater role of evidence-based factors—however,the evidence may, once again, be tied with emotions and beliefs oriented away from reason. Finally, there are prepotent beliefs that are resistant to change even over a lifetime. Often, these beliefs get revised only if we engage with our own selves, looking at conflicting forces within ourselves. In this context, we refer to *narratives* that are self-reinforcing and exercise almost a mesmerizing influence on us. In all this, there is a dual role of 'rationality' that needs being attended to in describing and explaining belief revision—rationality is not exclusively based on evidence and reason, but includes the implicit operation of affect and emotions too.

1 Beliefs: our lifeline

Belief is of fundamental relevance in human existence. We will, in this essay, look at how we hold on to a vast repertoire of beliefs in our journey through life in a world that is uncertain and precarious at every turn. In this, beliefs play a dual role: they carry *information* for us about the world out there and, at the same time, they *shield* us from a reality that is harsh and inimical. Beliefs, in other words, carry *information and misinformation* at the same time. How is it that we cherish our beliefs and stick to those in spite of this aspect of misinformation? This, indeed, holds the key to our continued existence.

2 Beliefs Emotions and Reality: a complex interaction

> *Belief · · · is the central problem in the analysis of mind. Believing seems the most "mental" thing we do, the thing most remote from what is done by mere matter.* (Bertrand Russell in [21].)

Beliefs, while being of fundamental relevance, are among the most contrary things in the human mind. These are supposed to be associated with our cognitive faculty, providing a rough and ready description of the reality we are embedded in, but their relation with that reality—a reality that is itself riddled with contrary features—is an exquisitely skewed one.

Beliefs are formed in our mind in response to our perception of the world, and in turn, shape that perception as we proceed in our journey through life. Believing is a fundamental compulsion of the human mind. A mind void of beliefs is a strange and crippled one.

> There is an unspoken but common trend of thought among those who vow to go by reason and rationality that beliefs are not formed in obedience to evidence, confirmation and logic, and are seldom 'objective' in any acceptable measure—that beliefs, therefore, are irrational and harmful things by which we remain caged in bigotry. This trend of thought leads to the idea that the mind has to be purged of these unwholesome impurities. However, as we cleanse the mind by means of rational education and persuasion, new beliefs find their way to the inner recesses of our psyche, largely evading the vigilance of our rationally oriented awareness.

Beliefs, in other words, constitute the means by which we make sense of the world, and are essential to our existence. These enable us to coexist with our fundamental existential anxiety in facing an uncertain and intimidating universe. The great web of beliefs (see sec. 6 below) provide security and shelter to the mind much as the mother's womb shelters and nourishes the fetus.

In this article we will be concerned with belief *revision*, where we will be called upon to examine the relation of our beliefs with reality, how and to what extent the impact of that reality on our mind induces us to revise our beliefs so as make those consistent with *evidence*, commonly taken to be constituted of 'objective', i.e., 'mind-independent' entities. Beliefs, according to a section of analysts, are supposed to reflect the mind-independent relations between the constituents of the world and, moreover, to be related to one another by rules of 'logic', thereby acquiring to status of being 'rational' ones and, in consequence, the process of belief revision is supposed to be driven by demands of rationality.

However, this view is to be complemented by examining the way our beliefs are tied to *affect* and *emotions*, and by looking at how emotions exert a dual role on our beliefs—first, by *holding those in a tight grip, away from change* and, secondly, by bringing in strange and, occasionally, precipitous changes in the very same system of beliefs.

In this, we first look at the issue of *how the human mind perceives reality* where we will find (in sec. 3 below) that the concept of 'reality' itself is a complex and warped one. The infinite-fold complexity of the world necessarily causes a complex structure to appear in the *mind* that has evolved to confront and to perceive it, trying to make *meaning* out of it.

Sec. 4 presents in brief outline a few aspects of how the mind is structured so as to perceive the world and to make sense out of it. As we will see (see sec. 4.1 below), the mind is structured into an *unconscious* and a *conscious* layer, where the two seemingly opposing poles of a binary actually merge into a complex unity. This complex merger of opposites strongly characterizes other aspects of the structuration and the functioning

of the mind too. Other instances of such intertwined opposites, of great relevance in the present context are, first, *affect and reason* (see sec. 4.2 below), the two constituting what can be referred to as the *implicit* and *explicit* aspects of our perception of reality, and then, the complex structure representing the *self* (sec. 4.3 below) that drives the mind in all its perceptions of the world, distinguishing it from the *non-self*. Once again, the non-self influences the self in a strange and intricate manner by inducing into the latter collective preferences and beliefs of social groups of various descriptions.

> The term 'affect' in the above paragraph is meant to be a broadly comprehensive one, including in it the large spectrum of *emotions*. In more precise terms, however, affect refers to a binary valence in the perception of reality, while emotions constitute a more complex implicit language of the mind. In this article, we will seek to maintain this distinction, while occasionally invoking the inclusive use of the term 'affect' so as to refer to the two together, taking care that such usage does not detract from the intended meaning. At times, on the other hand, the term 'emotion' will be used in this more inclusive sense.

Following this, we will devote a few lines in sec. 4.4 to explain, in bare outline, the term 'rationality' as an appropriate combination of affect-emotion on the one hand, and reason on the other or, in other words, a combination of the implicit and the explicit modes of functioning of the mind as it confronts reality. We will then engage more directly with our principal concern in this essay, namely, how beliefs are constituted, why they persist, and how they get revised.

3 Reality: the noumenal and the phenomenal

Reality is an infinite dimensional entity in which we all are embedded—it is infinitely complex and evolves ceaselessly in an infinitely complex manner—indeed, it is the *ultimate* in complexity.

It is because of the infinite-fold complexity of reality that we can perceive the world only in bits and pieces through experience. We assemble the incomplete, patchy, and evolving mass of information that we gather from experience into our *conception of the world*. The part of reality that goes into forming this conception constitutes our *phenomenal* reality, to be distinguished from the 'real' reality out there—one that we will refer to as

the *noumenal* reality. The noumenal is the ultimate repository of all the complexity there is, and is inaccessible to our perception precisely because we can perceive only parts of it, and can never grasp or comprehend reality as a whole.

The phenomenal is rooted in the noumenal and is evolving ceaselessly in an exquisitely intricate manner—this reflects an even more incomprehensible and entangled evolution of the noumenal reality that is far beyond our powers of description and imagination, if only because it encompasses *all spatial and temporal scales*.

> This distinction between the phenomenal and the noumenal is in keeping with the Kantian tradition, where the latter is, in a manner of speaking, naturalized by looking at it in the context of the science and philosophy of *complexity*.

An incredibly vast number of signals continuously reach us from diverse parts of the noumenal reality as these various parts interact with one another. Of these, we can perceive and register only an insignificantly tiny fraction, compatible with the capacities of our perceptual apparatus which is necessarily of a limited efficacy, since otherwise the infinitude of signals would appear to be utterly chaotic and incomprehensible to us. Only this microscopically limited fraction of signals, perceived and interpreted by us, goes to constitute our phenomenal world—indeed, the evolution of the phenomenal world has to be, by necessity, compatible with the evolution of our senses. In other words, our phenomenal world *co-evolves* with our perceptual and conceptual capacity. The human *mind*—which is itself of a complex structure—has a great role to play in this coevolution (section 4 gives a brief outline of how the human mind is constituted and how it attempts to comprehend the world out there).

> The idea of coevolution is taken from the field of biological evolution (see [27] for background; see also [12]). Hoffman ([9]) raises the important issue as to how our senses present only an insignificantly narrow window to the vast amount of data flowing in the universe, thereby effecting a huge data compression that ensures our survival and fitness.

> This article draws heavily on the idea of *complexity*. For background, see [10], [28], in addition to [12], [27].

The relation between the noumenal and the phenomenal is outlined in [12], [14].

4 The human mind: complexity of structure and function

The human mind can be described as an *emergent* aspect of the functioning of the brain, in association with a number of other physiological processes in the body as a whole. The brain-body composite is an incomprehensibly complex entity, emerging from which the mind is an incredibly complex system itself in terms of its structure and function.

Emergence commonly originates in the dynamical evolution of *complex* systems. Complexity and emergence are ubiquitous in nature. The evolution of a complex system, in which novelty appears at every turn, is marked by junctures where new modes of behavior of some subsystem or other (or of the system as a whole) make their appearance. The details of how and when such new modes appear, or of how those new modes are related to the earlier behavior of the system (and of its subsystems) are indeterminate and unpredictable, such unpredictability being a result of the fact that a complex system involves a *large* (ideally, infinite) number of components interacting with one another in diverse and multifarious manners, as a result of which the components and subsystems constitute an infinitely *entangled* system in their evolutionary dynamics.

Complex systems and their evolutionary dynamics are fruitfully represented in terms of highly interconnected complex *networks* involving an admixture of systematic and *random* features—see [27], [10].

The idea of emergence is elucidated in [10], [12].

However, the complex functioning of the mind is only partially explained in terms of its rootedness in the brain-body system. The mind of an individual is related to *other human minds* in an amazing and far-flung network of awesome complexity. It is this social interconnectedness of the mind, along with its rootedness in the brain-body system, that gives it an almost limitless structural and functional diversity and subtlety.

The complexity of the mind is a necessary requirement for it to face reality (the 'real' reality, that is) and to comprehend it. However, all its complexity notwithstanding, the mind is but a pygmy confronting that reality, if only because it is itself only a tiny subsystem of the latter—this, precisely, is why the limitations of the mind get

expressed in its ability to comprehend the world only in tiny bits at a time, and in its compulsion to form beliefs, enabling it to satisfy limited but essential needs. Those 'needs' may originate in either the inner (i.e., mental and psychological) world of an individual or in the outer (i.e., in the external phenomenal reality). However, even when the mind responds to needs arising from the impact of the outer reality, those needs appear proximately as a set of psychological preferences, intentions, and drives that have, generally speaking, a highly skewed fit with that reality. Beliefs, in other words, are only secondarily based on the requirement of accuracy and conformity to reality. This latter requirement, however, acquires ultimate relevance in the dynamics of belief revision.

Mental activities emerge as the collective functioning of *large* assemblies of neurons in the brain. There are two distinct but overlapping modes of functioning of such large assemblies. In *unconscious* mental activities, the assemblies function more or less independently, in parallel, there being only a rudimentary correlation between these. In *conscious* mental functioning, on the other hand, there takes place very significant *information exchange* between these assemblies in the form of interactions that integrate and coordinate their activities.

The large or 'macroscopic' assemblies or aggregates of neurons representing various 'modules' of the mind (such assemblies are often referred to as so many neuronal 'networks') emerge in the process of evolution, one that is remarkably complemented by the *plasticity* of the brain that operates during ontogenic development, based on personal and socially acquired *experience* of an individual.

> The interconnectedness of human minds, each rooted in its own brain-body system, and the resulting emergent processes of development in the brain-mind complex itself is elucidated in [24], [5]. This is a subject of great social and scientific interest. The neural underpinnings of the development of the mind by means of social interactions are to be found in the literature on attachment theory, neuroplasticity, and epigenetics: for background, see [23], [5], [22].

4.1 The unconscious and the conscious

The complexity of the human mind is made apparent by the two distinct, though correlated, types of mental activities—the unconscious and the conscious. While we are commonly aware of our conscious activities (awareness, indeed, is a close thing to consciousness) the unconscious ones occur below the level of awareness, and are known only indirectly. There has emerged a broad-based understanding of the role of the unconscious in our mental life during recent decades where, *inter alia*, a significant involvement of the unconscious mind has been found in our *cognitive* activities too. In this,the unconscious mind has been found to be involved to a considerable degree in what were earlier referred to as *higher* cognitive functions, especially in *social cognition*, such higher cognitive activities being in addition to the more commonly known ones such as *instinct*, *intuition*, and the use of *heuristics*.

As indicated in sec. 4, unconscious mental activities are carried out in parallel in numerous neuronal assemblies with little information exchange between these in the form of integrative interactions. In virtue of such activities (involving only rudimentary interactions between neuronal aggregates), the mind acquires *implicit* knowledge of reality, the latter made up of our inner mental world on the one hand and the outer world on the other, the world that makes up the rest of our phenomenal reality.

> The role of the unconscious mind in our mental life has been discussed and highlighted for a long time now. The Freudian approach to psychology was all but banished from the academic arena under the impact of behaviorism up to the seventies of the last century, when the relevance of the unconscious resurfaced as its role in our cognitive functioning, especially in social cognition, was noted in several influential studies For background, see [2], [11] . It is now being increasingly recognized that the unconscious and the conscious are intimately intertwined to form a composite whole. For an introduction to 'unconscious intelligence', see [8]

The conscious mind, based on the *integrated* activities of large neuronal aggregates (or 'networks', as these are often referred to), distinguishes itself in its ability to establish diverse *correlations* between entities of the world. Such entities generate representations in the neuronal assemblies in the form of *dynamical excitation patterns*, on the basis of which *concepts* are created and lodged in the mind. Concepts are the fundamental

building blocks by means of which the mind generates the *explicit* appraisal of the world, such explicit appraisal being made possible by means of far-flung correlations between concepts which, in turn, are based on associations between the dynamical excitation patterns generated in the various neuronal assemblies.

Both the conscious and the unconscious layers of the mind are capable of *abstraction*, which is an implicit process made use of in forming *categories* of concepts (concepts themselves are based on categories). Indeed, the two layers of the mind work together in a manner where one cannot be segregated from the other—the working of the mind as a whole generates the impression of the two layers in the mind itself.

> While concepts are generated by the working of the conscious mind, the unconscious mind generates *proto-concepts* based on limited and rudimentary correlations between entities of the world. Indeed, all conscious activity is based on unconscious process, and concepts are organically linked to proto-concepts.

One particular type of correlation between concepts (and, more generally, between bunches of concepts) set up by the conscious mind is *reasoning*. Reasoning, like many other activities in life, makes use of *rules*. Rules are abstract prescriptions that apply not exclusively to specific situations, but to situations in general within some given domain. While reasoning appears to be an activity of the conscious layer of the mind, it has its roots in the unconscious, involving preferences and intentions we are not always aware of. The deep links between the conscious and the unconscious make it possible for us to access and to be aware of our implicit appraisal of the world.

4.2 Affect and reason: the implicit and the explicit

> As mentioned earlier, the term 'affect' can be used in either a specific or an inclusive sense. In the present section, and in this essay generally, we attach this specific sense to the term. Occasionally, however, (as in the title to this section) the broader sense will be invoked, where emotions will be included as referent—the intended meaning is to be discerned from the context. Conversely, the term 'emotion' will at times be used to include 'affect' referred to in its specific sense.

Affect, as distinct from *emotions*, is a bivalent response to situations faced by individuals

(and also by social groups, see below) resulting in either a positive (desirable) or a negative (undesirable) appraisal of those situations. It operates mostly at an unconscious level almost all the while throughout the entire life of an individual, and generates pleasure and preferences or, conversely, displeasure and aversions (the terms 'reward' and 'punishment' are also commonly used). The neuronal assemblies responsible for the generation of affect are of quite ancient evolutionary origin, and operate in diverse ways throughout the animal world.

Neuronal signals from the affect-generating regions of the brain get *integrated* with signals from other neuronal assemblies in specific cortical regions to produce affective *meaning*, on the basis of which an individual comprehends her situation in a broader context, giving rise to her behavior, her *future plans*, and finally, her *beliefs* about the way the world is. Even as affect is rooted in the unconscious, consciously generated affect plays an important role in regulating our behavior.

This seminal role of affect is made more sweeping and broad-based by *emotions*. Emotions, added to affect, constitute an exquisitely enriched, effective, and subtle *implicit language* of the mind, that often finds expression in feelings. Emotions generate a complex and finely tuned appraisal and classification of situations that an individual faces in her life, over and above the dichotomous classification generated on the basis of affect. Emotions, moreover, provide for an *amplifying mechanism* in our mental processes by means of which such processes tend to be afflicted with *instability*. However, that instability may be moderated and stabilized by the opposite action of affect and emotions themselves—in the absence of such moderation the mind would have imploded and lost its efficacy altogether.

Affect and emotions operate in both the unconscious and the conscious layers of the mind—however, consciously operating affect and emotions are, to a large extent, rooted in the unconscious.

In contrast, *reason* pertains to a large extent to the conscious mind only, since reason correlates concepts of diverse descriptions. Reason operates on the basis of rules that

appear to apply to large classes of situations and, looked at formally, appear analogous to *rules of logic*. Instances of such rules are the *modus ponens*, *modus tollens*, and the *excluded middle*. These operate on statements to produce further statements, there being a number of such statements held to be *true* as axioms. The axioms in various domains of logic are required to be precisely defined and to be *consistent* with one another. However, the application of what is referred to as reason to ordinarily occurring situations of life is more often than not wide open to fatal flaws owing to the fact that their premises are mostly defined in loose terms and are often inconsistent with one another, being formed in the mind on the basis of affect and emotions. Still, it is reason that is accorded primacy by the conscious mind in our appraisal of what is 'true' and what is 'false' in the variously assembled descriptions of reality, among which beliefs hold a place of prominence. On the other hand, affect and emotions provide us with a pervasive implicit language where rules like the excluded middle hold no relevance, resulting in a distinct mode of appraisal of the world. It is an intimate admixture of the two modes that drives us in our onward journey in life.

The mind is ceaselessly engaged in the making of *decisions* and *inferences* in this journey by the use of affect-emotions on the one hand, and reason on the other. These two constitute, respectively, the implicit and the explicit modes of 'logic' of the mind. In order that the decisions and inferences may be effective in guiding us in our perilous journey in this world, affect and reason should be blended in an intimate and subtle admixture—one that cannot be determined by massive computation or lengthy mathematics.

In closing this section, we point out that affect, emotions, and reason are not generated in isolated minds, but in minds interacting with one another within a vast and complex social network. Various social groups that an individual may belong to have 'minds' of their own too, generating 'affect' (sets of preferences and aversions, and complex emotional responses as well) and 'reason' (modes of making of decisions and inferences) in diverse ways, with the consequence that these leave an imprint on the mind of an individual over and above the purely personal preferences and modes of inference-making. As a result, our appraisal of the world and our behavior generated from it, get endowed

with vastly complex dimensions. We will refer to these two distinct but deeply intertwined sets of approaches involving affect and reason as *self-linked* and *shared* aspects of the mind, where the term 'self-linked' is somewhat a misnomer since even shared preferences and modes of reasoning get linked to the self (see sec. 4.3 below) of an individual—it is a loosely coined term that we will retain for the sake of convenience.

4.3 The self

The *self* of an individual refers to her set of affect-generated preferences and aversions, her emotional tags to situations faced during the lifetime, and her privately generated beliefs that guide her in the journey through life (refer to sec. 5 below). It is the driving engine to the entire set of mental activities of an individual, and distinguishes her being from all that is distinct from her physical and mental world. There do, however, exist mental activities of an individual that do not connect to her self to any substantial degree—these pertain to the non-self part of her world.

> *Additionally*, the self is built upon such psychological ingredients as our yearnings, cravings, drives, desires, fantasies, and our privately felt ecstasies and agonies, most of which exert an overriding influence in our mental life; all these are eventually linked with the affect system.

Standing at the roadside I idly look at a bus passing by me, but suddenly jerk into attention when I observe a long-lost friend sitting in it, now receding from my view. Before the friend became visible, my mental activity mostly related to the non-self part of my world, but on sighting him, it became self-linked.

The self, however, has a *layered* structure. An individual generates preferences (and aversions), beliefs, and modes of reasoning (we refer to these—along with her desires, drives, and loathings—as psychological 'resources' or 'ingredients' of the mind) that have diverse origins in virtue of her membership to various social groups such as the family, circles of friends, colleagues at the workplace, like-minded political groups, and people sharing the same culture and religion. Ultimately, all these preferences get deposited on her self as so many layers in her repertoire of psychological resources, constituting her

'self' that segregates her being from the non-self part of her world. All these layers in the self generate a spectrum whose parts have varying degrees of 'self-ness'—for instance, an individual may have only a very weak affiliation to a religious faith, in which case there may be only a weak linkage of religious faith to her self.

Deeply embedded within this layered structure resides the layer of one's self generated during early infancy and childhood when only the attachment to mother or other caregivers and a few other family members are effective in generating the preferences, beliefs, and modes of reasoning of an individual. This constitutes the deepest and most private layer of the self, over which all other layers get deposited. The affect-based and emotion-laden ingredients of this deeply entrenched self are further added to by preferences and passions related to one's love life, sexual attitudes, and other similar orientations generated subsequently.

Finally, the formation of the self is initiated within the unconscious mind but the process continues within the conscious mind as well. Eventually, the self is a blend of unconscious and conscious mental processes on the one hand, and of affect-emotion and reason on the other.

In summary, the self, like all other aspects of our mental life, is an exquisitely complex mental formation.

4.4 Rationality: a blend of affect and reason

The human mind confronts, comprehends, and *acts back* on reality by employing the 'logic' of affect-emotions on the one hand and that of reason on the other. The twin devices of affect and reason are intimately blended into a remarkable unity in the making of our decisions and inferences, in which we often achieve success, as judged from the point of view of our intentions. On the other hand, any deviation from a balanced unity leads to failure, and even disaster. However, exactly what this optimum blend is and how it is realized in the mind is not likely to be known since it constitutes an emergent process in our mental life, largely occurring within the realm of the unconscious.

Rationality is commonly associated with reason. However, rationality makes copious use of the 'logic' of affect as well, without which it quickly degenerates into dogma in the garb of reason. As indicated earlier, reason makes use of rules operating on sets of beliefs that are often vaguely defined and inconsistent, having been generated in affect-linked processes. In the context of the vast web of beliefs lodged in our mind only very few, relatively speaking, acquire the status of knowledge, accepted universally to be justified and true, even though much of what is admitted as knowledge is actually defeasible and eventually undergoes revision.

> While evidence-based reason provides us with explicitly formulated information about reality, affect and emotions similarly generate *implicitly perceived* information about the world; perception, in other words, has two overlapping faces, one explicit and the other implicit. Put differently, the 'logic' of affect is not inimical to that of reason—they are intertwined into a strange and composite unity.

The term 'rational' applies to our inferential process, which includes the making of decisions. Only an insignificant few of the totality of our inferences are, however, based on purely logical deduction, the overwhelming majority being of the *inductive* type. An inductive inference is seldom based exclusively on shared rules of inference bearing a relatively high degree of credibility and logical integrity, instead making use of *self-linked* ones, mostly made up of unfounded beliefs in the nature of guesswork. However, most of the rules, whether self-linked or shared, are tied to *past* successes in inference-making in some measure, whether large or small. It is this near-universal tie-up of shared and self-linked inferential rules, based on past successes and failures and often invoked iteratively, that leads to success in the making of inductive inferences in spite of the fact that some of those are little better than unjustified guesswork.

> For general background to issues relating to inductive inference see [13], [14], where the requirement of an intimate blend of affect and reason for inference to succeed is explained. This 'intimate blend' is distinct from the binary made up of an emotion-based self and a distinct reason-based cognitive system, as indicated in [20]—that binary is, to all intents and purposes, a flawed one.

It is worthy of note that quite a few of the inferential 'rules' invoked by the mind are little better than *randomly* constructed ones. However, the effectiveness of randomly

chosen steps in processes involving *a large number of iterations* is known in the field of artificial intelligence. Looked at in the context of past instances of inference making, the inferential process in the human mind is also very much an iterative one where even a high degree of guesswork is conducive to correct inference, likely to be arrived at in the long run.

For background to principles and issues relating to artificial intelligence, refer to [17].

5 Belief: the mind's map of the world

There exists a large body of literature on the subject of beliefs and belief revision. For the purpose of this article I have drawn from [1], [25], [19], [4], [7], [16], with my own interpretations added throughout. Needless to say, I am solely responsible for any errors and misconceptions that may have crept into it.

Beliefs are like little *maps* of reality, effective in steering and guiding us through specific areas and domains of experience that happen to come our way all the while in our journey through life. And the vast and complex web lodged in our mind, made up of all our specific beliefs, acts as "a single great map of which the individual beliefs are sub-maps" ([1], chapter 1)—a continuously evolving map that guides us through a similarly evolving, unknown, and uncertain reality made up of our entire phenomenal world. In other words, beliefs are fundamental to the mind, which would be crippled without its vast web made up of these. It is this web of beliefs that enables us to navigate through the ceaseless pulls and pushes of life.

Beliefs span a vast spectrum in terms of conformation to evidence and requirements of logical consistency. At one end of the spectrum, there are almost totally unfounded beliefs that differ little from what are commonly referred to as superstition and, at the other, one finds beliefs that acquire the status of knowledge by being accepted as justified by requirements of logic and evidence. In between, there is great diversity among beliefs in terms of credibility. However, even though a belief is dismissed as being of little worth by people other than the one who holds it, the latter nevertheless guards it

like a precious possession.

This brings us to the *role of affect and emotions* in the generation and preservation of beliefs. As mentioned above, emotions (referred to in a broad sense, including affect) are the mind's implicit language in registering, classifying, and making sense of the innumerable situations that it faces and passes through. Indeed, emotions provide implicit *information* to the mind about the world. In the course of its journey through the world, the mind forms beliefs, much as we scribble down brief notes for later reference in passing through an unknown territory—initially the 'notes' are jotted down by relying on the mind's implicit language, but with growing experience we come to rely on the explicit language (based on concepts and their correlations, along with reason) as well, provided by the conscious mind, as a result of which our beliefs in some of the domains of experience begin to resemble justified knowledge, at the same time loosing their close ties with emotions.

In other words, beliefs, in gaining justification, shed their emotional ties. Emotions, in a manner of speaking, are the props to support our beliefs in the absence of confirmation and justification. At the same time, it is our emotional beliefs that propel us into *action*, which knowledge by itself fails to lead us to.

> The propensity to engage in action depends on a certain degree of emotional commitment, an involvement of the self of an individual.

Apart from, but intimately related to, their degree of credibility, beliefs are also spread across a big spectrum depending on the extent to which they are shared with other people in the world. As mentioned earlier, the self of an individual has a multilayered structure, with the deepest layer linked to her childhood when she had only a very limited interaction with larger social groups. Superposed on this, one generates layers of preference, emotional feelings, beliefs, attitudes, and modes of thought originating in attitudes and propensities of the various social groups to which she belongs. The 'outermost' layer, of course, is associated with humankind at large, in which case beliefs get transformed to knowledge. From the point of view of preferences and emotions, knowl-

edge has the weakest link to self—put differently, knowledge is impersonal while beliefs are, generally speaking, not so. In between the two extremes,—our deepest preferences, emotions, and beliefs on the one hand and knowledge on the other—our beliefs span a spectrum in terms of the way those are shared with larger social groups.

Our mind reaches out to reality by means of affect-emotions on the one hand, and 'reason' on the other, the former associated with our innermost layers of self and the latter with larger social groups with which we interact. Correspondingly, our beliefs, which help us navigate this world, span a spectrum from what we will refer to as self-linked ones (thereby referring to deeply entrenched layers of the self) and *shared* ones. As regards the latter, one has to acknowledge the existence of diverse degrees and modes of sharing and, correspondingly, diverse degrees of credibility of the beliefs from the point of view of evidence-based confirmation.

6 Our great web of beliefs

6.1 Beliefs: a complex network

The vast mosaic of beliefs lodged in our mind has been compared to a web, with interconnected threads forming an intricate pattern. In more concrete terms, this web is analogous to a vastly complex and convoluted network with nodes representing the beliefs themselves and links representing how these influence and interact with one another by means of preferences, emotions, and concepts (and at times, by other beliefs too) in addition to such psychological ingredients as our hopes, cravings, fantasies, and yearnings, many of which are repressed into a deep hinterland of our mind. Within this complex network, there exist *clusters* corresponding to sets of beliefs densely linked with one another, imparting a *structure* to it. What is more, the network is multi-layered, i.e.,there exist diverse *types* of links connecting the beliefs.

1. The links between nodes in a complex system represent correlations of various types, some of which may be indicative of causal interactions between those.
2. Incidentally, the belief network is closely related with our *conceptual network*, the richly structured ensemble (at times referred to as the conceptual *space*) made up of *proto-concepts* and concepts—while

concepts are frequently linked by beliefs, the latter themselves are made of concepts. In the present essay we will focus principally on the belief network and its dynamical evolution.

3. As mentioned earlier, proto-concepts are rudimentary concepts generated unconsciously, representing to a limited degree the relations between entities in the world, and are the precursors of concepts that the conscious mind generates, based on a wide range of mutual relations between entities, such broad-based correlations being made possible by the large scale integration of excitation patterns between diverse neural networks in the brain.

6.2 Belief revision: a brief overview

The dynamical evolution of the belief network is possessed of remarkable features, symptomatic of intriguing and deeply entrenched influences operating in the mind. In this process of ceaseless evolution, new beliefs are formed and linked with earlier ones, some beliefs are removed or radically altered, new layers of links are set up and some old layers are decimated, with diverse types of links established and removed—all this making the web of beliefs an incredibly enmeshed, undulating, and seething tangle that casts its spell to the most remotely hidden recesses of our mind. As is typical of complex systems, one can attempt to describe this evolution from either a *microscopic* or a *macroscopic* point of view. The microscopic view pertains to individual beliefs (or small clusters thereof) embedded in the mind that we are often not aware of, while the macroscopic view relates to closely linked clusters of beliefs that are open to a greater degree of introspective access. The macroscopic description includes *dominant* or *overarching* beliefs (or, more generally, the set of prepotent beliefs, see sec. 7.1 below)—ones linked with many others of diverse descriptions, where the latter, however, need not be closely correlated with one another.

The dynamics of belief revision involves a multitude of *time scales*, in addition to the *spatial* scales relating to the size of relevant clusters (e.g., those under the influence of the prepotent beliefs) in the belief network. For instance, many of the individual beliefs linked to only few others in the network (the 'microscopic' ones) get revised on rather small time scales by the impact of reality (commonly, our *social* reality), though the affect-based beliefs deeply entrenched in the mind and generated early in life are resistant to revision over such small time scales. Dominant or overarching beliefs on the other hand are, generally speaking, inordinately refractory against external impact

and get revised in strange ways through internal tectonic shifts, abetted by constantly acting external pulls.

From a fundamental point of view, belief revision may be said to result from *cognitive dissonance* (see [6] for background), a tension between a belief and the actual reality, that generates a latent tendency towards a resolution of the conflict. Our focus in this article will be to look at a number of aspects of the process of resolution. A key point in this context will be to compare our social beliefs with those about the natural reality—importantly, there exist a very large number of beliefs that involve an admixture of the two, spanning a vast spectrum between the two extremes.

> One needs to mention that cognitive dissonance does not necessarily lead to belief revision outright. Instead of revising a belief in discord with perceived reality it pertains to, one may, for instance, adopt an attitude of blaming others (or of pointing the finger at other circumstances) for the inadequacy of the belief, which succeeds in temporarily alleviating the dissonance. This explains why, cognitive dissonance notwithstanding, belief revision is a vastly complex process.

7 Taxonomy of beliefs

Looked at from the point of view of how beliefs are generated and how they get revised, one may attempt to make a classification so as to achieve clarity on the issue of belief revision. This, however, is no easy job to undertake. Beliefs are generated in a variety of manners and are marked by a huge diversity of types. We generate beliefs piecemeal, at every step and turn of life with no underlying scheme or pattern and, at the same time, we generate *prepotent* beliefs (see below) that provide context for the more specific and apparently prosaic or trivial ones. The staggeringly vast number of such prosaic and mundane beliefs generated routinely almost every minute of our existence is like the astronomical number of atoms and molecules of materials that make up a majestically sculptured palace, the sight of which obliterates all thought of those atoms and molecules—the microscopic constituents providing the very integrity of that sculpture.

7.1 Prepotent beliefs

Beliefs commonly come in *clusters* in the belief network—ones made up of correlated sets of beliefs that interact in multifarious ways with other clusters in it. Among these are the atomic or *microscopic* clusters referred to above, ceaselessly generated in the mind in our routine undertakings. Such microscopic beliefs are commonly not of major consequence in our behavior pattern, while *prepotent* beliefs are ones that do exert a major influence on other aggregates of beliefs in the network. These prepotent beliefs are not distinguished as much by their cluster size as by the strength of the influence they wield in the belief network from a macroscopic point of view, though a good number of prepotent beliefs do have their strength in cluster size too. Additionally, these are commonly the most recalcitrant ones in respect of revision under the impact of reality, in virtue of emotional ties of various types and degrees.

It is of interest to note that there are several types of prepotent beliefs on which emotional ties are the most tenacious, though operating in distinct ways—these are the ones that persist in the mind with the greatest indifference to evidence and reason. Among these are ones (commonly made up of small clusters) that get imprinted on the mind of an individual at a tender age when affect and emotions reign supreme and the self is only scantly receptive of evidence and reason. Further, there are the *overarching beliefs*—ones of a very general kind, many of which contribute to our *world-view* or *ideology*. These beliefs are responsible for an overall orientation in our journey through life, almost taking up the role of a divine reason that tells us what the world is ultimately like—these are the ones close to what we refer to as our metaphysics and our philosophy of life in this world. Among these two, we will focus on the latter, i.e., the overarching beliefs that have apparently very little to do with evidence and reason but are nevertheless of great relevance in our existence. Other important types of prepotent beliefs will be introduced by and by.

Examples of prepotent beliefs are the *theory of mind* (see below) and our religious beliefs. Some deeply affect-ridden beliefs represented by small clusters in our belief network are not necessarily acquired at an early age. For instance, a young lady's undying trust on her beloved is one that is rarely shaken. As another instance, a

traumatic experience generates beliefs in an individual that may appear to be completely meaningless from the point of view of others but may nevertheless be of appalling significance for her, not to be erased in her lifetime.

Incidentally, the two types of prepotent beliefs referred to above (as mentioned, these share the feature of being highly resistant to change) are located at opposite ends of a spectrum based on the degree of sharing (refer to sec. 5 above) by larger social groups. In the case of the overarching beliefs, the extent of sharing is not directly tied to evidence and reason (in contrast to the case of our knowledge base and our theories) but on a fundamental gap where evidence and reason cannot reach or, more precisely, where the totality of our experience in life is unable to provide us with definitive knowledge. Put differently, the overarching beliefs are underdetermined by our knowledge and available evidence, this being the case for instance, with our beliefs relating to some divine and omniscient Being and our metaphysics about the nature of reality. In other words, these beliefs are in the nature of meta-induction and possess the common characteristic of not being falsifiable by evidence (indeed very few of even our commonly accepted theories are falsifiable in the strict sense—evidence is always theory-laden). Among these, the ones oriented towards our social reality are heavily linked to imputed *intentions* of people ('*man is fundamentally evil*', '*cooperation is the last word in human society*') while the ones oriented towards the natural world also seek to inform us about some ulterior design or regularity in Nature ('*all processes in nature must ultimately reduce to the operation of fundamentally simple rules*', '*the most fundamental principle of Nature is symmetry*').

The overarching beliefs are commonly ones that are shared by an individual with relatively large social groups, and generate the comfort and confidence in our mind that we are in the company of large sections of humanity. It is this self-image of sharing the 'truth' with a community of people that often generates the emotional attachment to an overarching belief. The constant and continuing interaction with people belonging to the community and the constant reiteration of the veracity of the belief within the community leads to a very strong attachment (reinforced by fear of possible ostracization or of being a social outcast resulting from any attempt at revision of the overarching belief) that is virtually impossible to shake off. Such attachment is based on pride (generated

by a sense of 'belonging' and of 'being in possession of truth') on the one hand and shame (on being possibly marked as a renegade and an outcast in the event of belief change) on the other—it is the operation of pride and shame in tandem with each other that is responsible for a desirable self-image, a highly effective emotional prop for an overarching belief.

> Nathanson ([18]) dwells at length on the emotions of pride and shame, especially in relation to the self of an individual. What applies to an individual also applies to the collective 'self' of a social community.

As mentioned, overarching beliefs about the natural reality and those relating to the spheres of social and human existence are distinct in nature. In the case of human perception of what reality is ultimately like, affect and emotions play proxy to evidence-based reason since the latter is limited and fragmented in scope—put differently, overarching beliefs about natural reality are, in a manner of speaking, suspended in a void, not noticeably linked to layers of beliefs of a more localized and contextual nature. Overarching beliefs about the social and human reality, including the reality of the *self* are, on the other hand, commonly linked with a vast number of more specific and contextual ones, and are in constant interaction with those other beliefs, with social and human existential reality constantly exerting its influence on the mind. Among the two types of overarching beliefs (relating to natural reality and to the social-existential reality respectively) the former are, to a large extent, *unfalsifiable* because those are removed from the impact of evidence; the latter are, on the other hand, constantly in need of falsification but they are revised not so much on the evidence offered by social reality as on the basis of supposed *intention* of people and of social groups. Intention of people is something that one 'learns' to construct from early childhood. Intention, indeed, forms the bedrock on which our *theory of mind* rests—it is the one great strength and weakness in our intuitively learned theory of mind—to every act of an individual or a social group we interact with, *we assign an intention*. The assigned intention is, however, a construct of ours—the multifarious factors on which the 'state of mind' of an individual depends, determining his or her propensities and actions, are however, so complex and in such a state of constant flux as to be largely unknown by that person herself.

As mentioned, we pick up our theory of mind intuitively from early childhood and gradually keep on adding to it throughout life, possibly being informed of various learned theories of psychology. It is the theory of mind that remains basic to all our social interactions (see [15] for background).

7.2 Heuristics

Heuristics constitute a very special category of beliefs. These are generated ceaselessly in the mind of an individual, usually as results of incomplete inferential processes where these results may not be of immediate practical value but are nevertheless stored in the mind for subsequent use as 'lessons' learned from the past.

In a manner of speaking, heuristics are somewhat like *lemmas* in mathematics, where a lemma is made use of in deriving mathematical results of diverse descriptions. However, these do not always possess the rigorous justification that a mathematical lemma does. The great value of heuristics in all our decision making and inferential processes cannot be exaggerated—the huge relevance of heuristics in artificial intelligence provides indirect support to this. Commonly, heuristics are in the nature of microscopic beliefs, not belonging to densely linked large clusters, though occasionally a number of heuristics may be mutually linked so as to be used as a composite belief in an inference.

Examples of heuristics abound in everyday experience. As we ceaselessly keep on making small inferences in daily life (not to speak of more momentous instances of inference making), our mind passes through intermediate stages of setting up inferential links, among which some are perceived to lead to errors in inference and some to a correct course—both types of intermediate inferential steps are stored in the mind for future use as heuristics, providing immense service in subsequent instances of inference making. A good chess player keeps on playing chess moves in her imagination almost every waking moment of her life (and maybe in dream too), thereby generating a vast store of chess heuristics in her mind. Some of the great mathematicians in history such as Gauss and Ramanujan kept on generating heuristics (mathematical lemmas) in stupendous numbers that they never wrote down (didn't have the time to) and stored in their mind as aid to arriving at more serious theorems. Heuristics are generated in the minds of technicians as they learn their trade and hone their skills, as do all others who go through repetitive training to achieve perfection. Physicists and chemists use symmetry-based heuristics to arrive at elegant proofs of important results without going through more

elaborate and rigorous explanation. A heuristic may have a good degree of credibility but may often lack the status of confirmed inference based on evidence and reasoned justification.

Generally speaking, heuristics are not emotion-laden to any considerable degree, though these are usually self-linked in virtue of the pride and possessiveness these may be associated with, much as a collector of old news-clippings takes pride in his collection that he considers to be a rare one. It is the self-linked nature of heuristics that stamps a process of inductive inference undertaken by a person with a mark of individuality leading him to a successful inference by the use of these little gems of reasoning (often half-baked), where other individuals may fail in the act (see, for instance, [14]).

7.3 Taxonomy: further considerations

We have distinguished between beliefs pertaining to our social existence and those about the natural reality. In a manner of speaking, the former come into being more by the operation of affect and emotions than by the force of evidence, where our theory of mind plays a seminal role. Another influence of supreme relevance in the generation and stability of these beliefs is the theory of our own selves, driven by our *self-image* (see below). The beliefs pertaining to natural reality, on the other hand, come into being more in consequence of a void created by a lack of evidence rather than affect and emotions being of direct relevance. When there is a void generated in our world due to lack of evidence and reason, the mind has the natural tendency to generate a set of beliefs to fill up the void, where those beliefs are then given the support of affect and emotions by means of getting those linked to a fabric of norms followed by a community.

In the academic arena, hidden beliefs generating our world-view are nurtured by mutual support from closed groups of peers, membership in prestigious societies, appointments in universities, publications in journals, and so on—all this constitutes a very effective means of generating a uniformity in the norms (or 'paradigms') characterizing modes of thought in the academic sphere concerning science, technology, and the arts. In this sphere, acquiring latent beliefs in the guise of modes of thought bolsters one's self-image and also the image in the public eye beyond description.

Additionally, there exists a large number of clusters of beliefs of an intermediate type where beliefs about the natural reality are entwined with those relating to our social existence. These, evidently, are more complex in nature where the pulls and pushes for and against their stability involve a more obscure interplay between the forces of affect-emotions, culture, ideology, and evidence-based reason.

1. Our *self-image* constitutes the basis of our privately held *theory* of self. It is built around the axis provided by the social emotions of pride and shame that generate the *self* of an individual. The self-image differs from the self in that the latter is, to a large extent, independent of one's perception of oneself, being formed in the mind in virtue of the experiences one goes through in life. The self-image, on the other hand is the result of one's efforts at generating a narrative for oneself as to how he or she is situated in the society of others.
2. Examples of beliefs relating simultaneously to our perceptions of the natural reality and the social reality are numerous. For instance, our beliefs about the climate change, its possible effects on our life, and our responsibilities for adopting appropriate measures, are all of such a complex nature. As another instance, one can cite our beliefs about sex, sexual identity, and gender as relating to our ideas on biological facts and theories, and on social power structures too.

As mentioned above, another relevant approach to the classification of beliefs is based on *cluster size*. Beliefs come in clusters of diverse size and constitution. At one extreme, one has beliefs of almost atomic or microscopic individuality and at another, composite ones made up of large clusters of densely linked atomic beliefs or, of equal relevance, dominant or overarching beliefs with large numbers of more specific beliefs under their influence.

When these two approaches of classification are combined with the classifications based on degree of credibility and degree of sharing of the beliefs (sec. 5), one has a stupendously complex picture indeed relating to the various different types of beliefs in the context of their generation and revision.

Recall, incidentally, that the beliefs under the umbrella of an overarching belief are often densely correlated with one another while those linked to a dominant one need not be so correlated among themselves.

A few other types of prepotent beliefs will be briefly introduced in sec. 9. Among these, *narratives* are of major relevance, to be briefly considered in sec. 7.4 below.

7.4 Narratives

Narratives are *self-reinforcing* sets of beliefs built up by individuals or social groups where endlessly repeated reference to some particular point of view makes redundant all requirements of evidence-based and reasoned justification. Narratives generate a kind of long lasting trans-state of the mind that the latter falls in love with and does not want to be released from.

Notable instances of narratives abound in the fields of politics and religion, but are also of great relevance in human relations at smaller scales. When a husband's mind is poisoned against his wife by his sister and mother, and the husband, in this poisoned state of mind, establishes liaison with other ladies (instances of poisoning in the opposite direction are also not rare), his damaging beliefs about his wife keeps on being reinforced and all he cares about is 'evidence' against her, which he keeps on finding in plenty.

Narratives in the mind of individuals or social groups are very hard to break, mostly because an individual (or a social group) under the spell of a narrative *hates* to come out of it—he feels that he is in possession of 'truth' that others are prejudiced enough not to be able to access. At a fundamental level, a narrative serves the same purpose as beliefs in general—providing shelter to an anxious and insecure mind that we all share at some level or other; what is special to a narrative is that it is self-reinforcing to an extent that other beliefs, in general, are not. What is more, a narrative is usually generated and reinforced by individuals and social groups interacting with the person under its spell who gets exposed to repeated references to the veracity of the narrative—this ceaseless reiteration of a particular point of view is responsible for the mesmerizing influence that the narrative exercises.

> Anxiety and a sense of insecurity often give rise to a contrary feeling of false confidence and of hostility towards dissenting points of view. These have a tendency to propel the mind into a trans state. Trans states can be of various types, another instance being a state of submission to some 'higher' authority, even when the latter is diabolical and repressive.

8 Belief revision

As we see from sec. 7, there is a marked gradation in cluster size in our belief network—there are what may be termed atomic beliefs that are clustered to only a very small degree and there are overarching ones to which large numbers of beliefs are linked with dense clustering among themselves, while equally important are the dominant beliefs influencing large numbers of smaller ones that are not clustered to any appreciable degree. Evidently, this is only an improvised taxonomy, meant to be a rough and ready classification in order that the issue of belief revision may be approached with some conceptual clarity. Added to this, one has to attend to a number of other aspects while addressing the issue of belief revision, as outlined in sections 7 and 7.3.

Cluster size determines to a large extent the way beliefs are revised under the impact of reality—a complex combination of our social reality, the reality of our own selves, and the natural reality. The other factor influencing the time scale and mode of belief change is the manner and degree of involvement of affect and emotions in the beliefs undergoing revision. As seen in sections 7 and 7.3, there is a great variety of ways in which cluster size and emotional involvement get related to our beliefs. Added to this, one has to take into account the details of how specific sets of beliefs are exposed to the impact of the complex reality we are embedded in. The combined effect of all these makes for a great variety of ways in which our beliefs get revised. Of particular interest is the time scale involved in the process of revision, and the effect of the revision on the belief network of an individual—how other beliefs are affected, what types of new beliefs are generated, and how new correlations are set up in the network. In this, *very little* can be said by way of *general principles* characterizing belief revision as such because—I repeat—beliefs of great many varieties are generated piecemeal and revised in an equally erratic and unsystematic manner. In the context of such profusion of diversity, one can hope to look for characteristic features of belief revision only in respect of *specific types* of beliefs within the widely flung belief network.

8.1 Atomic beliefs

Generally speaking, atomic beliefs making up small clusters—ones correlated only sparsely to other sets of beliefs—are more fluid in their formation and revision than those making up large clusters. In particular, heuristics stand out as being exceptionally open to revision since these are of practical value in getting inferential processes reach successful conclusion in innumerable situations in life. On the other hand, beliefs generated by affective means early in life are largely immune to the impact of evidence and reason, and are relatively long lasting.

Incidentally, heuristics do not commonly undergo revision or replacement in the commonly understood sense of the term—more often than not, new heuristics are added to the already existing set. In this way, the repertoire of heuristics lodged in the mind of an individual grows by accretion, and gets modified by revision only less frequently. A heuristic that was found to have served some useful purpose in earlier acts of inference making gets modified when it is subsequently found lacking in the context of a more demanding inferential process. In such cases, a heuristic is not replaced completely but is only modified in accordance with the demands of circumstances—for instance, one or more of the few beliefs belonging to the small cluster making up the heuristic may get changed.

Such revision by modification rather than one by extinction and replacement also describes the case of other beliefs made up of small clusters, ones that are exposed in a relatively large measure to demands imposed by reality. However, this does not necessarily make a belief conform progressively to reality as such. For instance, the process of revision may only involve a different pattern of emotional involvement in the constitution of the belief. This happens in the case of beliefs pertaining to our social reality where the process of belief revision is emotion-driven, being frequently determined by the imputed intention of individuals or social groups.

> It is important to understand the pulls and pushes operating towards the revision of beliefs of various distinct types. Generally speaking, the resistance to belief revision arises due to the operation of affect and emotions while the driving force favoring belief revision is the impact of reality. However, we need to be clear as to what

that 'reality' is made up of. For instance, it may depend predominantly on widely shared perceptions of natural facts and events where our own emotional makeup is of a relatively secondary relevance. On the other hand, our perception of *social* facts and events may be of primary relevance in driving the belief revision, where that perception itself depends heavily on our own emotional forces, including our theory of mind. In this latter instance, *both* the restraining and driving factors operative in belief revision are emotion-ridden. There is a wide spectrum of intermediate types of belief revision, with varying degrees of emotional involvement in the forces driving the revision.

8.2 Belief revision: clusters and time scales

As an instance of emotion-driven belief revision in which part of the relevant belief cluster is retained, consider the hypothetical (but possible) belief of an individual (or of a community) that the state is necessarily an instrument for oppression and exploitation, unless all productive resources are monopolized by the state itself. Such a global belief is often associated with a cluster of other beliefs of a more specific kind, among which there may be a belief that the government of some particular country is particularly evil and dictatorial in virtue of the fact it leaves all resources of production to the control of private individuals, all of the latter protected and abetted by the government. As the government gets toppled by a coup and all productive resources are confiscated by the newly formed government, the specific belief referred to above gets revised *'now the state is no longer a machinery for repression'* while a large part of the rest of the cluster associated with the global belief remains intact.

While the above instance refers to a global belief associated with a large cluster of local ones of a more specific ('atomic') nature, examples abound where cluster as a whole is associated with a belief relatively more local and specific in nature ('*my neighbor harbors evil plans about my family*'), while a partial revision of it leaves some smaller constituent clusters unchanged ('*though he bailed me out from my recent financial crisis, I still suspect his intentions about my daughter*').

Thus, belief revision is a complex process where cluster size, the nature and degree of emotional involvement, and the nature and degree of the impact of reality on the belief, all are relevant in a crucial way. Corresponding to all this complexity, belief revision is characterized by a huge spectrum of associated *time scales*. While beliefs of

a specific (or local) nature, corresponding to a small cluster size, are generally revised over short time scales, those acquired at an early impressionable age or ones resulting from a traumatic experience may last one's lifetime. On the other hand, emotion-driven belief revision is, generally speaking, more summarily accomplished when compared to evidence-driven ones, though beliefs relating to one's faith—ones that get revised only through an emotional upheaval—are extremely resistant to change. Generally, the time scale of belief revision gets increased by many orders of magnitude if subjected to the influence of overarching or dominant beliefs.

8.3 Revision of overarching and dominant beliefs

Overarching beliefs are special ones that set a rigid context to a large number of other more specific beliefs lodged in our mind. These latter are in ceaseless flux under the impact of reality (the natural reality, our social reality, and the reality of our own selves) and of interactions among themselves, but always remain confined within the context set by the overarching beliefs. Of similar relevance are the dominant beliefs that once again restrain other small clusters of beliefs. It is to be mentioned here that we do not distinguish between individual or lone beliefs and those forming small clusters in the belief network; indeed, beliefs always come in clusters—we refer to the small clusters as the atomic or microscopic ones. The overarching and dominant beliefs, on the other hand, are 'macroscopic' in nature in that they wield influence over large sets of microscopic beliefs in the belief network.

> Examples of overarching beliefs are ones about the ultimate nature of reality, i.e., those of a metaphysical description. Instances of dominant beliefs, on the other hand, are ones relating to our faith or religion, and our beliefs about human nature ('*man is fundamentally selfish*').

As mentioned, these two types of beliefs—the overarching and the dominant ones—are the most resistant to change; even a lifetime of an individual or a few generations of a social community may prove insufficient for such beliefs to be revised. We are incapable of revising our overarching and dominant beliefs because we have a deep apprehension that we will then be rudderless in this stupendously complex and alien world, in which

these beliefs give us foothold and a sense of belonging. These, along with a few other types of beliefs (see sec. 9), make up our repertoire of prepotent beliefs .

8.3.1 Overarching beliefs and underlying hierarchies

Our network of beliefs possesses, in part, a hierarchical structure. More specifically, our overarching beliefs about reality, most of which go to make up our world view, shelter and nurture our *theories* of nature, ones that we accept to be true on the basis of evidence and reason. The hold of emotions on these theories is indirect and latent, being based on our self-image that we have accessed the 'truth' by deciphering a complex reality. The way our theories of reality get revised differs from the process of revision of other beliefs of ours where the sway of emotions is more direct and significant.

Theories, in turn nurture and rest on further layers of clusters of beliefs embedded ever deeper into our psyche, ones that end up with our deeply entrenched beliefs almost completely wrapped up in affect.

> As our scientific theories get revised, the newly emerging ones remain tied to earlier ones by a relation of *incommensurability*, since these are indicative of new dimensions of reality *in addition to* ones known earlier; in contrast, smaller clusters of beliefs with more explicit ties to emotions are commonly succeeded by *incompatible* ones since these are revised more under the impact of emotions as compared to that of evidence-based justification. However, here again, instances abound where belief revision leaves a large part of the relevant belief-cluster relatively intact and one finds feature of both incommensurability and incompatibility in the revision process.

In other words, there is a spectrum characterizing the various modes of belief revision, corresponding to the spectrum of beliefs themselves. At one end is the mode of belief revision that occurs almost entirely under the pulls and pushes of emotions—such revisions occur randomly where one occurrence of belief revision is uncorrelated with another. At the other end is the mode where belief revision occurs under the guidance of evidence and reason, with emotions playing a latent role—there is a kind of systematic orientation in such revisions—successively emerging beliefs are *correlated* with one another; in between, there occurs all sorts of belief revision with strange and complex combinations of these two extreme forms.

There is a certain pattern in the process of emergence of successive theories in various domains of scientific inquiry. For instance, such a process often bears the hallmark of *self-organized criticality* (SOC; see [12] for background).

On top of all this are the overarching beliefs themselves—notably those constituting our world-view about the nature of reality. These persists in the minds of individuals or of communities of people over very long times. An overarching belief is revised in unpredictable ways, at times under the strong impact of alternative sets of beliefs, but almost always by a process of thorough soul-searching (see sec. 9 below), based on the analysis and dissection our own deeply hidden prejudices.

8.3.2 Dominant beliefs

In contrast to the overarching beliefs, most of which pertain to the natural reality, our dominant beliefs are more directly tied to emotions, and are linked with large numbers of small emotion-laden clusters, without a marked hierarchical structure arranged in order of evidence-based justification. But these share with the overarching beliefs the feature of being held by large groups of people, which gives rise to a strong sense of belonging, different in nature compared to the sense inculcated by the overarching beliefs. The process of revision of these smaller clusters of beliefs is itself emotion-driven (refer back to sec. 8.1); however, there holds the general principle that successively larger clusters are more and more durable than smaller ones;

Dominant beliefs come in various shades—there are, on the one hand, religious beliefs under the umbrella of which large social groups, often numbering in millions, are gathered; and on the other, there are dominant beliefs on a somewhat smaller scale (recall that the term ‘scale’ refers to size of belief clusters and also to the size of social groups sharing these beliefs), mostly associated with cultural lives of people.

If the degree of sharing by large social groups is discounted as being not of relevance, i.e., when we refer to the belief network of individuals or small social groups, dominant beliefs still make their existence felt by means of exerting a restraining influence over large numbers of more specific beliefs (i.e., ones corresponding to clusters of small size—

mostly the 'microscopic' ones), where those specific beliefs are commonly not densely correlated with one another.

The most significant of the unchanging dominant beliefs are ones that pertain to the ubiquity of hidden intentions of people and of social groups. These set a more or less rigid context to a vast number of social beliefs of a more specific and microscopic nature which, in contrast, are in a ceaseless process of revision (over *multiple time scales*, see below), where that process is a more or less *random* one, i.e., the revision of any one belief is *uncorrelated* with that of any other chosen one. This is to be distinguished from the process of revision of our scientific *theories* that resembles one of *self-organized criticality*. This random process of belief revision is conditioned, on the one hand, by the rigid context set by our overarching and dominant social beliefs (much like the *boundary conditions on a dynamical system evolving under a set of differential equations*) based on the supposed intentions of people and, on the other, by the influence exercised by our *selves*, operating around the axis provided by affect and emotions. It is the combination of affect and emotions that generate our preferences (and aversions), our yearnings, our fantasies, our desires, drives, agonies and ecstasies. All this mark the process of belief revision with the stamp of an exquisite complexity—as one set of belief gets revised, another set is generated within the belief network, with new links between these new beliefs and the remaining ones in the web. The new beliefs may arise from a set of earlier ones, but the nature and disposition of the links between these and the remaining ones in the web bear no continuity with those of the earlier set of beliefs.

> One may consider, for instance, the rebelliousness of a young person against authority figures that gives way to a more responsible and nuanced attitude in a later stage of life. The belief in the role of the state as an instrument of repression may subsequently be replaced with one where the state is seen primarily as a machinery to make possible the coexistence of conflicting interests in the society.

More generally speaking, the successively emerging beliefs linked to dominant ones are, to a large extent, *incompatible* with one another, though they happen to reside within the same web of beliefs whose horizon is largely defined by the set of dominant ones. Though the dominant beliefs are highly resistant to revision, these cover a wide spectrum of time

scales necessary for change, analogous to the set of overarching beliefs.

In closing this section, we mention that an important set of dominant beliefs of major relevance in our mental life is made up of beliefs about our own *selves*. The *self-image* of an individual constitutes an instance—it is made up of a cluster of beliefs that keep on changing with one's situation within the social reality, though there remains a core to our self-image that is highly durable.

Dominant beliefs, like other prepotent ones, are revised only by a rare conjunction of circumstances where the impact of reality, including the reality of complex mental states, generates a will to confront deeply hidden prejudices buried within one's own self.

9 Belief revision: confronting the self

The question remains: how, if at all, are our prepotent beliefs revised? It may be mentioned that our prepotent beliefs include the overarching and the dominant ones, and *also* the deeply entrenched affect-ridden beliefs acquired early in life when evidence-based reason is yet to play a role in mental processes. Additionally, an important class of prepotent beliefs is constituted of *narratives* that we subscribe to. Finally, added to all this, prepotent beliefs include those that get lodged in the mind in consequence of some *traumatic experience* faced by an individual.

> At times, a traumatic experience in the life of an individual (or of a social group) generates deeply entrenched beliefs that never go away. Imagine an aged father having lost his only son—of a tender age—on the eleventh of a certain month in a car accident. He will never again be likely to feel comfortable in his lifetime when confronted with the number eleven and will, in all likelihood, avoid all contact with the world on the eleventh of every month, believing the day to bear ill portent.
>
> At the molecular-neuronal level, traumatic experience is likely to lead to *epigenetic* changes that may even be inherited, and to *neuroplastic* modifications in the brain ([22], [26]).

Prepotent beliefs are often linked directly or indirectly to *repressed* preferences and aversions (the term 'preferences' is commonly used inclusively to cover aversions too)

that generate propensities in the mind such as desires, cravings, yearnings, fantasies, social aberrations, and so on; these repressed propensities are the result of pervasive *conflicts* between our preferences and the social restraints operating on us that arise in the interest of smooth continuation of our social life.

> Conflicts of multifarious types are ubiquitous in complex systems. The mind harbors a vast range of conflicting preferences, beliefs, drives, and desires many of which are, of necessity, *repressed* so that these may not lead to disruptive effects in the existence of individuals and social communities (see, for instance, [14], [12]).

The revision of prepotent beliefs is rare in a lifetime (or in a generation in the case of a community); it requires an engagement with our deeply entrenched affect-ridden propensities, many of which are repressed in the mind; this, in turn requires an engagement with the *self* of an individual or with the collective self of a community. An individual confronts her own self only rarely and that too in unpredictable ways. The ceaseless interaction of an individual with her milieu creates junctures that arise unpredictably and in strange ways when she suddenly feels the need of self-introspection and a thorough encounter with her repressed propensities, where these juncture are indicative of the phenomenon of *emergence* in the joint evolution of two complex systems—her mind on the one hand and her interface with reality on the other ([14]). The more thorough the encounter, that much more of her prepotent beliefs get revised.

At times, an individual or a social community may feel *compelled* to look at the hidden propensities that generate emotions restraining the prepotent beliefs. Such compulsion may arise in momentous junctures in the life of an individual or a social community—for instance, in the case of a businessman swindled by his long-standing friend and facing insolvency, or of an errant husband left all alone in a vacant house as his wife suddenly moves away so as to live in separation, or even of a vanquished race or nation facing utter collapse. One may also imagine an aged scientist trying hard to convince his young colleagues of the logical errors in a newfound theory while he eventually looks at his own beliefs about the nature of reality and is compelled to admit that a new interpretation is necessary for him to come to terms with the emerging theory.

In the event of revision of a set of prepotent beliefs, there occurs a radical and precipitous passage through an instability (in the relevant part of the belief network) after a protracted phase of stability; such revision results in a momentous transformation of a large chunk of the world-view of a person—she begins to view the world in a different light; indeed, the revision of a set of prepotent beliefs is often accompanied by something like a domino effect where a large number of beliefs represented by relatively small clusters in the belief network get revised. In other words, the revision of prepotent beliefs results in a marked *restructuring* of the belief network—one that gives it the stamp of an emergent phenomenon.

10 Belief revision: concluding words

The revision of beliefs is fundamentally a complex process, much as the one of belief formation is. Beliefs are lodged in the mind at the interface of affect and reason or, equally significantly, at the interface of unconscious and conscious cognition—one can as well say that beliefs are at the interface of our affect-driven evolutionary past and our rationality driven journey to the future. There are diverse and contrary factors in operation as beliefs are generated and revised. No single systematic account of belief revision is adequate in describing and explaining all the multifarious aspects of the process of belief revision—one of great relevance in human existence.

> *Unconscious cognition* is mostly through affect, but also to some extent through the involvement of proto-concepts, where the latter are rudimentary concepts generated by limited sets of correlations between percepts registered in the unconscious layer of the mind. It is mostly by means of proto-concepts that non-human animals respond to reality.

It is not enough to say that belief revision is fundamentally based on a tension between affect-emotions on the one hand and reality on the other—the natural reality, social reality, and the reality of our own selves.

> All these three aspects of reality are intertwined in a vastly complex composite whole.

Indeed, our repertoire of beliefs spans a huge spectrum when looked at from any one of several alternative points of view, and accordingly, it is not well described in terms of a neat taxonomy. Parts of the belief network have a hierarchical structure while other parts are more messy and tangled. Beliefs are formed piecemeal in the course of life's journey to give us orientation—*locally* in space and time in the context of thousand and one little experiences in life and *globally* too in our attempt at acquiring *meaning* in our existence in a vast and incomprehensible universe.

In the resulting complexity of the belief network (our great web of beliefs) the pushes and pulls generated by affect-emotions and by the impact of reality operate in diversely distinct modes in the various different parts of the network, whose overall dynamics is exquisitely intriguing and obscure. Still, it is of considerable use to understand the existence of various time scales in the revision of beliefs as these correspond to diverse size of clusters in the network, to diverse modes of association with affect and emotions, and to diverse types of influence exerted by the reality we are embedded in.

> In the case of formation and revision of any particular belief (or a belief cluster), there are three time scales involved in the entire process, beginning with the formation and ending up with revision: the time scale of formation, the time scale of justification (the process of justification may be thwarted at an early stage because of emotional involvement), and that of revision; the life history of the belief depends to a considerable extent on the relative magnitudes of these time scales. Commonly, the time scale of formation is the shortest of the three.

There exists an account of belief revision based on *rationality*, where one adopts a logical explanation making use of the Bayesian framework of inference. However, this approach ignores the fundamental fact that the idea of rationality has two sides to it—the one of affect and emotions on the one hand and that of reason on the other.

> The rationality-based theory of decision making is an analogous one in that it too does not explicitly take into account the role of affect in the making of decisions, large and small. Our response to reality is fundamentally based on the making of inferences and decisions. Decisions are involved in our personal interactions and in momentous economic deals too, where choices are to be made at every step and turn. Choice between disparate entities always involves affect that provides for a 'common currency' in comparing those entities. For background, see [14], [3].

There is literally nothing in human existence that can be accounted for by being oblivious of the fundamental role of affect. Affect, indeed gives a whole new dimension to the concept of rationality. The truly rational account of belief revision recognizes this dual aspect of the process—one where affect-emotions and reason are intertwined in a strange admixture of 'love' and 'hate'. It is a process possessed of great complexity—but we have to recognize what this complexity consists of so that we can begin to make sense of our own existence in this vastly chaotic and obscure world.

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